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SADRŽAJ

DEAR READER,

This issue comprises scientific papers written by researchers from 13 countries, with research topics from the field of sports and a diverse population, providing a variety of content in this issue. New values are also promoted in this issue through research results from the areas of sports management, sports training, sports psychology, sports medicine, sports education, and sports marketing. We have received a multitude of papers and are grateful to everyone who has recognised our journal as the medium of promoting new scientific and professional achievements, the results of which will contribute to the performance of sports results.

Considering the multitude of submissions we received, the Editorial Board had a great responsibility in selecting papers for this issue. We would like to express our gratitude for the professional approach in which the quality of the work conducted by the authors represents a priority and a requirement for publishing papers in our journal.

We are glad that our journal continues to be a platform for the development of scientific thought and creation of new sports systems accompanied by the usage of advanced technology and its application in the field of sports. Continuous changes and novelties in sports disciplines, application and usage of new equipment, adaptation of the environment to different needs of athletes, the appearance of new techniques that keep up with new technologies, and many other factors affect the constant need for monitoring, researching and detecting obstacles that stand in the way of accomplishing the best results. We are witnessing the effects of the Covid-19 pandemic which has imposed other organisational forms for training processes, sports competitions and the functioning of sports systems, affecting the result achievements and creation of new values which will improve the sports system.

That is precisely why our journal is a platform for modelling and presenting results which will be applied in practice. Understanding new technologies in sports is a need and a requirement without which it is not possible to monitor and strive towards successful, top results. Promoting the results through papers in our journal is not only the fastest way to reach our readers, but also an obligation to maintain trust and the quality that will satisfy the readers' needs and expectations.

Wanting to make each issue different from the previous one, we strive to include an increasing number of authors from different sports environments, which can be seen in the issues at hand.

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

Nihad Selimović, MD, MSc
Editor in chief

DRAGI ČITATELJU,

U ovom broju nalaze se naučni radovi istraživača iz 13 zemalja sa tematikom istraživanja u oblasti sporta i različitom populacijom, a što je dalo raznovrsnost sadržaja ovog broja. Nove vrijednosti su i u ovom broju promovisane kroz rezultate istraživanja iz oblasti sportskog menadžmenta, sportskog treninga, sportske psihologije, sportske medicine, sportske edukacije i sportskog marketinga. Primili smo veliki broj radova i zahvalni smo svima koji su prepoznali naš časopis kao medij promocije novih naučnih i stručnih dostignuća čiji će rezultati doprinijeti uspješnosti sportskih rezultata.

Recenzentski odbor je imao odgovoran zadatak da napravi odabir radova za ovaj broj s obzirom na veliki broj pristiglih prijava. Zahvaljujemo se na profesionalnom pristupu u kojem je kvalitet autorskog djela prioritet i uslov za objavljivanje rada u našem časopisu.

Sretni smo što se naš časopis održava kao platforma za unaprjeđenje naučne misli i stvaranje novih sportskih sistema uz korištenje napredne tehnologije i njene primjene u oblasti sporta. Stalne izmjene i novine u sportskim disciplinama, primjena i korištenje nove opreme, prilagođavanje okruženja prema različitim potrebama sportista, pojava novih tehnika koje prate nove tehnologije i mnogo drugih faktora, utiču na stalnu potrebu za praćenjem, istraživanjem i otkrivanjem prepreka koje stoje na putu ostvarivanja najboljih rezultata. Svjedoci smo posljedica pandemije Covid-19 koja je nametnula neke druge oblike organizacije trenažnih procesa, sportskih takmičenja i funkcionisanje sportskih sistema koji su uticali na rezultatska dostignuća i stvaranje novih vrijednosti koje će unaprijediti sportski sistem.

Upravo zato je naš časopis platforma za modeliranje i prezentaciju rezultata koji će svoju primjenu naći u praksi. Poznavanje novih tehnologija u sportu je potreba i uslov bez kojeg nije moguće pratiti i težiti
ka uspješnim, vrhunskim rezultatima. Promovisanje rezultata preko radova u našem časopisu je najbrži put do naših čitatelja, ali i obaveza da održimo povjerenje i zadržimo kvalitet koji će zadovoljiti potrebe i očekivanja čitatelja.

Želeći da svaki broj bude drugačiji od predhodnog, nastojimo da uključimo što više autora iz različitih sportskih okruženja, a što se može vidjeti kroz izdanja koja su pred vama.

Pozivamo Vas, čitatelje, da budete dio našeg tima i da učestvujete u našem radu kako bi svi zajedno doprinosili kvalitetnom trendu i promjenama u svijetu sporta.

Mr. sci. dr. Nihad Selimović

SPECIALISATION AND INJURY RISK IN DIFFERENT YOUTH SPORTS: A BIO-EMOTIONAL EDUCATIONAL APPROACH

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ABSTRACT

Aims: Sport specialisation is an actual trend in youth athletes, but it can increase injury risk. The aim was to determine the possible correlation between sports specialisation and injury risk in various sports using a biopsychosocial approach. Methods: 169 sport-specialised athletes [(38 female, 131 male); (11.2 ± 2.7 years); (56.28 ± 15.72 kg); (161.3 ± 15.52cm)] completed a self-reported questionnaire regarding sociodemographic (age, gender, educational level), physical-attitudinal, injury and psychological-attitudinal aspects. A univariate and correlate analyses were used to analyse the data. Results: Out of 169 enrolled athletes, 53% were single-sport specialised (reported participation in one sport and trained > 8 months/year). In team sports (100%, OR = 0.75; p = .022), a high risk of having to remain at rest for up to 1 month because of overuse was observed. Males who suffered direct trauma (70%; OR = 1.03; p = .006) in the team group (95%, OR = 0.09; p = .008) were more exposed to that type of injury, and also the type of specialisation figured significantly (p = .047). In addition, interoceptive awareness correlates with injury (95%, 1.04, p = 0.01). Conclusions: Athletes in team sports are more specialised, have higher training volumes and greater rates of injuries correlated with interoceptive awareness than in individual sports.

Keywords: injury risk, sport specialisation, youth sports, adolescent, educational approach

INTRODUCTION

Sport specialisation is an actual trend among young athletes, but it can increase the risk of injury [1, 2]. This sport specialisation refers to a year- or nearly a year-round commitment to one sport to the exclusion of others [3], and it is becoming increasingly prevalent among pre-adolescent and adolescent athletes [4].

This trend could be driven by a large number of factors, such as an overall decrease in unstructured physical activity (i.e., "free play"), an increase in structured activity among youth [5], increased pressure on young athletes to excel in sport [6] but also the potential economic benefit of success in sports (e.g., college scholarships, elite achievement or high professional sports salaries) [7].

As a result, there is concern that there will soon be more young athletes becoming specialised at an earlier age [8], and this could lead to negative effects in these athletes, including psychological burnout and an increased risk of musculoskeletal injuries [9]. Specialised athletes typically engage in a large amount of sport-specific training throughout the year, which is intensive, often technical or otherwise specific [10, 11]. As a result, sport specialisation has been associated with an increased risk for injuries of overuse. Training volume is thought to be important

because intense, year-round participation in the sport of choice is a particularly concerning factor of specialisation [12]. Training volume recommendations commonly cited in literature relate to months of the year and hours of organised sports participation per week. It is recommended that children and youth who participate in organised sports should not practice the same sport for more than 8 months a year, no more hours per week than their age (i.e., an athlete of 13 years of age should not participate in organised sports for more than 13 hours per week), and no more than 16 hours per week in total [13]. Very little research is concerned with the influence of the emotions on injuries in young and specialised athletes. There are at least a dozen models that try to establish a connection between psychological antecedents and the occurrence of sports injuries. In fact, personality, anxiety, hardiness, life event stress, achievement motivation, and also interoceptive awareness (IAw) all seem to be particularly related to injury outcome [14]. Interoception has been classically conceived to be the maintenance of an optimal physiological balance in the body — the homeostasis of the physiological system — through autonomic, neuroendocrine, and behavioural responses. Interoception also means one's sense of the physiological condition of the body, and provides a basis for subjective feelings and emotions [15]. Many studies have suggested that individuals having a stronger interoceptive ability report more intense emotions [16], place more emphasis on the dimension of arousal in reporting their emotional experience [17], and manifest a stronger link between their bodily reactions to emotional stimuli and their subjective arousal ratings.

The aim of the present study was to determine whether there is an association between the risk of injury in young athletes (7-18 years of age) and factors related to specialisation, IAw and the physical well-being of young athletes.

METHODS

PARTICIPANTS

A cross-sectional study was conducted. The sample was composed of young athletes who practiced various individual and team sports, including basketball, volleyball, soccer, taekwondo, and judo. These volunteer athletes were from Southern Italy and were recruited during tournaments, competitions and summer training sessions. Eligible participants were between the ages of 7 and 18 and were those who had practiced organised sports during the previous 12 months. Parental consent was obtained for each participant under the age of 18. The study was approved by the Local Ethics Committee and was performed in accordance with the Declaration of Helsinki.

MEASUREMENTS

A questionnaire filled in by each athlete was used for data collection. This tool had been composed with the participation of an interdisciplinary team, including orthopaedic surgeons, physical therapists, athletic trainers, training academy instructors, and epidemiologists.

The questionnaire consists of four sections: sociodemographic (age, gender, educational level), physical-attitudinal, injury (recall and description) and psychological-attitudinal. The physical-attitudinal section includes the following information: months of participation in the primary sport and in organised sports in total per year; average weekly hours of participation in the primary sport during the first sporting season; total average weekly hours in organised sport, average weekly hours in unorganised sport (gymnastics lessons, playing with friends, etc.), and competitions (national, international). Based on their responses, the athletes were classified according to their self-described level of specialisation (high, medium, low) [1] and type of sport practiced (individual and/or team) [18].
The Pittsburgh Sleep Quality Index (PSQI), a self-reported scale using the "global score" [19], was used to assess the sleep quality of the athletes. The PSQI is the most commonly-used retrospective self-assessment questionnaire which measures the quality of sleep of an individual during the previous month. The questionnaire assesses seven clinically derived domains of sleep difficulties (sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction). All of these sleep domains are evaluated as a single factor for overall sleep quality. Usually, an overall score greater than 5 in at least two components indicates a significant sleep disorder, while an overall score of less than 5 in at least 3 components is an indication of good-quality sleep.
The CIGAS questionnaire was adopted in order to classify injuries [20] and is an Italian version of the questionnaire published by Pasulka et al. [1]. The tool includes a preliminary question ("Do you recall any injuries? yes/no") followed by 12 questions on the history of the injury. The questionnaire defines the following: athletes who have been injured (yes/no), athletes who have had to rest after a sports injury (< 1 month of rest from overuse/at least 1 month of rest from serious overuse), and whether athletes had sustained a direct or indirect injury.

The last section on psychological-attitudinal characteristics includes the following validated questionnaires: the Emotion Awareness Questionnaire (EAQ) [21], the Multidimensional Assessment of Interoceptive Awareness (MAIA) [22]

and the Awareness Interoceptive Scale (AIS) [23].

The EAQ is made up of 30 items and identifies how children or adolescents feel and what they think about their feelings. The current version uses a six-factor structure that describes six aspects of emotional functioning, that is, Differentiating Emotions, Verbal Sharing of Emotions, Bodily Awareness of Emotions, Acting Out Emotions, Analyses of Emotions, and Attention to Others' Emotions. Some items are formulated negatively and therefore have inverse scoring. Participants are asked to rate how true each element is for them on a three-point scale (1 = not true, 2 = sometimes true, 3 = often true).

The MAIA questionnaire is composed of 32 items on a 6-point Likert scale in which the participant has to rate "how often each statement applies to you generally in daily life," with ordinal responses coded from 0 ("never") to 5 ("always"). This instrument measures the IAw on the following eight scales: (1) Noticing, which measures the awareness of one's bodily sensations; (2) Not-distracting, which measures the tendency to avoid ignoring or distracting oneself from sensations of pain or discomfort; (3) Not-worrying, which measures the tendency to avoid experiencing emotional distress or worry with sensations of pain or discomfort; (4) Attention regulation, which measures the ability to sustain and control attention to bodily sensations; (5) Emotional awareness, which measures the awareness of the connection between bodily sensations and emotional states; (6) Self-regulation, which measures the ability to regulate psychological distress by attention to bodily sensations; (7) Body listening, which measures the tendency to actively listen to the body for insight; and lastly (8) Trusting, which measures how much the experiences of one's body are perceived as being safe and trustworthy.

Interoceptive Awareness: To assess IAw and to specifically investigate in what manner and with what frequency subjects feel signals arising from their own body, we used an extended version of the "'How do you feel?' questionnaire" [24]. The questionnaire included 35 items to be rated on a 5-point Likert scale (0 = never; 1 = sometimes; 2 = often; 3 = very often; 4 = always). The total score ranges from 0–140, with higher scores meaning a higher IAw.

The questionnaires were given on site at each athletic event and took approximately 15 minutes to complete.

ANALYSIS

The statistical analysis was performed using the software package SPSS 25.0 for Windows.
A descriptive analysis of the study participants' sociodemographic characteristics was carried out. Descriptive statistics were determined using absolute frequencies and percentages for categorical variables, while for the quantitative variables, we used the mean values with standard deviation (SD) and with minimum, medium and maximum values.

The associations among the sociodemographic factors, physical-attitudinal characteristics, injuries (recall and description) and psychological-attitudinal aspects were all evaluated. The differences between the results of the various groups — that is, self-referred (yes/no), serious overuse (yes/no) and direct injury (yes/no) — as compared to categorical variables, were analysed using the Chi-square test or Fisher Exact test. The Mann-Whitney test was used to evaluate the significant associations for the continuous variables. The Odds Ratios (ORs) with corresponding Confidence Intervals at 95% (95% CI) were calculated in order to estimate the risk of injury for dichotomous variables. Three multivariate logistic regression models were established in order to study the outcomes: referred injuries (yes/no), serious overuse (yes/no) and direct injury (yes/no). The inclusion of any covariate in the models was decided on the basis of the univariate analysis (p value lower than 0.25). The 'stepwise' passage of inferential statistics with backward elimination of non-significant variables (probability to entry p 50.05) was subsequently used to generate a minimal model. The suitability of fit for the models was assessed by means of Hosmer and Lemeshow's test [25]. Statistical significance was set at $p < 0.05$.

RESULTS

Participants' characteristics

Out of the 199 participants enrolled in the study, 168 provided satisfactory data for the analysis and successfully completed the questionnaire. Out of these, 38 were female (23%) and 131 male (77%); their ages were 11.2 ± 2.7 years, their weight was 56.28 ± 15.72 kg, and their height was 161.3 ± 15.52 cm. Table 1 shows the characteristics of the sample.

There were 139 (82%) athletes engaging in team sports, and 30 in individual sports; 93% reported training for more than 8 months a year. A high degree of specialisation was reported by 49.1% of the athletes (n = 169), but only 52% (n = 87) of them said that they practiced a single sport for fewer than 4 days/week and for more than 3 years (Table I a).

Qualitative Variables		N (tot 169)	%
gender	M	131	77
	F	38	22
Educational qualification	No.	15	13
	elementary school	36	21
	middle school	69	41
	secondary school	43	25
Sport	individual	30	18
	team	139	82
years of sport	< 3 years	82	48
	> 3 years	87	52
No. of days of training/week	< 4 days/week	151	89.3
	> 4 days/week	16	9.5
	missing	2	1.2
No. of months of training	< 8 months	12.0	7.0
	> 8 months	157.0	93.0
competitions	no	68	40
	yes	101	60
national competitions	no	71	42
	yes	98	58
international competitions	no	100	59
	yes	69	41
specialisation	low	11	6.5
	medium	75	44.4
	high	83	49.1
Self-referred injury	no	71	42.0
	yes	98	58.0
Rest from sports due to injury *	< 1 month of rest from sports (overuse)	81	82.7
	at least 1 month of rest from sports (serious overuse)	17	17.3
Type of injury	direct	67	68.4
	indirect	29	29.6
	missing	2	2.04
change in last week	hours training	49	29.0
	new technique	26	15.4
	new equipment	8	4.7
	missing	86	50.9
where do you have breakfast?	home	154	91.1
	school, office	1	0.6
	bar, fast food	9	5.3

	other	2	1.2
	missing	3	1.8
where do you have lunch?	**home**	121	71.6
	school, office	13	7.7
	bar, fast food	17	10.1
	other	3	1.8
	missing	15	8.9
where do you have snacks?	**home**	118	69.8
	school, office	5	3.0
	bar, fast food	11	6.5
	other	4	2.4
	missing	31	18.3
where do you have dinner?	**home**	131	77.5
	bar, fast food	11	6.5
	pizzeria, ristorante	15	8.9
	other	1	0.6
	missing	11	6.5
do you use supplements?	**no**	144	85.2

Table I a : Description of the qualitative variables of the sample.

A greater percentage of athletes (58%) reported injuries, with 68.4% (N = 67) reporting a direct type of injury and having to stop sports for up to 1 month during the year. Injured athletes had higher sports specialisation scores. As for eating habits, 91.1% (N = 154) reported eating breakfast, 71.1% (N = 121) said they have lunch, 69.8% (N = 118) have a snack, and 71.6% (N = 121) have dinner at home. Supplements were avoided by 85.2% of the athletes (N = 144). The self-reported sleep-quality data showed a low value for the PSQI_sum (3.1 ± 1.8) (Table 1 b). The emotional aspects of the study showed that all MAIA questions received a high value, particularly in "attention regulation" (16.0 ± 5.8) and "emotional awareness" (12.1± 4.7). The total IAw score was average (41.0 ± 19.2), and the eight different evaluation scales can be seen in Table I b.

Quantitative variables	Tot	mean	SD	med	min	max
age (years)	169	(tot 169) 11.2	2.7	10.0	7.0	18.0
weight (Kg)	126	(tot 126) 56.3	15.7	56.0	28.0	96.0
height (cm)	131	(tot 131) 161.3	15.5	163.0	127.0	207.0
MAIA _noticing	169	9.3		9.3	0.3	63.0
MAIA_not distracting		3.1	1.3	3.3	0.0	4.7
MAIA _not worrying		3.4	1.7	3.3	0.0	16.0

MAIA _attention regulation		16.0	5.8	15.6	3.3	30.7
MAIA_emotional awareness		12.1	4.7	11.4	1.2	21.0
MAIA_self regulation		8.3	3.3	8.3	0.0	16.3
MAIA_body listening		5.9	2.6	5.7	0.0	11.7
MAIA_trusting		7.3	3.2	7.0	0.0	11.7
PSQI_sleep quality	167	0.6	0.6	0.0	0.0	3.0
PSQI_latency	169	0.6	0.7	0.0	0.0	3.0
PSQI_duration	166	0.3	0.5	0.0	0.0	2.0
PSQI_efficacy	165	0.2	0.5	0.0	0.0	3.0
PSQI_disturbances	169	1.0	0.4	1.0	0.0	2.0
PSQI_hypnotics use	163	0.0	0.3	0.0	0.0	2.0
PSQI_day disturbances	169	0.4	0.6	0.0	0.0	2.0
PSQI_sum	169	3.1	1.8	3.0	0.0	10.0
Awareness Interoceptive Scale (AIS) total score	168	41.0	19.2	38.0	8.0	140.0
Differentiating emotions (EAQ)	143	2.0	0.4	2.0	1.0	3.0
Verbal sharing of emotions (EAQ)		2.1	0.5	2.0	1.0	3.0
Not hiding emotions (EAQ)		2.0	0.5	2.0	1.0	3.0
Bodily awareness of emotions (EAQ)		2.0	0.4	2.0	1.0	3.0
Attending to others' emotions (EAQ)		2.1	0.4	2.0	1.0	3.0
Analyses of (own) emotions (EAQ)		2.0	0.4	2.0	1.0	2.8

Table I b. Description of the quantitative variables of the sample

Surveys: risk of injury

The Univariate analysis, adjusted for gender, type of sport, national and international competitions, specialisation, and years of attendance in sports, showed that high specialisation for "reported injuries" is not a risk factor, but the difference was not statistically significant (82%, p = 0.214). The athletes who had been training for more than 3 years (70%, OR = 2.5; p = 0.003) or who participate in national competitions (70%, OR = 2.5; p = 0.005) turned out to be more exposed to risk (Table II).

Variables		***Referred injures***				***Rest from sports due to injury***				***Type of injures***			
		No	**Yes**			**< 1 month of rest from sports (overuse)**	**> 1 month of rest from sports (serious overuse)^**			**Indirect**	**Direct**		
		N (%)	**N (%)**	**p**	**OR**	**N (%)**	**N (%)**	**p***	**OR**	**N (%)**	**N (%)**	**p***	**OR**
gender	***F^***	11 (29)	27(71)	**0.064***	0.48	21 (78)	6 (22)	0.432	0.64	19 (70)	8 (30)	**0.006**	1.03
	M	60 (46)	71 (54)			60 (84)	11 (16)			48 (70)	21 (30)		
Sport	***individual***	61 (44)	78 (56)	0.288*	1.56	61 (78)	17 (22)	**0.022**	0.75	49 (64)	28 (36)	**0.008**	0.09
	team^	10 (33)	20 (67)			20 (100)	0 (0)			18 (95)	1 (5)		

national competition	***NO^***	39 (55)	32 (45)	**0.005°**	2.51	28 (87)	4 (12)	0.378	1.71	24 (75)	8 (25)	0.432	1.46
	YES	32 (33)	66 (67)			53 (80)	13 (20)			43 (67)	21 (33)		
international competition	***NO^***	45 (45)	26 (38)	0.428*	1.35	45 (82)	10 (18)	0.805	0.87	37 (67)	18 (33)	0.534	0.75
	YES	55 (55)	43 (62)			36 (84)	7 (16)			30 (73)	11 (27)		
Specialisation	***low***	2 (18)	9 (82)			8 (89)	1 (11)			8 (89)	1 (11)		
	medium	32 (43)	43 (57)	0.214*	-	38 (88)	5 (12)	0.271	-	24 (57)	18 (43)	**0.047**	-
	high	37 (45)	46 (55)			35 (76)	11 (24)			35 (78)	10 (22)		
> 3 training years	***NO^***	44 (54)	38 (46)	**0.003***	2.57	3 (84)	6 (16)	0.746	1.20	30 (81)	7 (19)	0.056	2.54
	YES	27 (31)	60 (69)			49 (82)	11 (18)			37 (63)	22 (37.3)		

Table II. Univariate analysis in "referred injury", "rest from sport due to injury" and "type of injury"

In team sports (100%, OR = 0.75; p = .022), a high risk of having to remain at rest for up to 1 month because of overuse was observed. Males who suffered direct trauma (70%; OR = 1.03; p = .006) in the team group (95%, OR = 0.09; p = .008) were more exposed to that type of injury, and also the type of specialisation figured significantly (p = .047) (See Table 2).

The anthropometric variables such as age (p = .007), weight (p = .007) and height (p = .007) were significant in the cases of self-referred injuries (self-referred traumas, not those derived from the patient's records), while these athletes had significant mean PSQI scores of 3.1 ± 1.8; p = .007 (Table I b). However, 3 variables of Emotional awareness were also noteworthy, namely, "body awareness of emotion" (EAQ) (p = .007), "attending to others' emotions" (EAQ) (p = .012) and "analyses of emotion" (EAQ) (p = .016). Only the variable "verbal sharing of emotions" (EAQ) (p = .002) was significant in cases of rest from sport because of the injury. Regarding the type of injury, the MAIA variables "noticing" (p = .061) and "not distracting" (p = 0.016) are as significant as those of "sleep quality" (PSQI) (p = .050).

Athletes who had had more than 3 years of training had a 19.79 times greater risk of sustaining a "self-referred injury", of belonging to the "medium-specialised" category (OR = 7.61; 95% CI: 1.4 - 41.4; p = .456), and of being more sensitive to the emotions of others ("attending to other's emotions" [EAQ]) (OR = 42.21; 95% CI: 3.6 - 487.9; p = .456). If the athlete was a male (OR = 4.60; 95% CI: 0.01 - 1.56; p = .456) and had a high "bodily awareness of emotions" score (OR = 0.02; 95% CI: 0.001 - 0.34; p = .456), he was at less risk of injury (Table III a).

Covariates	**Referred injures**		
	OR	**CI95%**	
		inf	**sup**
gender (M/F^)	0.4	0.1	1.56
age (years)	1.14	0.71	1.84
weight (Kg)	0.98	0.88	1.09
height (cm)	0.97	0.91	1.05
national competition (Y/N^)	1.37	0.76	2.4
> 3 training years (Y/N^)	**19.79**	**3.38**	**116.1**
high specialisation (Y/N^)	1.28	0.03	48.08

middle specialisation (Y/N^)	**7.61**	**1.4**	**41.45**
MAIA not worrying	0.95	0.68	1.33
PSQI	0.82	0.46	1.47
Verbal sharing of emotions (EAQ)	0.27	0.04	1.71
Not hiding emotions (EAQ)	**1.05**	**0.091**	**12.1**
Bodily (abod) awareness of emotions (EAQ)	**0.02**	**0.001**	**0.34**
Attending to others' emotions (EAQ)	**42.21**	**3.65**	**487.95**
Analyses of (own) emotions (EAQ)	1.37	0.16	11.54
Awareness Interoceptive Scale (AIS) total score	1.01	0.97	1.05
Hosmer and Lemeshow test p-value	0.456		

III Table a

Similarly, athletes with a high MAIA score on "not_distracting" (OR = 0.64; 95% CI: 0.41 – 1.00; p = .300) and weight factor (OR = 0.95; 95% CI: 0.91 – 1.00; p = .456) had less of a possibility of having to stay at rest from sports for up to 1 month because of overuse. Athletes with a low PSQI (indicating sleep disturbances) had 1.36 times the odds of being exposed to overuse (table III b).

Covariates	**Rest from sports due to injury**		
	OR	**CI95%**	
		inf	**sup**
MAIA not distracting	**0.64**	**0.41**	**1.00**
Verbal sharing of emotions (EAQ)	0.36	0.05	2.36
Bodily awareness of emotions (EAQ)	0.20	0.04	1.11
weight (Kg)	0.95	0.91	1.00
PSQI	1.36	0.90	2.07
Hosmer and Lemeshow test p-value	0.300		

Table III b

The third model of regression analysis showed that athletes who had more than 3 years of training (95% CI: 1.06 – 19.9; p = .476) had a 4.60 greater chance of sustaining a direct or indirect trauma ("type of injury") and, similarly, athletes having a high level of "analyses of emotion risk" had a 5.38 times greater chance (Table III c).

Covariates	**Type of injury**		
	OR	**CI95%**	
		inf	**sup**
gender (M/F^)	1.50	0.26	8.57
weight (Kg)	0.98	0.93	1.03
> 3 training years (Y/N^)	**4.60**	**1.06**	**19.94**
high specialisation (Y/N^)	0.42	0.12	1.46
middle specialisation (Y/N^)	1.12	0.05	24.13
MAIA trusting	1.13	0.89	1.44
MAIA distracting	**0.59**	**0.38**	**0.91**
PSQI	1.45	0.99	2.12
MAIA noticing	0.96	0.89	1.04
Not hiding emotions (EAQ)	2.20	0.41	11.80

Bodily awareness of emotions (EAQ)	0.25	0.06	1.01
Analyses of (own) emotions (EAQ)	**5.38**	**1.18**	**24.57**
Hosmer and Lemeshow test p-value	0.476		

Table III c

DISCUSSION

Although some studies have suggested that, regardless of the age and amount of training of young athletes, sports specialisation alone can increase the overall risk of serious injury from overuse, our data suggests that specialisation in a single sport or early specialisation in the sport cannot be considered as factors of risk for young athletes. Moreover, defining sports specialisation along a continuum (low, moderate, high) may be useful for studying and quantifying the risk of injury.

The first descriptive analysis that we carried out showed that 93% of team athletes have been training for more than 3 years, and that 49% are highly specialised because they have been training for more than 3 years, more than 4 days a week. Nonparametric univariate analysis showed that high specialisation is not a risk factor for reported injuries. But, if young athletes (> 12 years old) play team sports for more than 3 years, they are more likely to be injured. In the present study, mid-level athletes showed a greater risk of injuries, even serious ones due to overuse, equal to those who have been training for more than 3 years, while the risk is lower for athletes practicing individual sports. Several authors have argued that there is an independent risk of injury in young athletes specialising in a single sport [3, 1] as well as in elite young athletes [26]. Since the self-reported age of specialisation is similar for all involved subjects, it is not possible to determine whether the risk of injury is different for those who specialised at a younger age than for those at an older age. Long-term longitudinal studies are needed in which a younger population of specialised athletes is compared to diversified athletes in order to determine whether there is specific starting age that could reduce the risk of injury [3]. Based on the data, sleep [27, 28] and nutrition were the two biological variables to be linked to the emotional and psychological status of the athletes. Experiencing poor sleep quality has important implications including potentially impaired physiological and cognitive recovery, increased physical and mental health consequences, an increased risk of injury, and compromised performance outcomes [29-32]. The sleep health of individual- and team-sports athletes is generally poorly understood, including sleep quality and sleep duration, and how their functioning is affected outside the laboratory in the context of psychological, emotional, and physical demands that are present during a competitive season. Current data show that athletes generally sleep well, but the PSQI_sum is related to referred injury and direct sport type. Regularly obtaining PSQI_sum results scores of less than 5 means a 1.3 times greater risk for direct injury than athletes who have reported "referred injuries" or injuries resulting from overuse.

These findings suggest that the additional factors associated with sports specialisation increase the risk of injury. It has been reported in literature that significant psychological factors capable of predicting the occurrence of sports injuries include the following: somatic trait anxiety [33], mistrust [34], negative life-event stress and negative coping abilities [35]. However, it must be noted that the investigation of an athlete's psychological-attitudinal emotional status is a new field of research [36]. Interoception research typically distinguishes between interoceptive sensitivity (IS) and interoceptive awareness (IAw). Interoceptive sensitivity (IS) describes the objective detection of internal bodily sensations through behavioural measures, such as heartbeat perception tasks, while interoceptive awareness (IAw) refers to self-reported detection of internal bodily sensations using questionnaire-based measures [37]. Our descriptive analyses revealed significant scores on two of the eight MAIA scales, namely Emotional awareness and Attention regulation, which were high. Linear regression analyses further clarified the specific contribution of each MAIA scale by explaining the variability between participants. High scores on the "Not worrying" (tendency not to worry or experience emotional pain in the presence of physical pain) or "Feeling of discomfort" sections on the MAIA scale was a protective factor towards the self-referred injury and was linked to "Attending to others' emotions" (EAQ). Thus, participants who reported being more prone to feeling emotional distress or worry in response to negative body sensations (i.e., with a low score in the "Not worrying" scale) also reported being more likely to pay attention to others' emotions ("Attending to others' emotions") (EAQ), as the highest scores show. This result suggests there is a close connection between these two constructs, which makes sense, because both are related to measures of emotion. A high score on the MAIA variable "not distracting" (Tendency to avoid ignoring or distracting oneself from feelings of pain or discomfort) reduced the probability of having

to stop engagement in sport for more than 1 month due to injury by half. The second linear logistic model shows that those who had high scores on "Verbal sharing of emotions" (EAQ) and "Bodily awareness of emotions" (EAQ) had a lower risk of having to stop their sporting activities. So a good IAw has been shown to protect against overuse and severe overuse injuries. Two specific aspects of IAw independently contributed to explaining the variability in athletes. The IAw score on "Bodily awareness of emotions" was higher in the non-injury group, while the variable "Attending to others' emotions" was higher in the group with self-referred injuries. The "Analyses of (one's own) emotions" variable had a higher score for the type of injury; therefore, those who knew their emotions well were more at risk of direct injury. Research on health, social, and sport injury suggests that emotional awareness support has the potential to moderate those psychological responses to injury that are detrimental to athletes' health and well-being. Despite growing empirical research on the role of stress and psychological distress in sports injuries, there is a lack of study on emotional awareness and interoceptive functions in relation to responses to injury. The present work provides support for the functional aspects of the prevention of injury-related stress factors and is important for identifying possible interventions that might be useful for accelerating a positive return to sport in injured young athletes. It also has important implications for interventions that could aim at expediting an injured young athlete's successful return to sport. All these factors can and should be discussed with one's local sport technical and medical staff.

LIMITATIONS

Our study has several limitations. It is not population-based and therefore cannot provide real incidence rates for injuries in highly-skilled versus moderately-skilled versus low-skilled athletes, particularly in non-Italian populations. When defining sports specialisation using the three-point scale, it is important to take into account those athletes who have only participated in one sport. The wide variety of sports reported by participants in the present study does permit the inclusion of sport type in regression models. Since only self-referred injuries have been included, the number of overuse injuries could be an underestimation. The association between overuse injury and specialisation and training in specific sports needs to be further evaluated in order to provide sport-specific recommendations for injury prevention. The specific psychological factors of burnout, anxiety and pressure were not evaluated in our study, but the fact that they do interact with the incidence of injury in specialised young athletes is suggestive.

CONCLUSION

This study shows that, even though young athletes seem to be at a high risk of becoming injured, early team sport specialisation and a high performance level cannot be considered to be the only risk factors. Longitudinal studies that follow large cohorts of athletes in each type of sport are necessary in order to better understand the relationships between sports specialisation, sports type, injury risk and emotional and interoceptive status.

REFERENCES

1. Pasulka, J., Jayanthi, N., McCann, A., et al. (2017). Specialization patterns across various youth sports and relationship to injury risk. Phys Sportsmed, 45(3):344-352.
2. Post, E. G., Trigsted, S. M., Riekena, J. W., et al. (2017). Association of Sport Specialization and Training Volume With Injury History in Youth Athletes. Am. J. Sports Med., 45(6):1405-1412.
3. Jayanthi, N. A., Pinkham, C., Dugas, L., et al. (2013). Sports specialization in young athletes: evidence-based recommendations. Sports Health, 5:251–7.
4. Bell, D. R., Post, E. G., Trigsted, S. M., et al. (2016). Prevalence of sport specialization in high school athletics: a 1-year observational study. Am J Sports Med, 44:1469–74.
5. Somerset, S., Hoare, D. J. (2018). Barriers to voluntary participation in sport for children: A systematic review. BMC Pediat, 18, 47.
6. Gould, D. (2009). The professionalization of youth sports: it's time to act! Clin J Sport Med, 19:81–2.
7. Russell, W. D. (2014). The relationship between youth sport specialization, reasons for participation, and youth sport participation motivations: A retrospective study. J Sport Behav, 37, 286–305.
8. Malina, R. M. (2010). Early sport specialization: roots, effectiveness, risks. Curr Sports Med Rep, 9:364–71.
9. DiFiori, J. P., Benjamin, H. J., Brenner, J. S., et al. (2014). Overuse injuries and burnout in youth sports: a position statement from the American Medical Society for Sports Medicine. Br J Sports Med, 48:287–8.
10. LaPrade, R. F., Agel, J., Baker, J., et al. (2016). AOSSM early sport specialization consensus statement. Orthop J Sports Med, 4:2325967116644241.
11. Myer, G. D., Jayanthi, N., Difiori, J. P., et al. (2015). Sport Specialization, Part I: Does Early Sports Specialization Increase Negative Outcomes and Reduce the Opportunity for Success in Young Athletes? Sports Health, 7(5) 437-442.
12. Jayanthi, N. A., Pinkham, C., Durazo-Arivu, R., et al. (2011). The risks of sports specialization and rapid growth in young athletes. Clin J Sports Med, 21(2):157.
13. American Academy of Pediatrics. (2000). Intensive training and sports specialization in young athletes. Committee on Sports Medicine and

Fitness. Pediatr, 106 (1 Pt 1) 154-7.
14. Kalkhoven, J. T., Watsford, M. L., Impellizzeri, F. M. (2020). A conceptual model and detailed framework for stress-related, strain-related, and overuse athletic injury. J Sci Med Sport, 23(8):726-734.
15. Craig, A. D. (2003). Interoception: the sense of the physiological condition of the body. Current Opinion in Neurobiology, 13(4), 500–505.
16. Murphy, J., Catmur, C., Bird, G. (2019). Classifying individual differences in interoception: Implications for the measurement of interoceptive awareness. Psychon Bull Rev, 26:1467–1471.
17. Barrett, L. F., Simmons, W. K. (2015). Interoceptive predictions in the brain. Nat Rev Neurosci, 16(7): 419–429.
18. Stracciolini, A., Casciano, R., Friedman, H. L., et al. (2014). Pediatric Sports Injuries: A Comparison of Males Versus Females. Am J Sports Med, 42(4):965-972.
19. Buysse, D. J., Reynolds, C. F., Monk, T. H., et al. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res, 28:193–213.
20. Iona, T., Masala, D., Ammendolia, A., et al. (2021). Interrater reliability of the Italian version of questionnaire for classification Injuries of specialized young athletes: the CIGAS tool. Senses Sci, 7 (4) 1145-1154.
21. Rieffe, C., Terwogt, M. M., Petrides, K. V., et al. (2007). Psychometric properties of the Emotion Awareness Questionnaire for children. Pers Individ Differ, 43, 1, 95-105.
22. Mehling, W. E., Price, C., Daubenmier, J. J., et al. (2012). The Multidimensional Assessment of Interoceptive Awareness (MAIA). PLoS ONE, 7(11):e48230.
23. Longarzo, M., D'Olimpio, F., Chiavazzo, A., et al. (2015). The relationships between interoception and alexithymic trait. The Self-Awareness Questionnaire in healthy subjects. Front Psychol, 7(6), 1149.
24. Camodeca, M., Rieffe, C. (2013). Validation of the Italian Emotion Awareness Questionnaire for children and adolescents. Eur J Dev Psychol, 10, 402-409.
25. Lemeshow, S., Hosmer Jr, D. W. (1982). A review of goodness of fit statistics for use in the development of logistic regression models. Am J Epidemiol, 115:92–106
26. Moseid, C. H., Myklebust, G., Fagerland, M. W., et al. (2017). The prevalence and severity of health problems in youth elite sports: a 6-month prospective cohort study of 320 athletes. Scand J Med Sci Sports, 28(4):1412-1423.
27. Fullagar, H. H., Skorski, S., Duffield, R., et al. (2015). Sleep and athletic performance: the effects of sleep loss on exercise performance, and physiological and cognitive responses to exercise. Sports Med, 45(2): 161–186.
28. Leger, D., Metlaine, A., Choudat, D. (2005). Insomnia and sleep disruption: relevance for athletic performance. Clin Sports Med, 24(2):269–285 (viii).
29. Swinbourne, R., Gill, N., Vaile, J., et al. (2016). Prevalence of poor sleep quality, sleepiness and obstructive sleep apnoea risk factors in athletes. Eur J Sport Sci, 16(7): 850–858.
30. Leeder, J., Glaister, M., Pizzoferro, K., et al. (2012). Sleep duration and quality in elite athletes measured using wristwatch actigraphy. J Sports Sci, 30(6): 541–545.
31. Erlacher, D., Ehrlenspiel, F., Adegbesan, O. A., et al. (2011). Sleep habits in German athletes before important competitions or games. J Sports Sci, 29(8): 859–866.
32. Juliff, L. E., Halson, S. L., Peiffer, J. J. (2015). Understanding sleep disturbance in athletes prior to important competitions. J Sci Med Sport, 18(1):13–18.
33. Li, H., Moreland, J. J., Peek-Asa, C., Yang, J. (2017). Preseason Anxiety and Depressive Symptoms and Prospective Injury Risk in Collegiate Athletes. Am J Sports Med, 45(9):2148-2155.
34. Johnson, U., Ivarsson, A. (2011). Psychological predictors of sport injuries among junior soccer players. Scand J Med Sci Sports, 21(1):129-36.
35. Lathlean, T. J. H., Gastin, P.B., Newstead, S. V., et al. (2019). Prospective Cohort Study of Load and Wellness (Sleep, Fatigue, Soreness, Stress, and Mood) in Elite Junior Australian Football Players. Int J Sports Physiol Perform, 1; 14(6):829–840.
36. Erden, A., Emirzeoğlu, M. (2018). Investigation of Body Awareness Level and Performance Emotional Status of Athletes in Different Branches. J Sport Rehabil, 14:1-17.
37. Garfinkel, S. N., Seth, A. K., Barrett, A. B., et al. (2015). Knowing your own heart: Distinguishing interoceptive accuracy from interoceptive awareness. Biol Psychol, 104: 65–74.

SPECIJALIZACIJA I RIZIK OD POVREDA U RAZLIČITIM OMLADINSKIM SPORTOVIMA: BIOEMOCIONALNI OBRAZOVNI PRISTUP

Ciljevi: Sportska specijalizacija je trenutni trend kod mladih sportista, ali ona može povećati rizik od povreda. Cilj je bio utvrditi potencijalnu povezanost između sportske specijalizacije i rizika od povreda u različitim sportovima koristeći biopsihosocijalni pristup. Metode: 169 specijalizovanih sportista [(38 ženskog, 131 muškog spola); (11,2 ± 2,7 godina); (56.28 ± 15.72 kg);(161.3 ± 15.52 cm)] je ispunilo upitnik za samoprocjenu koji se odnosi na sociodemografske (dob, spol, nivo obrazovanja), fizičke individualne, stavove koji se tiču povreda, kao i psihološke individualne stavove. Univarijantna i korelacijska analiza su korištene za analizu podataka. Rezultati: Od 169 uključenih sportista, 53% su specijalizovani za jedan sport (navedeno učešće u jednom sportu i treniranje > 8 mjeseci u godini). U timskim sportovima (100%, OR = 0,75; p = ,022) je uočen visok rizik obaveze za mirovanjem do 1 mjeseca zbog prekomjernog praktikovanja. Muškarci koji su zadobili direktnu povredu (70%; OR = 1,03; p = ,006) u grupi sportista koji se bave timskim sportovima (95%, OR = 0,09; p = ,008) su bili više izloženi toj vrsti povrede, a vrsta specijalizacije je imala značajan udio (p = ,047). Nadalje, interoceptivna svijest je povezana sa povredom (95%, 1,04, p = 0,01). Zaključci: Sportisti koji se bave timskim sportovima su više specijalizovani, imaju veći obim treninga i veće stope povreda koje su povezane sa interoceptivnom svijesti nego oni koji se bave individualnim sportovima.

Ključne riječi: rizik od povreda, sportska specijalizacija, omladinski sportovi, adolescent, obrazovni pristup

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SPORT INJURIES PSYCHOLOGY FROM THE EXPERIENCE OF SPORTS KINESIOLOGISTS

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ABSTRACT

This study analyses, through a qualitative descriptive study, the perception of sports kinesiologists on the role of the mental factor in the injury process as well as the strategies used to manage this impact. A semi-structured interview was conducted with a sample of 16 male sports kinesiologists, ages between 26 and 45 years (M = 35.25 years) and work experience between 4 and 17 years (M = 9.38 years). The results show the recognition of the influence the mental factor plays in an injury, associating it with the emotional sphere (stress and anxiety) over the cognitive dimension. On the other hand, psychological intervention tends to be associated with relational aspects, such as communication and empathy, to manage emotional and mood states. In this context, there is a perceived gap in the training on strategies which have to be developed in this dimension of professional practice. This leads to the need to educate medical professionals in theoretical and practical aspects of psychological intervention techniques on cognitive and emotional aspects, as well as to emphasise the role of interpersonal coping, contributing to an integral vision of the recovery process.

Keywords: sports injury, medical professionals, professional training, intervention techniques, sports psychology

INTRODUCTION

Sports injuries are a consequence of sports practice associated with pain, physical dysfunction and behavioural, emotional and social alterations, and are, therefore, considered a health problem (Ortín, Garcés de los Fayos, & Olmedilla, 2010); it explains why their analysis has emphasised the clinical dimension over their mental correlate (Hemmings & Povey, 2002; Podlog, Banham, Wadey, & Hannon, 2015).

In this sense, the relationship between injuries and psychological factors, their effects and psychological reactions (Santi & Pietrantoni, 2013) as well as the psychological processes involved in the injury and the psychological techniques engaged in rehabilitation, such as goal setting (Hamson, Martin, & Walters, 2008), stress management, visualisation, relaxation (Kamphoff et al., 2010), and social support (Clement, Granquist, & Arvinen, 2011) have been studied.

This last resource evidences the psychosocial nature of an injury where the role of peers, coaches and a medical team on the mental state is relevant as potential sources of social support (Olmedilla, Ortega, Abenza, & Boladeras, 2011; Podlog et al., 2015). Thus, Arvinen, Massey and Hemmings (2014) argue that the medical team should understand the social dimension of the injury to favour recovery. Despite this, Wiese-Bjornstal (2014) indicates that the perceptions, personal characteristics and subjective experience of medical professionals have not been considered to affect the development of an instance of social support recognised by athletes.

Medical professionals should manage the psychosocial variables involved in an injury, know psychological techniques and manage relational processes as well as intervention programmes, and contemplate personal and situational factors that facilitate adherence to the process (Ortín et al., 2014).

PROBLEM AND AIM

The present study aims to investigate the perception of sports kinesiologists on the incidence of the mental factor in a sports injury as well as the psychological skills and/or techniques they use in the rehabilitation process, which enable interdisciplinary work instances that favour the achievement of the objectives related to sports reinsertion.

METHODS

Participants: a non-probabilistic sampling was used, taking as inclusion criteria: 1) to have at least one year of work experience in the sports field, and 2) to dedicate more than 50% of the work practice to the sports field. The work was carried out with a sample of 16 male sports kinesiologists between 26 and 45 years of age (M = 35.25 years) and work experience between 4 and 17 years (M = 9.38 years).

Design: a qualitative descriptive exploratory study was conducted based on a phenomenological design to gather information from the experience of the participants, an approach already used in the study of sports injuries (Arvinen, Massey, & Hemmings, 2014; Hemmings & Povey, 2002; Ninedek & Kolt, 2000; Niven, 2007; Podlog et al., 2015).

Instrument: participants responded to a semi-structured interview that addressed topics associated with the research objectives (mental factor in an injury, strategies to manage mental states and needs associated with the topic). Open-ended questions were used to explore participants' experiences, realities and constructs.

Procedure: participants were contacted to explain the objectives of the study, ensuring the anonymity and confidentiality of the information provided, following the ethical considerations inherent to studies with human beings. Subsequently, the interviews were conducted and recorded with authorisation.

Data analysis: inductive analysis of the textual content was used by means of axial coding based on the establishment of categories associated with the work objectives.

RESULTS

1. The psychological factor in sports injuries: the importance of the mental factor in sports injuries and the need for a specific approach considering its emotional and sporting consequences is recognised. This is explained from its biological effect ("the psychological factor as a stressor can interfere in the nervous system") and its implications for treatment ("the psychological issue is very important because it provides support for adherence to the work done, follow-up and not giving up"). Therefore, some participants understand the psychological factor as a dimension in itself to be addressed for a better understanding of the injury process.
2. Psychological states in sports injury: the concept of 'mental factor' tends to be associated with emotional states such as anxiety as a state that affects at different times of the injury: "basically uncertainty, anxiety.... At first it is the resistance to the fact that 'why did I get injured', then comes the anxiety of the times, of the recovery deadlines".

Likewise, personality is mentioned as a relevant psychological component since it generates vulnerability and demand for help ("there are some who are more prone to injuries, demanding, requiring treatment every day... personality also has a lot to do with injuries") and mood state as an immediate effect after the injury ("the athlete is very active, very fast and you tell him something and he answers with a joke, and when he is injured that usually goes down, the mood goes down"). Both factors, therefore, receive the impact of an effective therapeutic process: "he starts to normalize his moods, to be happier, to improve the personality that one is used to seeing".

The participants consider the psychological aspect as an internal quality ("it is clearly the player's, his personality"), believing that the professional cannot do much more, ignoring his own influence despite the fact that "the kinesiologist is the person who is generally closest to the injured person (...) the doctor has little contact with the athlete, the one who really interacts with the athlete is the kinesiologist".
3. Psychological intervention strategies used: the participants centred their need for intervention at the level of interaction, given a bond marked by support that strengthens the relationship with the athlete: "the kinesiologist often fulfills this role [psychologist], he is the person who knows the needs, the fears". Likewise, they suggest the provision of information about the injury as a technique to reduce uncertainty, assuming that this maintains motivation in recovery and promotes the adequate emotions management.

Participants do not identify specific techniques to manage psychological states but allude to generic elements ("encouragement", "support") or understand social skills (talking, containing, empathising and giving feedback) as intervention strategies.

Despite the importance given to the management of the emotional impact of an injury, the participants express the lack of specific training in the field by appealing to self-taught training ("It is a little bit

of the training they give you in terms of empathy, giving support. These are the tools that one acquires in practice, there is a lot of management in daily practice"). This is also due to a curricular planning that does not consider this field in depth: "What happens is that kinesiology has many areas of work, so they gave me child psychology focused on development and not on the support of a therapy. They didn't teach us anything about working with athletes".

In this sense, the need for training in intervention strategies linked to the relational aspect is expressed: "how to approach the player, strategies or techniques when he/she is discouraged or does not feel like training". This becomes even more relevant when considering the competencies and professional suitability at the base: "many times you act as a psychologist without knowing or having experience in the area, but they tell you their problems and advise you with what you think is right".

DISCUSSION

The findings show an explicit recognition of the importance of the mental factor in sports injury which, according to the participants, is due to intrinsic features of the athlete associated with the emotional experience rather than cognitive processes. Being understood as factors inherent to the athlete, the professionals do not address or intervene directly on mental states, but state, following Niven (2007), that by providing information on the injury they act on adherence. Technical expertise, then, focuses on knowledge rather than on professional or relational skills that can be acquired through specific training.

Although social support evidences the interpersonal dimension of the rehabilitation process, it is not perceived as an intentional intervention but rather as a consequence of the conditions of the work itself, which is why participants do not perceive themselves as agents of social support and do not use the link as a strategy, focusing on a basically medical-educational vision. Therefore, participants provide social support not to generate wellbeing but as a context for carrying out clinical work.

This explains why the idea of psychological strategy is linked to relational and effective communication skills, with elements such as the ability to dialogue, contain and empathise being conceptualised as "psychological techniques", while techniques such as goal setting, self-dialogue, relaxation and visualisation are not mentioned (Kamphoff et al., 2010).

For this reason, it is important to highlight the role of social support and the training of the medical team in the management of psychological variables, especially when, according to Wiese-Bjornstal (2014), they are the ones who face and directly influence the reality of the injury by performing psychological assistance, and they are the ones who need to expand their possibilities of intervention.

CONCLUSION

The above background reveals the importance of implementing educational processes in the management of psychological variables by the medical team (Stiller & Ostrowski, 2009) since the participants perceive a gap in their professional training, even more so considering the characteristics of the sports environment and, more specifically, the emotional commitment and impact that an injury has on the well-being of the subject, assuming, finally, that the mental factor plays a role in the process: "I cannot achieve rehabilitation without an important psychological component". Thus, a challenge arises for training institutions to include this topic in their work plans in order to provide future professionals with tools that will optimise their performance and benefit the athlete or user.

REFERENCES

1. Arvinen, M., Massey, W., & Hemmings, B. (2014). Role of sport medicine professionals in addressing psychosocial aspects of sport-injury rehabilitation: professional athletes' views. Journal of Athletic Training, 49(6), 764-772. doi:10.4085/1062-6050-49.3.44.
2. Clement, D., Granquist, M., & Arvinen, M. (2013). Psychosocial aspects of athletic injuries as perceived by athletic trainers. Journal of Athletic Training, 48(4), 512-521. doi:10.4085/1062-6050-48.3.21.
3. Hamson, J., Martin, S., & Walters, J. (2008). Athletic trainers' and physical therapists' perceptions of the effectiveness of psychological skills within sport injury rehabilitation programs. Journal of Athletic Training, 43(3), 258-264. doi:10.4085/1062-6050-43.3.258.
4. Hemmings, B., & Povey, L. (2002). Views of chartered physiotherapists on the psychological content of their practice: a preliminary study in the United Kingdom. British Journal of Sports Medicine, 36(1), 61-64.
5. Kamphoff, C., Hamson, J., Antoine, B., Knutson, R., Thomae, J., & Hoenig, C. (2010). Athletic training students' perceptions of and academic preparation in the use of psychological skills in sport injury rehabilitation. Athletic Training Educational Journal, 5(3), 109-116.
6. Ninedek, A., & Kolt, G. (2000). Sport physiotherapists' perceptions of psychological strategies in sport injury rehabilitation. Journal of Sport Rehabilitation, 9(3), 191-206.
7. Niven, A. (2007). Rehabilitation adherence in sport injury: sport physiotherapists' perceptions. Journal of Sport Rehabilitation, 16(2), 93-110.
8. Olmedilla, A., Ortega, E., Abenza, L., & Boladeras, A. (2011). Lesiones deportivas y psicología: una revisión (2000-2009). Cuadernos de Psicología del Deporte, 11(1), 45-57.
9. Ortín, F., Garcés de los Fayos, E., & Olmedilla, A. (2010). Influence of psychological factors on sports injuries. Papeles del Psicólogo, 31(3), 281-288.
10. Podlog, L., Banham, S., Wadey, R., & Hannon, J. (2015). Psychological readiness to return to competitive sport following injury: a qualitative study. The Sport Psychologist, 29, 1-14.
11. Santi, G., & Pietrantoni, L. (2013). Psychology of sport injury rehabilitation: a review of models and interventions. Journal of Human and Sport Exercise, 8(4), 1029-1044.
12. Stiller, J., & Ostrowski, J. (2009). Recently certified athletic trainers' undergraduate educational preparation in psychosocial intervention and referral. Journal of Athletic Training, 44(1), 67-75.
13. Tracey, J. (2008). Inside the clinic: health professionals' role in their clients' psychological rehabilitation. Journal of Sport Rehabilitation, 17(4), 413-431.
14. Wiese-Bjornstal, D. (2014). Reflections on a quarter-century of research in sports medicine psychology. Revista de Psicología del Deporte, 23(2), 411-421.

PSIHOLOGIJA SPORTSKIH POVREDA KROZ ISKUSTVO SPORTSKIH KINEZIOLOGA

Putem kvalitativne deskriptivne studije, ovo istraživanje analizira percepciju sportskih kineziologa po pitanju uloge mentalnog faktora u procesu povrede, kao i strategije koje se koriste za nošenje sa ovim uticajem. Polustrukturirani intervju je proveden na uzorku od 16 sportskih kineziologa, muškaraca starosti između 26 i 45 godina (M = 35,25 godina) i radnog iskustva između 4 i 17 godina (M = 9,38 godina). Rezultati pokazuju prepoznavanje utjecaja mentalnog faktora na povredu povezujući ga sa emocionalnom sferom (stres i anksioznost) prije nego sa kognitivnom dimenzijom. S druge strane, psihološka intervencija je obično povezana sa relacionim aspektima poput komunikacije i empatije za upravljanje emocionalnim stanjima i raspoloženjem. U ovom kontekstu se uočava jaz u obuci o strategijama koje je potrebno razviti u ovoj dimenziji profesionalne prakse. To dovodi do potrebe za obukom medicinskih stručnjaka o teorijskim i praktičnim aspektima tehnika psihološke intervencije koje se tiču kognitivnih i emocionalnih aspekata, kao i naglašavanjem uloge međuljudskog suočavanja doprinoseći integralnoj viziji procesa oporavka.

Ključne riječi: : sportske povrede, medicinski stručnjaci, stručno usavršavanje, tehnike intervencije, sportska psihologija

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THE RELATIONSHIP BETWEEN VERTICAL JUMP, 20 METRES SPRINT TIME AND HANDGRIP STRENGTH IN PHYSICAL EDUCATION STUDENTS

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ABSTRACT

Sprint ability and vertical jump are essential motor skills in many sports. Handgrip strength has been recently investigated as a predictor of muscular strength of the lower limbs, but its relationships with vertical jump and sprint has not been fully studied. Therefore, the aim of this study was: 1) to assess vertical jump performance, 20 m sprint time and handgrip strength in a group of males and females, students of Physical Education aged 19 – 25 years; 2) to analyse the possible relationships between those three different tests. 15 male and 15 female students of Physical Education were recruited to the study, and they were required to perform 3 maximal countermovement jumps (CMJ) without arm swing on a Chronojump contact mat, 3 maximum effort 20 m sprints measured with a Witty Timing System and three handgrip strength tests for each hand measured with a Jamar dynamometer. The results revealed strong/very strong correlations between CMJ height and handgrip strength ($r = 0.588$, $p = 0.001$), CMJ height and 20 m sprint time ($r = -0.602$, $p = 0.000$), CMJ peak power and 20 m sprint time ($r = 0.699$, $p = 0.000$), 20 m sprint time and handgrip strength ($r = -0.536$, $p = 0.002$), and CMJ peak power and handgrip strength ($r = 0.733$, $p = 0.000$). This study confirms that handgrip strength could be a predictor of physical fitness and an effective tool to monitor sprint performance in-season, without requiring maximal sprint testing.

Keywords: vertical jump, sprint performance, handgrip strength, physical fitness, muscular power

INTRODUCTION

Sprint ability is an essential motor skill in many sports, and contributes to successful performance (Haugen & Buchheit, 2016; Slawinski et al., 2017; Asadi, 2016). The ability to start, stop and change directions rapidly and efficiently is especially important in most team sports (Lockie et al., 2013; Mohr et al., 2003) in which athletes need to accelerate over short distances to be more effective (Jhonston et al., 2018; McFarland et al., 2016)
Vertical jump is also an essential skill in many team sports (Reiser et al., 2006; Sarvestan et al., 2018). In high intensity intermittent sports, the success of an action frequently depends on the capacity of the player to jump high and fast (Vaverka et al., 2016; Abdelkrin et al., 2007). Therefore, important physical capacities in many team sports include both sprinting and jumping (Hoff et al., 2004; Carr et al. 2015; Asadi, 2016).

Sprinting, particularly during the acceleration phase, involves the use of the stretch shortening cycle (SSC) at each ground contact (Carr et al., 2015). Most of the

jumps performed in many sports are also made with the contribution of the SSC (Rojano-Ortega et al., 2021), and according to some authors, sprinting and vertical jump have biomechanical, kinematic, and muscular similarities (Marques et al., 2011).

Nowadays, maximal vertical jump height is considered an excellent indicator of physical fitness and muscular strength and power of the lower limbs (Brown et al., 2007; Sarvestan et al., 2018). In addition, numerous studies have examined the relationships between sprint performance and indices of dynamic force and power during a vertical jump. Squat jump (SJ) and countermovement jump (CMJ) have demonstrated moderate to strong correlations with maximal sprint velocity (Cronin & Hansen, 2005; Doobs et al., 2015; Shalwafi et al., 2014). Because CMJ has proved to be useful to monitor and assess athletes' sprinting ability, it is considered by some authors an effective tool to measure sprinting ability without the risk of injury associated with a maximal sprint test, particularly in-season (Loturco et al., 2015a; Loturco et al., 2015b).

Handgrip strength (i.e., the isometric force of the hand evaluated with a hand dynamometer) is widely used as a predictive measure of several health markers. Decreased grip strength has been associated with mortality and complications in hospitalised individuals (Gale et al., 2007; Rantanen et al., 2003). The isometric grip strength of the hand and forearm has been used as an inexpensive predictor of nutritional status (Norman et al., 2011).

Handgrip strength has also been used as a predictor of basic health and fitness. Some studies have indicated that it is a good predictor of total body strength and functional ability (Wind et al., 2010; DeBeliso et al., 2015). Recently, handgrip strength was investigated as a predictor of performance. Haynes and DeBeliso (2019) observed a moderate correlation between handgrip strength and sit-up performance in a group of 15 female adult CrossFit athletes and, after 8 weeks of grip strength training, Alshdokhi et al. (2020) concluded that improving grip strength might contribute towards faster 50 m freestyle swim performance in adolescent swimmers.

In addition, some authors have observed moderate correlation between handgrip strength and vertical jump height (Matsudo et al., 2015; Vaydya & Nariya, 2021), concluding that handgrip strength can be an effective tool for predicting muscular strength of the lower limbs.

This relationship has not always been found (Koley & Kaur, 2017; Mbada et al., 2020), and new studies that clarify these contradictory results are warranted. Furthermore, to the best of our knowledge, only Matsudo et al. (2015) studied the relationship between handgrip strength and sprint performance, and they found a moderate negative correlation between handgrip strength and the time taken to run 50 m. New studies are needed to support this result, especially with shorter sprints. Therefore, the aim of this study was: 1) to assess vertical jump performance, 20 m sprint time and handgrip strength in a group of males and females, students of Physical Education aged 19 – 25 years; 2) to analyse the possible relationships between those three different tests.

METHODS

PARTICIPANTS

15 male and 15 female students of Physical Education aged 19 – 25 years volunteered to participate in this study (22.53 ± 1.50 years, 170.93 ± 7.06 cm, 67.63 ± 9.07 kg). None of the participants had experienced serious injuries at least 12 months before the testing sessions. All the participants gave written informed consent according to the Declaration of Helsinki. The study was approved by the University Research Ethics Committee.

TESTING PROCEDURES

One preparatory session was undertaken a few days before the data collection. During the experimental session, participants performed the tests in the following order: CMJ, 20 m sprint and handgrip strength tests. The experimental session was carried out between 17:00 and 20:00 hours.

Following a standard warm-up routine of 15 minutes, all participants performed 3 maximal CMJ without arm swing on a Chronojump contact mat (Chro¬nojump Boscosystem, Barcelona, Spain) with a minute rest between them. CMJ is similar to the jumps performed in many sports because they are made with the contribution of the SSC, and CMJ without arm swing is carried out with the hands on the hips. Participants were allowed to jump with their preferred self-selected countermovement depth, and they were instructed to jump "as high as possible" keeping their hands on their hips. The highest jump of the three trials was used for subsequent analysis. The test-retest reliability in this sample for vertical jump height measured with the Chronojump contact mat showed an intraclass correlation coefficient (ICC) of 0.864 and a within-subject coefficient of variation (CV) of 3.82%. Peak power during the propulsion phase of CMJ was calculated with Sayers power equation (Sayers et al., 1999): Peak power (Watts) = 60.7 • Jump height (cm) + 45.3 • body mass (kg) – 2055. Peak power normalised to body mass was used for analysis.
Prior to the sprint test, participants undertook a standardised 10 minute warm-up, which included sprint drills and progressive sprints. Then, the participants performed 3 maximum effort 20 m sprints with 3 minute rest periods. Sprint time was measured using a Witty Timing System (Microgate SRL, Italy). The best of 3 trials was used for analysis. The test-retest reliability in this sample for 20 m sprint-time with the Witty

Timing System gave an ICC of 0.807 and a within-subject CV of 4.19%.
The grip strength of both right and left hands was measured using a Jamar handgrip dynamometer (Asimow Engineering Co., USA). The handgrip strength was recorded in kilograms. Participants performed the test three times for each hand, with a minute rest between them and alternating right and left hands. They were instructed to squeeze the handgrip with maximum force with an outstretched arm, at a standing position. The sum of the best results for the right and left hand was used for analysis. The test-retest reliability in this sample for maximal isometric handgrip strength with a Jamar dynamometer gave an ICC of 0.791 and a within-subject CV of 4.45%.

STATISTICAL ANALYSIS

Statistical analysis was performed with the SPSS program for Windows, v. 22.0 (SPSS Inc., USA). Means and standard deviations of all variables were calculated. A Shapiro-Wilk test was applied for testing the normality of data. As this condition was always fulfilled, Pearson's r correlation coefficients were calculated to evaluate the possible relationships between variables. The correlation coefficients were interpreted according to the following criteria: $r < 0.1$, trivial; $0.1 < r \leq 0.3$, weak; $0.3 < r \leq 0.5$, moderate; $0.5 < r \leq 0.7$, strong; $0.7 < r \leq 0.9$, very strong; and $r > 0.9$, almost perfect (Hopkins et al., 2009). The statistical level of significance was set as $p < 0.05$ for all analyses. The ICC and within-subject CV were used to determine the reliability of the measurements.

RESULTS

Table 1 presents means and standard deviations of all the variables measured for all participants and also partitioned by sex. When the data from males and females were pooled together, important relationships were observed between CMJ height, CMJ peak power, 20 m sprint time, and handgripstrength (Table 2).

Variables	Whole group (n = 30)	Females (n = 15)	Males (n = 15)
CMJ height (cm)	25.42 ± 5.03	22.37 ± 4.28	28.46 ± 3.76
CMJ peak power (W/kg)	38.16 ± 4.53	34.69 ± 3.14	41.62 ± 2.65
20 m sprint time (s)	3.21 ± 0.21	3.31 ± 0.20	3.10 ± 0.18
Handgrip strength (kg)	75.20 ± 16.88	62.51 ± 6.28	87.89 ± 14.34

Table 1. Means and standard deviations of the study variables for the sample as a whole and partitioned by sex.

Strong correlations were observed between CMJ height and handgrip strength ($r = 0.588$, $p = 0.001$), CMJ height and 20 m sprint time ($r = -0.602$, $p = 0.000$), CMJ peak power and 20 m sprint time ($r = 0.699$, $p = 0.000$), and 20 m sprint time and handgrip strength ($r = -0.536$, $p = 0.002$). A very strong correlation was found between CMJ peak power and handgrip strength ($r = 0.733$, $p = 0.000$). When the data were partitioned by sex, almost no significant correlations were found, but this was probably due to the low number of subjects in each group.

Table 2. Pearson's correlation coefficients between all the study variables.

	CMJ height	CMJ peak power	20 m sprint time	Handgrip strength
CMJ height	1	0.927***	-.602***	0.588**
CMJ peak power		1	-0.699***	0.733***
20 m sprint time			1	-0.536**
Handgrip strength				1

*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

DISCUSSION

The first purpose of this study was to assess vertical jump height, 20 m sprint time and handgrip strength in a group of males and females, students of Physical Education aged 19 – 25 years. The average value of CMJ height was 25.42 ± 5.03 cm for the whole group (22.37 ± 4.28 cm for females and 28.46 ± 3.76 cm for males), and the average value of CMJ peak power was 38.16 ± 4.53 W/kg for the whole group (34.69 ± 3.14 W/kg for females and 41.62 ± 2.65 W/kg for males). As it was expected, these results are a bit lower than those obtained in elite athletes of the same age range (McFarland et al., 2016: Morris et al., 2020; Bujang et al., 2021) or even younger (Asadi, 2016; Pedersen et al., 2021). However, our results for CMJ height are also far below the values obtained by Vaidya and Nariya (2021) in a group of 30 college students aged 18 – 25 years, and even below the values obtained by Matsudo et al. (2015) in adolescents. The reason for our lower values is that they measured the vertical jump height as the difference between the highest point during the jump and the standing reach height, which means that their vertical jump height takes into account the athlete reach height with the ankles extended before take-off. Thus, if they had subtracted the value of the ankle extension, our values would

have not been so different.

The mean value of 20 m sprint time was of 3.21 ± 0.21 s for the whole group, 3.31 ± 0.20 s for females and 3.10 ± 0.18 s for males. As it was also expected, these values are a bit higher than those found in other investigations with high-level athletes of the same age range (Carr et al., 2015; Morris et al., 2020) or even younger (Izquierdo & Redondo, 2020).

Our average value of the handgrip strength (the sum of right and left hand) was 75.20 ± 16.88 kg for the whole group, 62.51 ± 6.28 kg for females and 87.89 ± 14.34 kg for males. These results are in accordance with the reference values established by Sánchez-Torralvo et al. (2018) with a Jamar dynamometer for a standard population under 45 years of age. In addition, our subjects were Physical Education students, recreationally active, and their average handgrip strength value falls between those found by Mbada et al. (2020) for athletes and non-athletes of approximately the same age range.

The second purpose of this study was to analyse the possible relationships between vertical jump performance, 20 m sprint time and handgrip strength. The strong significant correlations found between CMJ height or CMJ peak power and 20 m sprint-time proves that CMJ is a useful test to assess athletes' sprinting ability. This relationship was found in numerous studies. For example, Carr et al. (2015) observed a strong, inverse relationship between CMJ height and 20 m sprint time ($r = -0.741$, $p = 0.006$) in a group of first-class county cricketers. Asadi et al. (2016) obtained similar results in a group of elite young basketball players ($r = -0.61$; $p = 0.01$), and Morris et al. (2020) also found the same relationship in a group of elite Australian rules football athletes ($r = -0.550$; $p < 0.05$).
These results support ours and suggest that strength and conditioning coaches should focus on developing explosive strength and enhancing the stretch-shortening cycle ability with appropriate plyometric tasks to improve sprint performance (Carr et al., 2015). Furthermore, associations between CMJ height and CMJ peak power also suggest that CMJs provide practitioners with an approach to monitor sprint performance in-season, without requiring maximal sprint testing (Morris et al., 2020).

Strong or very strong significant positive correlations were observed between handgrip strength and CMJ height or CMJ peak power, respectively. Our results confirm those of Matsudo et al. (2015) and Vaidya and Nariya (2021), and suggest that handgrip strength could be an effective tool for predicting muscular strength and endurance. However, Koley and Kaur (2017) and Mbada et al. (2020) did not find the same results, but they used a CMJ with arm swing, also using the upper limb to impel the subject upward. Therefore, we can conclude that handgrip strength can be a good predictor of muscular strength and power of the lower limb.

To our best knowledge, only Matsudo et al. (2015) analysed the relationship between handgrip strength and sprint performance. They obtained a moderate negative correlation between handgrip strength and the time to run 50 m but their results needed the support of additional studies. The strong significant correlation found in our study between handgrip strength and 20 m sprint time underpins the results observed by Matsudo et al. (2015) and indicates that handgrip strength may be a valid predictor of sprint performance.

CONCLUSIONS

This study confirms the relationship between vertical jump, particularly CMJ, and sprint performance observed in previous literature. In addition, our results also support the idea that handgrip strength could be a predictor of physical fitness due to the relationships observed between handgrip strength and CMJ height, CMJ peak power or 20 m sprint time. Therefore, handgrip strength might be employed for identifying potentially talented athletes and could also be used as an effective tool to monitor sprint performance in-season, without requiring maximal sprint testing. Nonetheless, future studies confirming the same results with different populations are still warranted.

REFERENCES

1. Abdelkrim, N., Fazaa, S., & Ati, J. (2007). Time–motion analysis and physiological data of elite under-19-year-old basketball players during competition. British Journal of Sports Medicine, 41, 69-75. doi:10.1136/bjsm.2006.032318

2. Alshdokhi, K. A., Petersen, K. J., & Clarke, J. C. (2020). Effect of 8 weeks of grip strength training on adolescent sprint swimming: a randomized controlled trial. Exercise Medicine, 4:1. doi:10.26644/em.2020.001

3. Asadi, A. (2016). Relationship Between Jumping Ability, Agility and Sprint Performance of Elite Young Basketball Players: A Field-Test Approach. Revista Brasileira de Cineantropometria e Desempenho Humano, 18, 177-186. doi:10.5007/1980-0037.2016v18n2p177

4. Brown, A. C., Wells, T. J., Schade, M. L., Smith, D. L., & Fehling, P. C. (2007). Effects of Plyometric Training versus Traditional Weight Training on Strength, Power and Aesthetic Jumping Ability in Female Collegiate Dancers. Journal of Dance Medicine and Science, 11(2), 38-44.

5. Bujang, Rusdiana, A., Samsudin, Asmawi, M., Dlis, F., Abidin, D., Haqiyah, A., (2021). The effect of core muscle fatigue on biomechanical

parameters during jump serve in volleyball. Sport Science, 14, 97-104.

6. Carr, C., McMahon, J. J., & Comfort, P. (2015). Relationships between jump and sprint performance in first-class county cricketers. Journal of Trainology, 4:1-5. doi:10.17338/trainology.4.1_1

7. Cronin, J. B., & Hansen, K. T. (2005). Strength and power predictors of sports speed. Journal of Strength & Conditioning Research, 19, 349-357. doi:10.1519/14323.1

8. DeBeliso, M., Boham, M., Harris, C., Carson, C., Berning, J. M., Sevene, T. G., Adams, K. J., & Climstein, M. (2015). Grip strength and functional measures in the mature adult: Brief report II. International Journal of Science and Engineering Investigations, 4, 1-4.

9. Dobbs, C. W., Gill, N.D., Smart, D. J., & McGuigan, M. R. (2015). Relationship between vertical and horizontal jump variables and muscular performance in athletes. Journal of Strength & Conditioning Research, 29, 661-671. doi:10.1519/JSC.0000000000000694

10. Gale, C. R., Martyn, C. N., Cooper, C., & Sayer, A. A. (2007). Grip strength, body composition, and mortality. International Journal of Epidemiology, 36, 228-35. doi:10.1093/ije/dyl224

11. Haugen, T., & Buchheit, M. (2016). Sprint running performance monitoring: Methodological and practical considerations. Sports Medicine (Auckland, N.Z.), 46, 641-656. doi:10.1007/s40279-015-0446-0

12. Haynes, E., & DeBeliso, M. (2019). The relationship between CrossFit performance and grip strength. Turkish Journal of Kinesiology, 5. 15-21. doi: 10.31459/turkjkin.515874

13. Hoff, J., & Helgerud, J. (2004). Endurance and strength training for soccer players: physiological considerations. Sports Medicine, 34, 165-180. doi: 10.2165/00007256-200434030-00003

14. Hopkins W., Marshall S., Batterham A., & Hanin J. (2009). Progressive statistics for studies in sports medicine and exercise science. Medicine and Science in Sports and Exercise, 41, 3-13. doi:10.1249/MSS.0b013e31818cb278

15. Izquierdo, J. M., & Redondo, J. C. (2020). Acute effects of basketball competition on physical performance factors in under-18 female players RICYDE. Revista Internacional de Ciencias del Deporte, 61, 285-297. doi:10.5232/ricyde2020.06104

16. Johnston, R. D., Black, G. M., Harrison, P. W., Murray, N. B., & Austin, D. J. (2018). Applied sport science of Australian football: A systematic review. Sports Medicine, 48, 1673-1694. doi:10.1007/s40279-018-0919-z

17. Koley, S., & Kaur, A. (2017). Estimation of Handgrip Strength and its Correlations with Selected Anthropometric Variables and Performance Tests in Indian Interuniversity Female Field Hockey Players. Archives of Sports Medicine and Physiotherapy, 2, 1-4.

18. Lockie, R., Shultz, A., Callaghan, S., Jeffriess, M., & Berry, S. (2013). Reliability and validity of a newchange-of-direction speed for field based sports; the change-of-direction and acceleration tests (CODAT). Journal of Sports Science and Medicine, 12, 88-96.

19. Loturco, I., D'Angelo, R. A., Fernandes, V., Gil, S., Kobal, R., Cal Abad, C. C., Kitamura, K., & Nakamura, F. Y. (2015a). Relationship between sprint ability and loaded/unloaded jump tests in elite sprinters. Journal of Strength & Conditioning Research, 29: 758-764. doi:10.1519/JSC.0000000000000660

20. Loturco, I., Pereira, L. A., Cal Abad, C. C., D'Angelo, R. A., Fernandes, V., Kitamura, K., Kobal, R., & Nakamura, F. Y. (2015b). Vertical and horizontal jump tests are strongly associated with competitive performance in 100-m dash events. Journal of Strength & Conditioning Research, 29, 1966–1971. doi:10.1519/JSC.0000000000000849

21. Marques, M. C., Gil, H., Ramos, R. J., Costa, A. M., & Marinho, D. A. (2011). Relationships Between Vertical Jump Strength Metrics and 5 Meters Sprint Time. Journal of Human Kinetics, 29, 115-122. doi:10.2478/v10078-011-0045-6

22. Matsudo, V. K., Matsudo, S., Machado de Rezende, L., & Raso, V. (2015). Handgrip strength as a predictor of physical fitness in children and adolescents. Revista Brasileira de Cineantropometria e Desempenho Humano, 17. doi:10.5007/1980-0037.2015v17n1p1

23. Mbada, C. E., Quadri, S. A., Oghumu, S. N., Israel, K. O., Fasuyi, F., & Oyewole, A. I. (2020). Hand grip strength, leg explosive power and vertical jump performance among Nigerian university male basketball players and healthy controls. Medicina Sportiva, XVI, 3156-3162.

24. McFarland, I. T., Dawes, J. J., Elder, C. L., & Lockie, R. G. (2016). Relationship of Two Vertical Jumping Tests to Sprint and Change of Direction Speed among Male and Female Collegiate Soccer Players. Sports, 4, 11. doi:10.3390/sports4010011

25. Mohr, M., Krustrup, P., & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. Journal of Sports Sciences, 21, 519-528. doi:10.1080/0264041031000071182

26. Morris, C. G., Weber, J. A., & Netto, K. J. (2021). Relationship Between Mechanical Effectiveness in Sprint Running and Force-Velocity Characteristics of a Countermovement Jump in Australian Rules Football Athletes. Journal of Strength and Conditioning Research, 00, 1–7. doi:10.1519/JSC.0000000000003583 Online ahead of print.

27. Norman, K., Stobäus, N., González, M. C., Schulzke, J. D., Pirlich, M. (2011). Hand grip strength: Outcome predictor and marker of nutritional status. Clinical Nutrition, 30, 135-42. doi:10.1016/j.clnu.2010.09.010

28. Pedersen, S., Welde, B., Sagelv, E. H., Heitmann, K. A., Randers, M. B., Johansen, D., & Pettersen, S. A. (2021). Associations between maximal strength, sprint, and jump height and match physical performance in high-level female football players Scandinavian Journal of Medicine & Science in Sports, 0, 1-8. doi:10.1111/sms.14009 Online ahead of print.

29. Rantanen, T., Volpato, S., Ferrucci, L., Heikkinen, E., Fried, L. P., & Guralnik, J. M. (2003). Handgrip strength and cause-specific and total mortality in older disabled women: Exploring the mechanism. Journal of the American Geriatrics Society, 51: 636-41. doi:10.1034/j.1600-0579.2003.00207.x

30. Reiser, R. F., Rocheford, E. C., & Armstrong, C. J. (2006). Building a Better Understanding of Basic Mechanical Principles Through Analysis of the Vertical Jump. Strength and Conditioning Journal, 28(4), 70–80. doi:10.1519/00126548-200608000-00012

31. Rojano-Ortega, D., Berral-Aguilar, A. J., & Berral-de la Rosa, F. J. (2021). Kinetic variables and vertical stiffness of female volleyball players during a vertical jump. Journal of Physical Education and Sport, 21, 201-207. doi:10.7752/jpes.2021.01027

32. Sánchez-Torralvo, F. J., Porras N., Abuín-Fernández, J., García-Torres, F., Tapia, M. J., Lima, F., Soriguer, F., Gonzalo, M., Rojo-Martínez, G., & Olveira, G. (2018). Normative reference values for hand grip dynamometry in Spain. Association with lean mass Nutrición Hospitalaria, 35, 98-103. doi:10.20960/nh.1052

33. Sarvestan, J., Cheraghi, M., Sebyani, M., Shirzad, E., & Svoboda, Z. (2018). Relationships between force-time curve variables and jump height during countermovement jumps in young elite volleyball players. Acta Gymnica, 48, 9-14. doi:10.5507/ag.2018.003

34. Sayers, S. P., Harackiewicz, D. V., Harman, E. A., Frykman, P. N., & Rosenstein, M. T. (1999). Cross-validation of three jump power equations. Medicine & Science in Sports & Exercise, 31, 572-577. doi:10.1097/00005768-199904000-00013

35. Shalfawi, S., Enoksen, E., & Tonnessen, E. (2014). The relationship between measures of sprinting, aerobic fitness, and lower body strength and power in well trained female soccer players. International Journal of Applied Sports Sciences, 26, 18-25. doi:10.24985/ijass.2014.26.1.18

36. Slawinski, J., Termoz, N., Rabita, G., Guilhem, G., Dorel, S., Morin, J. B., & Samozino, P. (2017). How 100-m event analyses improve our understanding of world-class men's and women's sprint performance. Scandinavian Journal of Medicine & Science in Sports, 27, 45-54. doi:10.1111/sms.12627

37. Vaverka, F., Jandačka, D., Zahradník, D., Uchytil, J., Farana, R., Supej, M., & Vodičar, J. (2016). Effect of an Arm Swing on Countermovement Vertical Jump Performance in Elite Volleyball Players. Journal of Human Kinetics, 53, 41-50. https://doi.org/10.1515/hukin-2016-0009

38. Vaydia, S. M., & Nariya, D. M. (2021). Handgrip Strength as a Predictor of Muscular Strength and Endurance: A Cross-sectional Study. Journal of Clinical and Diagnostic Research, 15, 1-4. doi:10.7860/JCDR/2021/45573.14437

39. Wind, A. E., Takken, T., Helders, P. M., & Engelbert, R. H. (2010). Is grip strength a predictor for total muscle strength in healthy children, adolescents, and young adults? European Journal of Pediatrics, 169, 281-287. doi:10.1007/s00431-009-1010-4

ODNOS IZMEĐU SKOKA U VIS, VREMENA SPRINTA NA 20M I SNAGE STISKA RUKE KOD STUDENATA FIZIČKOG OBRAZOVANJA

Sposobnost sprinta i skok u vis su osnovne motoričke vještine u mnogim sportovima. Snaga stiska ruke je u posljednje vrijeme proučavana kao pokazatelj mišićne snage donjih ekstremiteta, ali se njen odnos sa skokom u vis i sprintom nije u potpunosti istraživao. Prema tome, cilj ove studije je bio: 1) procijeniti izvedbu skoka u vis, vrijeme sprinta na 20m i snagu stiska ruke u grupi muškaraca i žena, studenata fizičkog obrazovanja u dobi od 19 do 25 godina; 2) analizirati potencijalnu vezu između ova tri različita testa. 15 studenata i 15 studentica fizičkog obrazovanja je dobrovoljno učestvovalo u studiji te se od njih zahtijevalo da izvedu 3 maksimalna skoka iz čučnja sa pripremom (CMJ) bez upotrebe ruku na Chronojump kontaktnoj strunjači, 3 maksimalna sprinta na 20m koja su mjerena putem Witty Timing System uređaja i 3 testa snage stiska ruke za svaku ruku, a što je mjereno putem Jamar dinamometra. Rezultati su otkrili visoke/iznimno visoke korelacije između visine CMJ-a te snage stiska ruke ($r = 0,588$, $p = 0,001$), visine CMJ-a i vremena sprinta na 20m ($r = -0,602$, $p = 0,000$), maksimalne snage CMJ-a i vremena sprinta na 20m ($r = 0,699$, $p = 0,000$), vremena sprinta na 20m i snage stiska ruke ($r = -0,536$, $p = 0,002$), te maksimalne snage CMJ-a i snage stiska ruke ($r = 0,733$, $p = 0,000$). Ova studija potvrđuje da snaga stiska ruke može biti pokazatelj fizičke spremnosti i učinkovit alat za praćenje izvedbe sprinta tokom sezone, a bez potrebe za testiranjem maksimalnog sprinta

Ključne riječi: : skok u vis, izvedba sprinta, snaga stiska ruke, fizička spremnost, mišićna snaga

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REPEATED BOUT EFFECT AND EPOC: A NARRATIVE REVIEW

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ABSTRACT

As with other exercise modalities, resistance exercises can cause excessive post-exertion oxygen consumption (EPOC) to have different magnitudes and durations. Muscle damage may be one of the factors influencing EPOC. Thus, the repetition of an unusual resistance exercise, also known in the literature as the repeated bout effect (RBE), reduces muscle damage during the second session. The objective of this narrative review was to verify the possible existing relationships between the RBE and EPOC and consequently suggest future works that show this possible relationship. When analysing the association between studies related to RBE, EPOC, and muscle damage, it can be hypothesised that EPOC is less present in exercises with a higher incidence of RBE. That is, the defence mechanisms arising from the RBE also cause the EPOC to be consequently lower, making these variables inversely proportional.

Keywords: muscle damage, energy expenditure, resistance training, body composition

INTRODUCTION

The human body as a living organism has its physiology formed by different types of cells, structures, and systems that work together to perform all the necessary functions and, in the face of what it is submitted to, adapt itself (Tourinho, 2001). One of the organic adaptations related to exercise is the reduction of muscular damage caused by any exercise, including resistance exercises. For resistance exercises, muscle damage seems to be a stimulus of great relevance for the increase in hypertrophic responses of skeletal muscles. However, it tends to be reduced as the repetition of the exercise causes the damage since the body promotes adaptations that recover the affected muscles, creating a kind of protection against similar stimuli that may occur again (Neves, 2014).

According to the repetition of the exercise that caused it, this attenuation of damage is referred to in the literature as the Repeated Bout Effect (RBE). According to Nosaka and Aoki (2011), the RBE is an adaptation that occurs in skeletal muscles when subjected to unusual stimuli that, as a result, can generate muscle damage. When repeated after a period of rest, these unusual stimuli can generate an adaptive process with a reduction of the damage caused in the first moment. Similarly, Togashi (2009) reports that exercise-induced muscle damage (EIMD) occurs when a person performs exercises that are unusual to their routine, of high intensity or long duration. In addition, he points out that the magnitude of muscle damage will depend directly on the overload imposed, the individual's conditioning, and the type of exercise performed. Moreover, the author calls attention to the fact that mechanical stress is the main factor responsible for EIDM, triggered mainly by eccentric exercises, which in turn result in a higher ratio of load per muscle fibre, causing greater stress on actin and myosin filaments, causing the rupture of sarcomeres more easily when compared to concentric and isometric exercises.

Another adaptive response of the body to exercise is the excess post-exercise oxygen consumption, also known as EPOC. This can be defined as the elevation

in oxygen uptake above resting levels during the post-exercise recovery process (Sedlock, Lee, Flynn, Park, & Kamimori, 2010).

Abboud, Greer, Campbell and Panton (2013) report that resistance training can cause the EPOC to last up to 48 hours after the practice. According to the muscle damage caused by the stimuli, this time may be longer or shorter because the body enters a state of muscle tissue repair that requires a higher energy expenditure at rest, resulting in a higher oxygen uptake. According to Burt, Lamb, Nicholas and Twist (2014), the increase in resting energy expenditure after an acute session of partially eccentric exercise is attributed to muscle damage along with the stimulus for muscle recovery. The same authors also report that the energy cost for protein synthesis, a factor of great importance in muscle tissue repair, accounts for approximately 20% of the resting metabolism rate post exertion.

Børsheim and Bahr (2003) report that trained individuals tend to have a shorter EPOC duration when compared to untrained individuals. The authors point out that more studies are needed to conclude this statement. Thus, based on the assumptions above, the present narrative review aims to verify the theoretical endorsement in literature that supports a possible relation between the repeated bout effect and attenuation of EPOC.

EXCESS POST-EXERCISE OXYGEN CONSUMPTION (EPOC)

EPOC is defined as the energy expenditure above resting levels after an acute physical activity. As mentioned in the introduction, this effect can last for up to 48 hours. Several studies point out that the magnitude of EPOC is proportionally related to exercise intensity. However, when we talk about calorie expenditure in the resistance training session itself, the volume variable is the most responsible for the session's energy expenditure (Matsuura, Meirelles, & Gomes, 2006).

Larsen, Welde, Martins and Tjønna (2014) verified the magnitude of EPOC in patients with metabolic syndrome after performing three different exercise sessions, two high-intensity sessions (1x4 min and 4x4 min) at 85-95% of HRmax with active rest at 70% of HRmax for the intermittent session, and one moderate-intensity session, continuous exercise for 47 min at 70% of HRmax. The authors concluded that the high-intensity intermittent session (4x4 min) resulted in the highest magnitudes of EPOC, reaching almost a 50% increase in oxygen uptake compared to the other two sessions. The authors suggest that several mechanisms can be attributed to EPOC, such as the recovery of muscle and blood oxygen stores, increased blood circulation and lactate removal, resynthesis of adenosine triphosphate (ATP) and creatine phosphate (PCr), increased heart rate (HR), ventilation, body temperature, and fatty acid cycling.

Gore and Withers (1990) point to exercise intensity as a determining factor in the increase of EPOC, contributing up to 45.5% of its systematic variation. It can be assumed that exercise intensity reflects the longer duration and magnitude of EPOC after the training session. Similar to aerobic training, resistance training also causes an increase in EPOC right after the session (Paoli et al., 2012). In a study by the same authors, they found that traditional resistance training (TRT) compared to high-intensity interval resistance training (HIIRT) led to a lower magnitude of EPOC. The HIIRT technique used in this study was described as the following: 6 repetitions, 20 seconds rest, 2-3 repetitions, 20 seconds rest, 2-3 repetitions, and 2'30'' rest between each set, with three exercises for a total of 7 sets. On the other hand, TRT consisted of 8 exercises of 4 sets with 8-12 repetitions and 1-2 minutes of rest. These results confirm the hypothesis that EPOC seems to be more influenced by intensity when compared to exercise volume, even though the HIIRT, despite the shorter session time (32 minutes) when compared to TRT (62 minutes), generated a higher magnitude of EPOC in the post-exercise.

Neto, Silva and Farinatti (2009) mention that high-intensity resistance activities with pronounced eccentric contractions may increase the residence time of EPOC up to 48 hours after the exercise and result in an increase of up to 20% in the resting metabolic rate (RMR).

According to Matsuura et al. (2006), there are three components of EPOC: I) the fast component (restoration in the concentration of high-energy phosphates, restoration of oxyhaemoglobin and oxymyoglobin) characterised by a duration of 10 seconds to a few minutes; II) the slow component (thermogenic effects, sympathetic stimulation, lactate removal, and change in energy substrate) with the duration dependent on the degree of intensity of physical activity, which may reach several hours; and III) the ultra-slow component (protein turnover, recovery of homeostasis after intense exhaustion caused by exercises with prevalent eccentric contraction) lasting up to 48 hours. The highest EPOC values are observed in the fast phase. In the slow phase, there is a considerable decrease in energy expenditure because, even though it is still in the process of recovery, the need for oxygen uptake is significantly reduced compared to the fast phase.

REPEATED BOUT EFFECT (RBE)

As already mentioned, the RBE is an adaptation that occurs in skeletal muscles when they are subjected to unusual stimuli, generating muscle damage (Nosaka & Aoki, 2011). Chen et al. (2019) report the existence of the Repeated Bout Effect (RBE) in limbs such as arms, legs, and trunk by performing

Matsuura et al. (2006) also complement their studies, corroborating them with other studies stating that the duration and magnitude of EPOC are interconnected with exercise intensity. On the other hand, the intensity does not reflect a higher energy expenditure in the session itself, when compared to volume.

nine different bilateral exercises performed only eccentrically by 15 young people. Using maximal voluntary contraction (MVC), plasma creatine kinase (CK), delayed muscle soreness (DMS), and myoglobin concentration (Mb) as markers of damage, the study analysed the behaviour of the RBE between two eccentric training sessions with a 2-week interval between each session. At the end of the study, it was concluded that muscle damage was shown to be higher in the arms, when compared to the trunk and lower limbs. It was also found that the magnitude of the damage marker values was significantly reduced after the second training session, proving the action of the RBE.

In another work conducted by Zourdos et al. (2015), they studied the action of the RBE by performing exercises similar to the one performed in the first session to clarify if the action of the RBE is dependent on the repetition of the same exercise. In this study, 21 men with an average age of 21 years, separated into two groups, performed two training sessions. In the first, both groups performed five sets of 6 repetitions of the inclined barbell curl exercise, using 50% of the load obtained by testing a maximum isometric contraction. In the second session, one group repeated the same exercise. The other performed a similar exercise, known as preacher curl or Scott thread. Both groups demonstrated significantly faster recovery after the second session, when compared to the first, even though one group performed a different exercise than the previous one in the second session. Such results suggest the occurrence of the RBE not only in identical exercises but also in similar exercises.

The magnitude of muscle damage induced by eccentric exercises is affected by different factors, such as training intensity, speed of contraction, number of contractions, muscle amplitude, muscle group, exposure to daily activities with the presence of characteristics similar to eccentric contractions (e.g., heavy manual labour), age, and sex. It can also be affected according to the intensity of the contraction. In a study conducted by Hyldahl, Chen and Nosaka (2017), the RBE in elbow flexor exercises at four intensities, 80%, 60%, and 40% of maximum, performed in two sessions with a 2-3 week interval between each session, was compared. The results obtained through the markers of damage (MVC, range of motion, arm circumference, muscle swelling, CK, and myoglobin) showed that the RBE occurs proportionally according to the intensity of the exercise, but that regardless of the intensity, the protective effects become present after the second training session in which the same or similar exercises are performed again. Another important finding of the study is that the magnitude of muscle damage is attenuated in the sessions following the first one, even at different intensities, velocities, number of contractions, and muscle amplitude, and it is also noticed after maximal isometric contractions at a large muscle amplitude (20°)Chen et al. (2019) analysed the contralateral RBE (CL-RBE), i.e., tests were performed to test the hypothesis that, even when an exercise is performed by only one side of the body (left or right), the other limb also experiences the effect of the RBE. At the end of the study, it was concluded that the CL-RBE was evident for the knee extensors, lasting only seven days after the first exercise was performed on the contralateral limb. Another important finding of the study is that the magnitude of the CL-RBE was similar between the arms (elbow extensors and flexors) and legs (knee extensors and flexors). However, the duration of the RBE for the legs is shorter, when compared to the arms.

DELAYED ONSET MUSCLE SORENESS (DOMS)

As the RBE acts in various ways, subsequent sessions experience reductions in their signalling aspects of muscle damage. As excess post-exercise oxygen consumption (EPOC) is related to caloric expenditure for muscle recovery, it can be said that there is an interrelationship between RBE and EPOC, affecting the intensity and duration of exercise.

Because of the protective effect of the RBE, it becomes necessary to talk about ways to stimulate the body to perform such adaptations. According to Yamada, Junior and Pereira (2010), resistance exercise is considered one of the best methods in terms of effectiveness when it comes to improving sports performance, as well as promoting and maintaining physical capabilities such as strength, speed, power, balance, endurance, and motor coordination, as well as hypertrophy. Numerous training methodologies aim to manipulate the variables that compose it (repetitions, loads, intensity, recovery intervals, and volume, among others) for a specific purpose.

One of the most noticeable consequences of resistance exercise, especially for beginners, is the presence of delayed onset muscle soreness (DOMS). Hotfiel et al. (2018) characterised the DOMS as an ultrastructural muscle damage caused by eccentric or unusual exercise to the routine. Among the signs of DOMS, we can cite reduced strength capacity, painful restriction to movement, muscle stiffness, swelling, and dysfunction of adjacent joints. DOMS signals protein degradation, apoptosis ("cell death"), and local inflammatory response. Also, according to the authors, its presence can start

6 to 12 hours after the exercise, reaching a peak of pain in 48 to 72 hours, being diminished from then on, disappearing after 5 to 7 days. However, it is relevant to point out that such values are relative to the intensity and form of the exercises.

One of the most noticeable consequences of resistance exercise, especially for beginners, is the presence of delayed onset muscle soreness (DOMS).
wLewis, Ruby and Bush-Joseph (2012) present six theories that help explain the mechanism of DOMS: lactate accumulation, muscle spasm, microtrauma, connective tissue damage, inflammation, and efflux of electrolytes and enzymes. Although these are individual mechanisms and theories, there is a strong suggestion that they work together when it comes to muscle damage. In conclusion, the authors establish a connection of these six theories initiated by microtrauma upon exercise, affecting the connective tissues surrounding the microtrauma, signalling a local inflammatory process along with electrolyte and fluid exchange. As a result of these events, we may witness muscle spasms in response to the exacerbation of the overall condition. Out of all the ways to manage DOMS symptoms, the most recommended is to continue physical activity, both because it releases endorphins and increases local blood circulation, causing an anaesthetic effect and because continuity causes physiological and biochemical adaptations that may reduce DOMS on the next occasion

When dealing with strength training, muscle damage, and DOMS, we cannot leave aside one of the main components that cover these issues: the type of contraction. In a systematic review, Douglas, Pearson, Ross and McGuigan (2017) address the eccentric contraction compared to concentric and isometric contractions in traditional resistance training, which usually covers the three types of contraction due to the final objective of the training. The authors conclude that eccentric training, when performed emphatically or with a load greater than the maximum load obtained in a concentric contraction test, is of greater relevance in promoting adaptive factors for the human being.
A training with eccentric characteristics has a different hypertrophic nature than training with concentric characteristics, once the first promotes an increase of sarcomeres in series, causing changes in the distance of the muscular fascia. The increase in sarcomeres can also increase the speed of muscle shortening and increase force production at greater ranges of motion. On the other hand, concentration training can derive greater mean (peak muscle) muscle hypertrophy (Douglas et al., 2017). The study on eccentric training has been gaining much importance given its importance in developing individuals' performance and physical capabilities. It can also be related to numerous morphological, physiological, and biochemical changes.

It is also worth noting that this type of contraction alone is solely responsible for these improvements and the speed at which the eccentric contraction is performed. Eccentric exercises performed at a higher speed tend to induce greater gains in strength, power, and elongation-shortening cycle, subsequently influencing the increase in cross-sectional area and the increase in type IIx fibre composition (Douglas et al., 2017).
It is known that there is an interdependent relationship between all the variables used in this review since a specific factor leads to the occurrence of the other both directly and indirectly. Initially, resistance exercise has countless manipulable variables (e.g., intensity, volume, type of contraction, training methodologies) that can be readjusted according to the intention of the training sessions for a given individual. The vast majority of the time, physical exercises performed both concentrically but primarily eccentrically tend to stimulate the occurrence of what we call DOMS (Heiss et al., 2019). Muscle damage triggers a series of processes that have as a primary purpose the reconstruction of muscle tissue and its adaptation to similar stimuli that may be performed in future training sessions, what we call repeated load effect (RCE) (Hyldahl et al., 2017). Thus, it is known that there is an energy expenditure related to physical activities and depends on all its manipulative variations. Such energy expenditure happens both during the session (proportionally more affected by volume than intensity) and after the session, where EPOC occurs. The latter, in its turn, is proportionally more related to the intensity of the stimuli performed during the session (Matsuura et al., 2006). The EPOC, more specifically, is the energy expenditure derived from the constant attempt of our body to reach homeostasis again (after a stressful stimulus from physical activities), which is the perfect balance of the body's internal conditions. All these factors act in direct dependence on the initial capacity of the individual to perform such activities, with variations according to age, gender, and chronic limitations, such as diseases and disabilities. However, all these factors are adaptive; that is, following the principles of resistance training, our body can develop and adapt, attenuating the magnitude of muscle damage, DOMS, EPOC, and other adaptive components. Thus, it can be said that the RBE inevitably affects all these factors, contributing to our hypothesis that EPOC may have its magnitude and duration reduced after the second resistance training session with the same characteristics as the first.

CONCLUSION

Considering all the studies analysed, it can be assumed that EPOC is closely related to muscle damage because whenever the latter occurs in a higher incidence, the body will consequently have a higher EPOC due to muscle repair processes. Therefore, as the Repeated Load Effect is characterised by the reduction of muscle damage from the repetition of similar exercises, such variables (RBE and EPOC) become inversely proportional.

Other information obtained with this study indicates different panoramas that refer to several ways of manipulating training variables, aiming at different objectives represented by each individual's needs, helping to elaborate training protocols that fit the practitioner's objectives. Such assumptions are essential, but more research is needed that can relate the RBE to the EPOC in order to contribute to the literature with the intention of researching, evaluating, and developing possible methodologies and training variables, both resistance and aerobic, that are important for the control of energy expenditure related to body weight maintenance and improvement in quality of life facing this condition studied in the present study.

REFERENCES

1. Abboud, G. J., Greer, B. K., Campbell, S. C., & Panton, L. B. (2013). Effects of Load-Volume on EPOC After Acute Bouts of Resistance Training in Resistance-Trained Men. J Strength Cond Res, 27(7), 1936–1941.
2. Børsheim, E., & Bahr, R. (2003). Effect of exercise intensity, duration and mode on post-exercise oxygen consumption. Sports Med, 33(14), 1037-1060.
3. Burt, D. G., Lamb, K., Nicholas, C., & Twist, C. (2014). Effects of exercise-induced muscle damage on resting metabolic rate, sub-maximal running and post-exercise oxygen consumption. Eur J Sport Sci, 14(4), 337–344.
4. Chen, T. C., Lin, M. J., Chen, H. L., Yu, H. I., & Nosaka, K. (2018). Contralateral Repeated Bout Effect of the Knee Flexors. Med Sci Sports Exerc, 50(3), 542–550.
5. Chen, T. C., Yang, T. J., Huang, M. J., Wang, H. S., Tseng, K. W., Chen, H. L. ... Nosaka, K. (2019). Damage and the repeated bout effect of arm, leg, and trunk muscles induced by eccentric resistance exercises. Scand J Med Sci Sports, 29(5), 725–735.
6. Douglas, J., Pearson, S., Ross, A., & McGuigan, M. (2017). Chronic Adaptations to Eccentric Training: A Systematic Review. Sports Med, 47(5), 917–941.
7. Gore, C. J., & Withers, R. T. (1990). The effect of exercise intensity and duration on the oxygen deficit and excess post-exercise oxygen consumption. Eur J Appl Physiol Occup Physiol, 60(3), 169-174.
8. Heiss, R., Lutter, C., Freiwald, J., Hoppe, M. W., Grim, C., Poettgen, K. ... Hotfiel, T. (2019). Advances in Delayed-Onset Muscle Soreness (DOMS) – Part II: Treatment and Prevention. Sportverletz Sportschaden, 33(1), 21–29.
9. Hotfiel, T., Freiwald, J., Hoppe, M. W., Lutter, C., Forst, R., Grim, C. ... Heiss, R. (2018). Advances in Delayed-Onset Muscle Soreness (DOMS): Part I: Pathogenesis and Diagnostics. Sportverletz Sportschaden, 32(4): 243–250.
10. Hyldahl, R. D., Chen, T. C., & Nosaka, K. (2017). Mechanisms and Mediators of the Skeletal Muscle Repeated Bout Effect. Exerc Sport Sci Rev, 45(1), 24–33.
11. Larsen, I., Welde, B., Martins, C., & Tjønna, A. E. (2014). High- and moderate-intensity aerobic exercise and excess post-exercise oxygen consumption in men with metabolic syndrome: Exercise and post-exercise oxygen consumption. Scand J Med Sci Sports, 24(3), e174–e179.
12. Lewis, P. B., Ruby, D., Bush-Joseph, C. A. (2012). Muscle Soreness and Delayed-Onset Muscle Soreness. Clin Sports Med, 31(2), 255–262.
13. Matsuura, C., Meirelles, C. M., & Gomes, P. S. C. (2006). Gasto energético e consumo de oxigênio pós-exercício contra-resistência. Rev Nutr, 19(6), 729–740.
14. Neto, A. G. C., Silva, N. L., & Farinatti, P. T. V. (2009). Influência das variáveis do treinamento contra-resistência sobre o consumo de oxigênio em excesso após o exercício: uma revisão sistemática. Rev Bras Med Esporte, 15(1), 70–78.
15. Neves, R. (2014). Efeito da carga repetida: uma breve revisão sobre os mecanismos envolvidos na proteção contra o dano muscular decorrente do treinamento de força. Rev Corpoconsciência, 18(2), 8–20.
16. Nosaka, K., & Aoki, M. S. (2011). Repeated bout effect: research update and future perspective. Braz J Biomotricity, 5(1), 5-15.
17. Paoli, A., Moro, T., Marcolin, G., Neri, M., Bianco, A., Palma, A. ... Grimaldi, K. (2012). High-Intensity Interval Resistance Training (HIRT) influences resting energy expenditure and respiratory ratio in non-dieting individuals. J Transl Med, 10(1), 237.
18. Sedlock, D. A., Lee, M. G., Flynn, M. G., Park, K. S., & Kamimori, G. H. (2010). Excess Postexercise Oxygen Consumption After Aerobic Exercise Training. Int J Sport Nutr Exerc Metab, 20(4), 336–349.
19. Togashi, G. B. (2009). Dano muscular induzido pelo sistema de treinamento de cargas descendentes em exercício resistido (Dissertação - Mestrado em Bioengenharia). Universidade de São Paulo, São Carlos, Brazil.
20. Tourinho, H. F. (2001). Respostas morfo-fisiológicas do organismo ao treinamento aeróbio e de força. Rev Médica HSVP, 11(28), 23-30.
21. Yamada, A. K., Junior, T. P. S., & Pereira, B. (2010). Treinamento de força e hipertrofia muscular: respostas inflamatórias e imunológicas. Arquivos em Movimento, 6(1), 141–160.
22. Zourdos, M. C., Henning, P. C., Jo, E., Khamoui, A. V., Lee, S. R., Park. Y. M. ... Kim, J. S. (2015). Repeated Bout Effect in Muscle-Specific Exercise Variations. J Strength Cond Res, 29(8), 2270–2276.

EFEKAT PONAVLJANJA SERIJE VJEŽBI I PREKOMJERNA POTROŠNJA KISIKA NAKON VJEŽBANJA (EPOC): NARATIVNI PREGLED

Baš kao i drugi načini vježbanja, vježbe sa opterećenjem mogu prouzrokovati različit intenzitet i trajanje prekomjerne potrošnje kisika nakon vježbanja (EPOC). Oštećenje mišića može predstavljati jedan od faktora koji utiču na EPOC. Prema tome, ponavljanje neuobičajene vježbe sa opterećenjem, u literaturi poznato i kao efekat ponavljanja serije vježbi (RBE), smanjuje oštećenje mišića tokom druge serije. Cilj ovog narativnog pregleda je bio provjeriti potencijalne odnose između RBE i EPOC-a i, prema tome, predložiti buduća istraživanja koja bi ukazala na ovu eventualnu povezanost. Analizirajući povezanost između istraživanja koja se odnose na RBE, EPOC i oštećenje mišića, možemo postaviti hipotezu da je EPOC manje prisutan kod vježbi koje imaju veću učestalost RBE-a. To znači da odbrambeni mehanizmi koji proizlaze iz RBE-a također uzrokuju niže vrijednosti EPOC-a te čine ove varijable obrnuto proporcionalnim.

Ključne riječi: oštećenje mišića, potrošnja tjelesne energije, trening sa opterećenjem, tjelesna građa

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THE RELATIONSHIP OF AGE, BODY MASS INDEX AND PLAYER POSITION ON INJURY RATES IN WOMEN'S HANDBALL

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ABSTRACT

The aim of the paper was to describe the most common injuries in senior and cadet handball players of Croatia Women's National Handball Team during a period of two years and investigate the connection between the most common injuries and player positions such as back, wing and line position, as well as to investigate the possible impact of player's age and body mass index (BMI) on the injury rates using Poisson regression.

Older players had a lower probability of ankle dislocations but a higher probability for dislocations of the middle phalanx of the finger, thigh contusions and generally getting injured. Wing players had a lower probability of ankle dislocation and a lower probability of generally experiencing any injury than back players. BMI showed no relationship with the injury rates.

Keywords: sports injuries, handball, player positions in female handball

INTRODUCTION

The most commonly stated acute injuries in research conducted in handball (Åman et al., 2018; Luig & Henke, 2011; Mónaco et al., 2014; Rafnsson et al., 2019; Raya-González et al., 2020) are sprains and contusions, and the parts of the body that are most commonly injured are the knees, ankles and fingers. Injuries in athletes occur due to frequent changes of the surface on which handball is played, such as the inflammation of the Achilles tendons and periostitis (Olsen et al., 2003). Research shows that handball resin, which is used in handball in order to improve the grip of the ball, contributes to the occurrence of jammed fingers and the displacement of small finger bones (Luig & Henke, 2011). Due to the greater number of contacts, there is a greater number of blows that cause bruises, abrasions, stretching of muscles and ligaments, crushing, bruising, and other sports injuries (Bere et al., 2015).

In the research conducted by German authors (Henke et al., 2010), they state that, in the female and male active handball players pertaining to the age range of 14 to 45 years in Germany, the most common acute injuries are sprains and contusions. Their ratio is two injuries per 1000 (working) hours of training or playing. It is important to emphasise that women have more frequent non-contact lower extremity injuries – 32% of knee injuries and 22% of ankle injuries. Male handball players have a higher share of contact injuries and their injuries also depend on the position they play. The authors state that, in female handball players, the most common injuries of the lower extremities are sprains and contusions.

The results of systematic monitoring of athletes' injuries by player positions and manner of movement (whether playing attack or defence) indicate that athletes are more exposed to injuries in the position of a line (Bere et al., 2015), left, centre and right back players in attacking position. Attacking players are more exposed to acute sports injuries (Seil et al., 1998).
The type of surface also affects the incidence and type of injury. Olsen et al. (Olsen et al., 2003) reported that there is a higher number of anterior cruciate ligament (ACL) injuries in women on an artificial surface than there is in men. According to them, all artificial surfaces have higher friction compared to parquet, and thus can increase the risk of knee and ankle injuries in female players. Acute knee injuries in female players on artificial surfaces often occur without contact with a rival female player. The same study found that younger athletes in Scandinavia are more prone to injuries and fractures of fingers, wrists, and forearms. They found that the percentage of injuries in handball increases in younger handball players who play handball at a higher level, for example, in the European and World Championships where injuries occur due to the nature of the sport which is based on changing movement direction, speed, strength, and explosiveness (Póvoas et al., 2012).
The aim of the research is to ascertain the relationship of age, BMI and player position with injury rates.

METHODS

In this observational research, we collected data and information on Croatia women's national handball team players (seniors, ages 19-35 and cadets, ages 17-19) concerning their general health, acute and chronic injuries in the period from 2015 and 2016 during preparations and competitions of individual national teams. A total of 42 handball players were included in the research.

The IOC form was used, which is filled in during the occurrence of an injury in the course of training or competitive matches that are played exclusively in connection with the World and European Championships in the preparation period, qualifications and the championship itself.

In addition to injury and player position data, socio-demographic and anthropometric data, such as age, height, and weight, were collected, while BMI was calculated using the height and weight data.

The collected data were statistically processed using the R version 4.0.3 program. Prior to analysis, the assumption that injury incidence data were reasonably consistent with the Poisson distribution was verified. The influence of age, body mass index (BMI) and player position of female players on the incidence of injuries was modelled using Poisson regression. For the analysis of the categorical variable of player position (back, wing and line players), the back player category was used as a reference category due to having highest injury rates. The probability of a Type I error was placed at 5%.

RESULTS

Out of the total number of 42 female handball players, 19 were cadets and 23 were senior handball players. The average age of all handball players is 23.13 years, while their average body mass index is 23.13 kg/m2. The average height is 176 cm and the weight is 69.87 kg. The majority of the players (83.3%) have a dominant right hand, 47.6% are left, centre and right backs, 14.3% are line players, and 38.1% play in other positions

Table 1 shows the means and standard deviation parameters of age, height, weight, and BMI of 42 Croatia women's national handball team players by player positions.

Table 1. Anthropometric variables of female handball players (N = 42)

	Back (N = 20)	Wing (N = 16)	Line (N = 6)
Age	23.5 (5.16)	23.4 (5.84)	22.5 (4.97)
Height	179 (6.51)	173 (5.92)	176 (5.61)
Weight	71.9 (8.44)	63.5 (5.63)	74.2 (8.30)
BMI	22.5 (1.45)	21.2 (0.93)	23.9 (2.71)

Table 2 shows the results of Poisson regression models.

Table 2. Basic parameters of Poisson regression models for all dependent variables

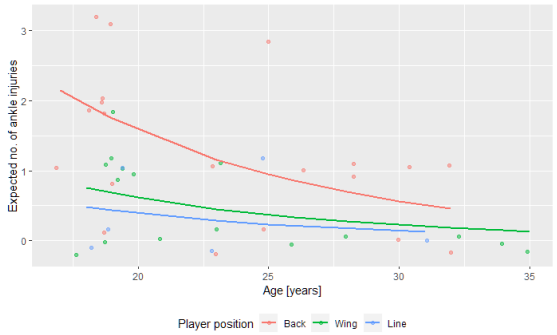
Ankle dislocation	**B**	**SE**	***p***	**Exp (B)**
• Age	-0.103	2.961	0.014	0.902
• BMI	0.004	0.119	0.975	/
• Back vs Wing	-0.934	0.434	0.0311	0.393
• Back vs Line	-1.398	0.765	0.677	/
Dislocations of the middle phalanx of the finger				

• Age	0.064	0.016	< 0.001	1.066
• BMI	-0,055	0.062	0.375	/
• Back vs Wing	-0.272	0.21	0.196	/
• Back vs Line	0.247	0.254	0.972	/
Thigh contusion				
• Age	0.064	0.022	0.003	1.066
• BMI	0.043	0.071	0.537	/
• Back vs Wing	-0.539	0.306	0.078	/
• Back vs Line	0.526	0.297	0.077	/
Thumb dislocation				
• Age	0.022	0.044	0.618	/
• BMI	-0.115	0.186	0.537	/
• Back vs Wing	-0.052	0.561	0.927	/
• Back vs Line	-0.035	0.809	0.965	/
Total injuries				
• Age	0.0291	0.009	< 0.001	1.03
• BMI	-0.007	0.031	0.0835	/
• Back vs Wing	-0.346	0.115	0.003	0.707
• Back vs Line	0.113	0.137	0.826	/

Legend: B - regression coefficient; **SE** - standard error, **Exp (B) –** injury rate ratio

For each additional year, there is a 9.8% lower probability of ankle dislocation, a 6.6% higher probability both of dislocation of the middle phalanx of the finger and of thigh contusion, and a 3% higher probability of injury in general. Wing players had 60.7% lower probability of ankle dislocation than wing players (reference category).

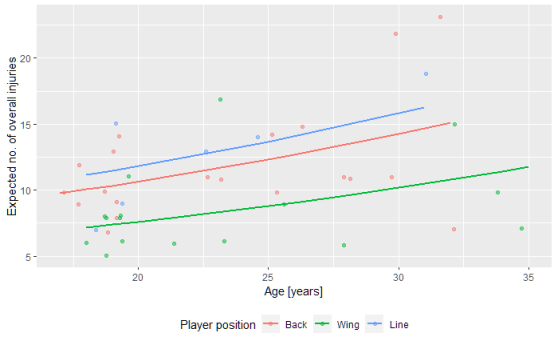
Graph 1. Predicted number of ankle injuries



Graph 1 shows the predicted number of injuries according to our model if the Age variable is held constant across player positions. Back position players have the highest rate of ankle dislocations; however, the injury rate drops more rapidly with age when compared to the wing position players. Graph 2 shows the predicted overall number of injuries if age is held constant.

Back position players have a consistently higher rate of overall injuries than line position players. While line position player rates appear to have higher overall injury rate, the comparison was statistically insignificant, and this result stems from the low sample size.

Graph 2. Predicted number of overall injuries



DISCUSSION

For each additional year of age, the incidence of injuries increases by approximately 3%, which is also expected according to the research of senior handball players to date (Achenbach et al., 2018; Raya-González et al., 2020). Related to this, in our study, the incidence of dislocation of the middle phalanx of the finger is increased by 6.6%. The assumption is that with each year, the incidence of injuries increases as a result of an increase in the number of hours of training and playing high-level handball, which results in an increase in the number of thigh contusions and dislocations of the middle phalanx of the hand in the national team. Data from Spanish researchers (Achenbach et al., 2018) report

that senior players had a higher overall incidence of injuries; however, their research was conducted on female handball players competing at a lower level. Raya-González et al. (Raya-González et al., 2020) emphasise the frequency of injuries in older female professional handball players (such as bruises and sprains). A higher level of competition, i.e., national teams, requires more hours of training and playing, and these athletes are more prone to a higher number of injuries. In younger age groups, and especially in women, the physical body is developing and it takes a period of time to achieve motor agility. In women of the younger age groups, there is a higher number of ankle dislocations, which is an indicator of the need to implement targeted prevention exercise programmes. Similarly, Bahr et al. (Bahr et al., 2018) state the need to introduce guidelines for the control of sports injuries in order to monitor injuries and their causes, and thus implement protection measures.

According to the player positions in the study conducted by Raya-González et al. (Raya-González et al., 2020), wings and backs had the highest percentage of injuries.

In our research, when compared to wing players, back players had a higher probability of ankle distortions and of generally getting injured. The type of injuries in back players is influenced by the position of the body during contact and the speed and change of direction in the game. During attack, back players are blocked by opponent players when shooting. Situational play, quick reactions and sudden stops from opponent players lead to unforeseen injuries. Both earlier (Fagerli et al., 1990; Myklebust et al., 1998) and more recent research (Bere et al., 2015; Yousefi, 2015) on elite male players show very similar results.

CONCLUSION

Age is significantly related to the number of ankle dislocations, dislocations of the middle phalanx of the finger, and total injuries. Back players are more at risk of generally getting injured than wing players. The risk is even higher for ankle dislocations injures, specifically.

REFERENCES

1. Achenbach, L., Loose, O., Laver, L., Zeman, F., Nerlich, M., Angele, P., & Krutsch, W. (2018). Beach handball is safer than indoor team handball: Injury rates during the 2017 European Beach Handball Championships. Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal of the ESSKA, 26(7), 1909–1915. https://doi.org/10.1007/s00167-018-4907-5

2. Åman, M., Forssblad, M., & Larsén, K. (2018). Incidence and body location of reported acute sport injuries in seven sports using a national insurance database. Scandinavian Journal of Medicine & Science in Sports, 28(3), 1147–1158. https://doi.org/10.1111/sms.12956

3. Bahr, R., Clarsen, B., & Ekstrand, J. (2018). Why we should focus on the burden of injuries and illnesses, not just their incidence. British Journal of Sports Medicine, 52(16), 1018–1021. https://doi.org/10.1136/bjsports-2017-098160

4. Bere, T., Alonso, J.-M., Wangensteen, A., Bakken, A., Eirale, C., Dijkstra, H. P., Ahmed, H., Bahr, R., & Popovic, N. (2015). Injury and illness surveillance during the 24th Men's Handball World Championship 2015 in Qatar. British Journal of Sports Medicine, 49(17), 1151–1156. https://doi.org/10.1136/bjsports-2015-094972

5. Fagerli, U. M., Lereim, I., & Sahlin, Y. (1990). [Injuries in handball players. Tidsskrift for den Norske laegeforening, 110(4), 475–478.

6. Henke, T., Luig, P., Kisser, R., Rogmans, W., Kloet, S., & Schulz, D. (2010). Safety in sports development of practical guidelines for injury prevention and safety promotion in sports. Injury Prevention - INJ PREV, 16. https://doi.org/10.1136/ip.2010.029215.788

7. Luig, P., & Henke, T. (2011). Acute Injuries in Handball (pp. 78–83).

8. Mónaco, M., Gutiérrez Rincón, J. A., Montoro Ronsano, J. B., Til, L., Drobnic, F., Nardi Vilardaga, J., Puigdellivol Grifell, J., Pedret Carballido, C., & Rodas, G. (2014). Epidemiología lesional del balonmano de elite: Estudio retrospectivo en equipos profesional y formativo de un mismo club. Apunts Sports Medicine, 49(181), 11–19. https://doi.org/10.1016/j.apunts.2013.06.002

9. Myklebust, G., Maehlum, S., Holm, I., & Bahr, R. (1998). A prospective cohort study of anterior cruciate ligament injuries in elite Norwegian team handball. Scandinavian Journal of Medicine & Science in Sports, 8(3), 149–153. https://doi.org/10.1111/j.1600-0838.1998.tb00185.x

10. Olsen, O. E., Myklebust, G., Engebretsen, L., Holme, I., & Bahr, R. (2003). Relationship between floor type and risk of ACL injury in team handball. Scandinavian Journal of Medicine & Science in Sports, 13(5), 299–304. https://doi.org/10.1034/j.1600-0838.2003.00329.x

11. Póvoas, S. C. A., Seabra, A. F. T., Ascensão, A. A. M. R., Magalhães, J., Soares, J. M. C., & Rebelo, A. N. C. (2012). Physical and physiological demands of elite team handball. Journal of Strength and Conditioning Research, 26(12), 3365–3375. https://doi.org/10.1519/JSC.0b013e318248aeee

12. Rafnsson, E. T., Valdimarsson, Ö., Sveinsson, T., & Árnason, Á. (2019). Injury Pattern in Icelandic Elite Male Handball Players. Clinical Journal of Sport Medicine: Official Journal of the Canadian Academy of Sport Medicine, 29(3), 232–237. https://doi.org/10.1097/JSM.0000000000000499

13. Raya-González, J., Clemente, F. M., Beato, M., & Castillo, D. (2020). Injury Profile of Male and Female Senior and Youth Handball Players: A Systematic Review. International Journal of Environmental Research and Public Health, 17(11), 3925. https://doi.org/10.3390/ijerph17113925

14. Seil, R., Rupp, S., Tempelhof, S., & Kohn, D. (1998). Sports injuries in team handball. A one-year prospective study of sixteen men's senior

teams of a superior nonprofessional level. The American Journal of Sports Medicine, 26(5), 681–687. https://doi.org/10.1177/036354659 80260051401

15. Vuleta, D., Milanović, D., & Gruić, I. (2003). Kondicijska priprema rukometaša. Kondicijska priprema sportaša, 491.

16. Yousefi, M. (2015). Handball Injuries in Elite Asian Players. https://doi.org/10.13140/RG.2.1.1359.5608

POVEZANOST DOBI, INDEKSA TJELESNE MASE I POZICIJE IGRAČA SA STOPOM POVREDA U ŽENSKOM RUKOMETU

Cilj rada je bio opisati najčešće povrede rukometašica, seniorki i kadetkinja Ženske rukometne reprezentacije Hrvatske, u periodu od dvije godine i istražiti vezu između najčešćih povreda i pozicija igrača kao što su bek, krilo i pivot, kao i istražiti mogući utjecaj dobi igračica i indeksa tjelesne mase (BMI) na stopu povreda koristeći Poissonovu regresiju.
Starije igračice su imale manju vjerovatnoću iščašenja skočnog zgloba, ali veću vjerovatnoću iščašenja srednje falange prsta, kontuzije butine i općih povreda. Krilne igračice su imale manju vjerovatnoću iščašenja skočnog zgloba i manju vjerovatnoću da će općenito zadobiti bilo kakvu povredu nego igračice na poziciji beka. BMI nije pokazao vezu sa stopom povreda.

Ključne riječi: sportske povrede, rukomet, pozicije igrača u ženskom rukometu

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THE ROLE OF SPORTS FEDERATIONS IN OPPOSING FAN HOOLIGANISM – FC RED STAR CASE STUDY

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ABSTRACT

States oppose hooliganism at sports events in various ways. The entities that can be involved in solving this problem are sports federations and clubs, but their role is not much considered in professional literature. For the purposes of this paper, an analysis of 388 delegate reports from the matches played by FC Red Star was performed from the season 2010/2011 to 2018/2019 in addition to 94 decisions to punish FC Red Star by the disciplinary bodies of the FSS and UEFA. The results of the conducted research indicate that, in practice, the disciplinary sanctions imposed by UEFA gave better results in relation to, in our opinion, inadequate sanctions imposed by the disciplinary bodies of the Football Association of Serbia (FSS).

Keywords: sports federation, oppose, hooliganism, FC Red Star

INTRODUCTION

Hooliganism in sports is present everywhere in the world. States oppose this problem in various ways. Legal systems try to provide appropriate answers to this negative phenomenon (Stanić & Andonović, 2020), first of all, by passing special laws that are exclusively intended to suppress hooliganism at sports competitions.

The primary role in resolving violence at sports events is attributed to the police (Adang & Brown, 2008; Milojević & Janković, 2012; Stott, Livingstone, Adang, & Schreiber, 2008) and the administration of justice. Recently, private security agencies have become increasingly involved too. (Đurđević & Otašević, 2016; Janković, 2020). However, these are mainly repressive activities of various social entities, while in the countries of the Western Balkans in particular, there are no prevention programmes aimed at young people and fans (Milojević, Simonović, Janković, Otašević, & Turanjanin, 2014).

In addition to the mentioned entities, a very important role is played by sports federations and international sports organisations, which are directly in charge of the realisation of sports competitions. However, their role in solving these problems is not much considered, neither in the professional nor in the general public (Šuput, 2012). Sports federations must have good regulations governing the rules of conduct for all participants in a sports event (Kastratović, Ahmić, Slijepčević, & Stanković, 2019), but they must also be involved in various preventive activities related to the development of a culture of cheering, supporting and fair play.

RESEARCH-RELATED PROBLEMS

Different ways used by national sports federations and international sports organisations in applying the provisions related to violent behaviour of fans can be shown on the example of fines imposed on football clubs in accordance with the provisions of the disciplinary regulations of the Football Association of Serbia (FSS, 2017) and UEFA, 2020 (Đurđević, 2018). What distinguishes these two regulations is that the UEFA Regulations list the exact fines for certain offenses. Thus, for example, for the ignition of pyrotechnic devices, the UEFA Regulations provide for a fine in the amount of 500 Euros for each lit pyrotechnic device, and if this violation is repeated, the fine is increased by 50%. It is important to note that the FSS Rulebook does not provide for the amount of fines, but they are determined by a special decision, which is usually made before the start of the season. A special decision of the FSS from 2016 very imprecisely prescribes that a fine of 100,000to 1,500,000 dinars can be imposed for disciplinary offenses, without explaining either in the Decision or in the Rulebook for which offenses a certain fine is imposed. The manner in which the legal norms contained in the mentioned regulations are applied and their results in practice will be shown on the example of FC Red Star.

FC Red Star is one of the most trophy-winning clubs in Serbia, and the club with the largest number of fans and supporters. This is also shown by the data of the Ministry of Internal Affairs of the Republic of Serbia which indicate that 727 Red Star fans categorised as risky were registered in the territory of Belgrade alone, and most of them are persons with substantial criminal files (Otašević, 2010).

METHOD

For the purposes of the research, an analysis of 388 delegate reports from the matches played by FC Red Star was performed from the season 2010/2011 to 2018/2019 in addition to 94 decisions to punish FC Red Star by the disciplinary bodies of the FSS and UEFA. Out of 94 decisions on penalties, 56 (26 decisions on penalties for several matches and 30 decisions on penalties for individual matches) were issued by the FSS, while 38 decisions were issued by UEFA disciplinary bodies. The Red Star football club was taken as an example because, in the observed period, it played the most football matches, out of all Serbian clubs in Serbia, under the patronage of UEFA.

RESULTS

In the observed period, FC Red Star played a total of 388 matches, out of which 334 were played in domestic competitions (Serbian championship and cup) and 54 in UEFA competitions (Chart 1).

Table 1. FC Red Star matches played – by competitions and seasons

Season	Number of matches in the championship	Number of matches in the Cup competition	Total number of matches in domestic competitions	Number of matches in European competitions	Total number of matches per season
2010/2011	30	5	35	2	37
2011/2012	30	6	36	4	40
2012/2013	30	3	33	6	39
2013/2014	30	3	33	4	37
2014/2015	30	2	32	-	32
2015/2016	37	2	39	2	41
2016/2017	37	6	43	6	49
2017/2018	37	3	40	16	56
2018/2019	37	6	43	14	57
Total for all seasons	**298**	**36**	**334**	**54**	**388**

Out of a total of 334 matches played in domestic competitions, due to various outbursts of its fans, FC Red Star was penalised for outbursts of its fans in 33% of matches played (110 matches), out of which 60 matches were played at home and 50 away. The largest number of fines imposed were fines in the total amount of 138,284.00 Euros (Table 2) for bringing and using pyrotechnic devices (torches, cannon crackers, firecrackers), throwing objects on the field, causing riots in the stands, displaying banners of inappropriate content, misconduct and inappropriate chanting, and destruction of inventory.

In addition to the fines imposed on 110 matches, the club was fined for two more matches with other, more severe penalties. For example, due to the riots in the match with FC Partizan, played on 16th April 2016, at home, the club, in addition to a fine, was sentenced to play three championship or cup matches without the presence of spectators. This came as a result of the incidents caused by home fans which reflected in the mass use of pyrotechnics due to which the game was interrupted several times. A large number of objects were thrown onto the field; there were mutual physical clashes between fans of the two clubs and clashes between home team fans and the police. Broken chairs and torches were thrown at the police officers, together with various hard and solid objects thrown at one of the FC Partizan players. Additionally, banners of unacceptable content were also displayed.

Table 2. Fines imposed on FC Red Star by competitions and per seasons

Season	Matches in domestic competitions	Matches in European competitions	Total per season
2010/2011	4,338	10,000	14,338
2011/2012	32,173	60,000	92,173
2012/2013	10,463	52,750	63,213
2013/2014	*	175,000	175,000
2014/2015	4,216	**	4,216
2015/2016	6,647	***	6,647
2016/2017	34,919	89,000	123,919
2017/2018	19,333	364,000	383,333
2018/2019	26,195	305,250	331,445
Total for all seasons	**138,284**	**1,056,000**	**1,194,284**

The amounts in the charts are given in Euros
For 2013/2014 season, there were no domestic competitions scheduled
**In the 2014/2015 season, the club did not participate in European competitions
*** In the 2015/2016 season, the club was not penalised in European competitions

Out of a total of 54 matches played in European competitions, due to various outbursts of its fans, FC Red Star was penalised for outbursts of its fans in 70% of matches played (38 matches), out of which 21 matches were played at home and 17 away. In the observed period, a fine was imposed on the club in the total amount of 1,056,000 Euros due to disciplinary offenses because of poor organisation of matches, most often due to carrying and the use of pyrotechnics, lasers or similar electronic devices, throwing objects onto the field, destroying inventory, blocking stairways in stadium stands, causing riots in the stands, using gestures, words, objects or any other means to convey any message that is not appropriate for sporting events, especially messages that are political, ideological, religious, offensive or provocative, displaying banners which had inappropriate content, and interfering with national anthems performed by club fans. In addition to fines, the club has penalties for any other means of transmitting any message that is not appropriate for sporting events, especially messages that are political, ideological, religious, offensive or provocative, displaying banners of inappropriate content, and obstructing national anthems performed by club fans. In addition to the fine, in the 2017/2018 season, due to serious violations committed by the fans, the club was sentenced to a partial closure of the stadium, i.e., the north and south stands for the next two games hosted by the club. The following season, FC Red Star was punished by playing one game at home without the presence of spectators, as well as a ban on selling tickets to its fans in one game when the team is playing away.

Out of the total amount of fines imposed on the club, within all competitions, the percentage of fines imposed by UEFA is 88% (Chart 3).

Table 3. The share of fines imposed by FSS and UEFA against FC Red Star

Total	FSS	UEFA
1,194.284	138,284	1,056.000
100%	12%	88%

The amounts in the charts are given in Euros

The trend of punishing FC Red Star by the FSS and UEFA, due to similar, hooligan outbursts by fans, can be seen through concrete examples. For comparison, in 2010, for three championship games played, FC Red Star (FC Indjija, FC Jagodina, FC BSK) was fined by a single amount of 1,424 Euros for the use of pyrotechnics, destruction of inventory and throwing objects by fans, and for a similar offense upon its execution, in only one international match played at home, also in 2010, for destroying inventory and throwing objects onto the field, the club was fined 7,000 Euros by the UEFA. At first glance, looking at the video of the mentioned matches, it can be seen that only a few pyrotechnic devices were lit at one international match, while at the domestic championship matches, the stands were simply "burned" due to the great use of pyrotechnic devices by Red Star fans.

DISCUSSION

The analysed results indicate that FC Red Star was often punished for hooligan outbursts of its fans, almost equally at home and in away matches. However, from the results shown, it can be seen that the penalties imposed by UEFA are much stricter. For example, when it comes to fines, they were imposed on the club by UEFA for similar hooligan outbursts in three times the amount than is the case with the FSS fines. Also, from the analysed decisions on penalties, it can be noticed that individual penalties were imposed on the mentioned club for each individual match for UEFA international matches, while in domestic matches, almost the same number was imposed for a single penalty for violence in several different matches. This result indicates that the disciplinary bodies of the FSS viewed the hooligan outbursts of FC Red Star fans favourably, and that they imposed unjustifiably low fines which were related to the poor organisation of matches and fan violence.

Article 42 of the FSS Disciplinary Rulebook states that serious cases of disciplinary offenses for which disciplinary bodies may impose a more severe punishment on the perpetrator are those offenses in which the perpetrator acted with special responsibility, persistence or recklessness, or when the offense caused particularly serious consequences, or it was done under particularly difficult circumstances. The cases which should be considered as more serious are determined by the Rulebook on Safety and Security at Football Matches (FSS, 2007), where in Article 20, serious cases of endangering the safety of people and property, in addition to all these situations, include riots characterised by reckless throwing of pyrotechnic and other means onto the playing field and the athletic track, which are prohibited at the stadium. As in most the matches under the auspices of the FSS, there was a mass use of pyrotechnic devices, which means that the FSS authorities imposed inadequate penalties and were not consistent in punishing. Even in cases when the incidents were characterised as more serious, the mildest measure was reimposed, i.e., playing only one game without the presence of spectators despite a significant number of incidents in some matches.

CONCLUSION

The example of FC Red Star provides a conclusion that the disciplinary sanctions imposed by UEFA have an exceptional effect. Adequate, high fines for football clubs and suspensions from international competitions in practice have given better results in terms of reducing violence at sports events. Contrary to UEFA measures, due to the imposition of inadequate penalties enforced by the disciplinary bodies of the FSS, hooligan outbursts of fans at matches under the jurisdiction of the FSS were not prevented. Comparing the disciplinary sanctions imposed by UEFA and the FSS, it is clear that the important role of national sports federations is in counteracting fan hooliganism, and that if measures are adequately applied, there will be a reduction in riots at football matches.

The provisions of the FSS Disciplinary Rulebook state that the amount of the fine that can be imposed on clubs is determined by a special decision of the FSS Executive Board at least once during the competition season. This needs to be changed in the sense that the FSS Rulebook clearly defines fines for certain disciplinary offenses as well as specifies which incidents are considered a more serious case, and which penalties are imposed for those offenses. Also, consistent application of regulations is needed in accordance with the provisions of the FSS Rulebook because there were cases when penalties were imposed, but they were far below the prescribed minimum.

The conducted research is a good basis for future research on the role of sports federations and clubs

in opposing hooliganism. Similar research is necessary to be conducted in other countries that have a problem with hooliganism, and the obtained results need to be compared with this research in order to get a broader picture of the role of sports federations in solving this problem.

REFERENCES

1. Adang, O., & Brown, E. (2008). Policing football in Europe. Apeldoorn: Politieacademie Apeldoorn.
2. Đurđević, N. (2018). Autonomy of sport - obligatoriness of sports rules of international associations at national level [Autonomija sporta – obaveznost sportskih pravila međunarodnih sportskih organizacija na nacionalnom nivou]. Zbornik radova Pravnog fakulteta u Splitu, 55(2), 289-306.
3. Đurđević, N., & Otašević, B. (2016). Stewarding at sporting events. [Redarska služba na sportskim priredbama]. Pravni život, 65(9), 549-564.
4. Pravilnik o bezbednosti i sigurnosti na fudbalskim utakmicama. (2007). Rulebook of safety and security at football matches. (2007).
5. Odluka o visini novčanih kazni koje se mogu izreći klubovima, igračima, trenerima, sudijama i drugim sportskim radnicima. (2016). Decision of the amercement that can be imposed on clubs, players, coaches, referees and other sports workers. (2016).
6. FSS. (2017). Disciplinary regulations of the Football Association of Serbia. [Disciplinski pravilnik Fudbalskog saveza Srbije]. Retrieved from https://fss.rs/wp-content/uploads/2019/07/disciplinski-pravilnik_15062017.pdf
7. Janković, B. (2020). The Role of Stewards at Sports Events in the Republic of Serbia. Zbornik radova Pravnog fakulteta Novi Sad, 54(1), 353–365.
8. Kastratović, M., Ahmić, D., Slijepčević, D., & Stanković, V. (2019). The legal nature and basis of civil liability in sports. Sport Science, 12(2), 58-64.
9. Milojević, S., & Janković, B. (2012). Police measures and actions in confronting football hooliganism in some European countries. In Archibald Reiss Days (pp. 613–629). Belgrade: The Academy of Criminalistic and Police Studies.
10. Milojević, S., Simonović, B., Janković, B., Otašević, B., & Turanjanin, V. (2014). Youth and hooliganism at sports events. [Mladi i huliganizam na sportskim priredbama]. Beograd: OEBS-Misija u Srbiji.
11. Otašević, B. (2010). Urban environment and violence in sport events. [Urbano okruženje i nasilje u sportu]. Bezbednost, 52(3), 267-281.
12. Stanić, M., & Andonović, S. (2020). Police detention of footbal fans as measure of preventing violence in case law of the European Court of Human Rights. In S. Jaćimovski (Ed.), Archibald Reiss Days, 2020 (pp. 65-75). Belgrade: University of Criminal Investigation and Police Studies.
13. Stott, C., Livingstone, A., Adang, O., & Schreiber, M. (2008). Tackling Football Hooliganism - A Quantitative Study of Public Order, Policing and Crowd Psychology. Psychology, Public Policy, and Law, 14(2), 115–141. doi:10.1037/a0013419
14. Šuput, D. (2012). FIFA and UEFA Regulations Against Violence at Football Matches - Problem of Jurisdiction Overlapping Between State and Sports Organizations. [Propisi FIFA i UEFA protiv nasilja na fudbalskim utakmicama - problem preklapanja nadležnosti države i sportskih organizacija]. Bezbednost, 54(1), 166-179.
15. UEFA. (2020). UEFA Disciplinary Regulations. Retrieved from https://documents.uefa.com/v/u/ZNsWJsRSmOuSS2Ql_y8~qQ

ULOGA SPORTSKIH SAVEZA U SUPROTSTAVLJANJU NAVIJAČKOM HULIGANIZMU: STUDIJA SLUČAJA FK CRVENA ZVIJEZDA

Države se na različite načine suprotstavljaju huliganizmu na sportskim priredbama. Subjekti koji se mogu uključiti u rješavanje ovog problema jesu sportski savezi i klubovi, ali se njihova uloga u literaturi ne razmatra previše. Za potrebe ovog rada izvršena je analiza 338 izvještaja delegata sa odigranih utakmica FK "Crvena Zvijezda", od sezone 2010/2011 do 2018/2019, kao i 94 rješenja o kažnjavanju FK "Crvena Zvijezda" od strane disciplinskih organa FSS i UEFA. Rezultati sprovedenog istraživanja ukazuju da su u praksi disciplinske sankcije koje izriče UEFA dale bolje rezultate u odnosu na, po našem mišljenju, neadekvatne sankcije izrečene od strane disciplinskih organa Fudbalskog saveza Srbije (FSS).

Ključne riječi: sportski savez, opiranje, huliganstvo, FK Crvena Zvezda

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SENIORS' OPINIONS ON PHYSICAL ACTIVITY AS A PREVENTION OF CARDIOVASCULAR AND METABOLIC DISEASES

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ABSTRACT

Introduction: Physical activity (PA) positively influences and facilitates the aging process, improves physiological processes in the human body and reduces the risk of metabolic and cardiovascular diseases.

Problem and Aim: The aim of our study was to collect and analyse opinions of the elderly on the importance of physical activity in the prevention and treatment of their health condition.

Methods: The sample consisted of 262 elderly people (age - 72.03 ± 5.9 years). The subjects were divided into two groups: patients with cardiovascular diseases (CVD, n = 157) and patients with metabolic diseases (MD, n = 105) that do not prevent physical activity. For data collection, we used a non-standardised questionnaire, which was part of a questionnaire battery designed for a broader research project and which also included the IPAQ-questionnaire items. In this study, we selected some of the questions that we used to find out the views of seniors on health prevention through exercise and lifestyle changes.

Results: We found that CVD and MD patients in our study consider diet and nutrition the most important factor in the management and treatment of their disease (p = 0.046). This was followed by regular check-ups in both men and women. Both groups positively perceive the influence of PA (p = 0.150). With regard to their lifestyle, they would change their diet and nutrition (p = 0.006). The priorities regarding the type of leisure time physical activity, in both males and females, are similar.

Keywords: seniors, physical activity, metabolic diseases, cardiovascular diseases

INTRODUCTION

Circulatory diseases had been classified among the most common cause of death in Europe in all EU Member States. They represented 50-60 % of all deaths in the Baltic Member States. For men and for women, the highest death rates for diseases of the circulatory system were recorded in regions of Bulgaria (Eurostat, 2021). Similar tendencies as in the rest of Europe were observed in Slovakia as well. The most deaths were caused by heart and vascular diseases, followed by cancer (OECD/

European Observatory on Health Systems and Policies, 2019).

Appropriately performed routine and adequate physical activity (PA) improve the cardiovascular system and aerobic fitness, decrease the rate of structural and functional changes in the locomotor apparatus, help stabilise diseases, atherosclerosis, hypertension, ischemic heart disease, diabetes, osteoporosis or obesity (Al-Sari et al., 2018). This topic has been discussed by many experts in the field, in particular medicine and sport. Regular PA is not only beneficial but it can also be regarded as an inexpensive tool in the prevention of most non-communicable diseases. A number of studies showed that individuals regularly performing health-oriented PA have a lower risk of many limiting health problems and a lower incidence of chronic diseases than in inactive people (Svačina, 2010; Mikušová, 2008).

Interventions to increase PA have been discussed among medical and preventive care professionals for generations. Due to a low adherence of the population to these general appeals, it is necessary to educate the professionals in this field so that they could prescribe PA in the management of such diseases (Daďová et al., 2007).

Aerobic PA plays a key role in both primary and secondary prevention and treatment of cardiovascular diseases and their risk factors. Asymptomatic individuals in primary prevention can employ PA to prevent the development of non-communicable diseases, in particular the development of hypertension, obesity, insulin resistance, diabetes mellitus, and hyperlipidaemia. In both primary and secondary prevention, PA is an integral part of the treatment of people with cardiovascular diseases such as ischemic heart disease and heart failure (El Ansari et al., 2011).

Metabolic syndrome (MS) is a cluster of conditions that occur simultaneously: abdominal obesity, arterial hypertension, glucose metabolism disorders, and dyslipidaemia (Grundy et al., 2005). MS is recognised as one of the most prominent factors contributing to the cardiovascular diseases and type 2 diabetes (Mikušová, 2008). An increased rate of MS diseases in developed countries for the past 30 years is directly related to the change in lifestyle which is characterised by the lack of PA and access to high-energy foods and beverages (Urbánek, 2007). However, a majority of MS patients are able to perform PA with regard to their secondary diseases. In order for PA to be effective, it is important to consider its frequency, intensity, and duration. Regular PA positively influences body composition. It reduces fat stores and increases muscle mass and overall fitness which can positively influence MS conditions (Cho et al., 2009; Thompson et al., 2003).

In addition to diet, PA is one of the key non-pharmacological treatments of cardiac and metabolic diseases not only in younger individuals but also in the elderly (Cho et al., 2009; Thompson et al., 2003).

One of the basic principles of the National Active Aging Program 2014-2020 in Slovakia is the concept of self-realisation by the elderly, which will help them to realise their potential for achieving physical, social and mental well-being. The life-cycle principle is based on the fact that older people do not form a homogeneous group and that interindividual diversity increases with age (National Active Aging Program 2014-2020).

PROBLEM AND AIM

The aim of our study was to collect and analyse opinions of the elderly on the importance of physical activity in the prevention and treatment of their health condition, and find what lifestyle changes they are willing to make.

METHODS

The sample comprises 262 elderly people aged from 65 and older. The subgroup of cardiovascular patients (CVD) and metabolic disease patients (MD) consisted of 157 and 105 subjects, respectively.

The study was conducted from October 2018 to February 2019 in the outpatient clinics in the eastern Slovakia. In particular, it included patients from 19 cardiology and 14 metabolic outpatient clinics. We were granted a written approval from the physicians or heads of these clinics to approach their patients.

Respondents were enrolled in the research following the meeting of these criteria: the occurrence of one diagnosis from the two underlying non-communicable diseases that do not prevent physical activity, willingness to give informed consent to participate in the research, willingness to fill in questionnaires regarding physical activity, and awareness of PA possibilities for a given diagnosis.

This study was supported by Grant project 1/0825/17 "Recommendations for physical activities in prevention and control of non-communicable diseases and their implementation in the eastern part of Slovakia" implemented at P. J. Šafárik University in Košice. All respondents were approached in person by trained university students. The aim and methods of the research had been explained to the patients before the survey started. Subsequently, the patients filled in a questionnaire explicitly designed for this research.

The questionnaire consisted of 29 items. However, we are presenting only the results that are directly related to the subject matter of this study. We monitored demographic indicators (age and residence), information regarding health conditions and physical activity (including IPAQ). The aim of our study was to find and analyse awareness among the elderly on the importance of physical activity in their conditions, and changes they are willing to make in their lifestyles. After the completion of the questionnaire, we informed the elderly about the advantages of PA and instructed them as to which PA is the most suitable in treating their disorder. All patients received a leaflet with general information about PA that is in line with the FIIT principle.

Table 1. Demographic indicators of subjects (n = 262)

Health condition	Count n	Males		Females		Urban residence		Rural residence	
		n	%	n	%	n	%	n	%
CVD	157	111	71	46	29	84	54	73	46
MD	105	79	75	26	25	77	73	28	27
Total	262	190	73	72	27	161	61	101	39

CVD – cardiovascular diseases, MD – metabolic diseases

DATA ANALYSIS

Absolute count (n), percentage (%) and frequency tables were used to analyse data. The Pearson's chi-squared test, t-test and F-test were used to evaluate relationships between variables. Statistical significance level was set at 0.05 and 0.01. Data analysis was carried out using a statistical tool Statistica v.12 and MS Excel 2013. The research was approved by the Ethical commission at the Pavol Jozef Šafárik University in Košice (PJSU-0825/17-1).

The second table presents the relationship between the health condition and age, gender, and residence. We did not find a relationship between the health condition and age (both groups were represented by the elderly of roughly the same age) and gender. However, we found a statistically significant relationship between the health condition and the place of residence (patients residing in rural areas were found to have smaller health problems).

Table 2. Relationship between health issues and age, gender, residence, and education.

	Age	Gender	Residence	Education
χ^2	2.544	0.65	10.444	7.326
p	0.28	0.42	0.0012**	0.062

x^2 - Pearson's chi - squared test
** - $p < 0.01$

Table 3 presents the preferences of our subjects regarding the most important preventive factor in treating and managing their disease. These preferences were similar in both groups (MD and CVD patients). The most common were diet and nutrition, followed by regular check-ups and sleep and rest. In both groups, PA was indicated by only 13 subjects (5%).

Table 3. Relationship between health condition with prevention and treatment

$\chi^2 = 1.0227$, df = 5, p = 0.9607							
Health condition	a	b	c	d	e	ac	n
CVD	85.6908	14.3816	38.9503	9.5877	7.7900	0.5992	157
MD	57.3092	9.6182	26.0496	6.4122	5.2099	0.4008	105
Total	143.0000	24.0000	65.0000	16.0000	13.0000	1.0000	262

x^2 - Pearson's chi - squared test, df – degree of freedom
CVD – cardiovascular disease, MD – metabolic disease
a – diet and nutrition, b – sleep and rest, c – regular check-ups,
d – drug therapy, e – regular PA, ac – diet and nutrition/regular check-ups – pooled

Table 4 presents results regarding gender preferences in the treatment of the diseases. Both genders ranked highest in diet and nutrition, followed by check-ups and sleep and rest. Female respondents preferred PA to drug therapy.

Table 4. Gender differences in relation to prevention and treatment

χ^2 = 11.2760, df = 5, p = 0.0462							
Gender	a	b	c	d	e	ac	n
F	107	22	41	10	10	0	190
M	36	2	24	6	3	1	72
Total	143	24	65	16	13	1	262

x^2 - Pearson's chi - squared test, df – degree of freedom
F – females, M – males, a – diet and nutrition, b – sleep and rest, c – regular check-ups,
d – drug therapy, e – regular PA, ac – diet and nutrition/regular check-ups

Table 5 presents gender differences in relation to selected lifestyle factors. We found a statistically significant difference (p = 0.046) between male and female subjects regarding the importance of PA in the treatment and management of their diseases. We can also say that both males and females understand that PA is beneficial for their health (p = 0.621). We found a statistically significant difference between males and females with regard to lifestyle changes (0.006) and awareness of PA benefits (0.019). Moreover, females were more likely to seek information about the benefits of PA. Furthermore, we found no statistical difference between males and females in terms of the type of PA and its effect on their health (p = 0.913).

Table 5. Gender differences in relation to selected lifestyle factors

	1	2	3	4	5
χ^2	11.276	2.633	23.018	2.068	7.849
p	0.046*	0.621	0.006**	0.913	0.019*

x^2 - Pearson's chi-squared test*
*- p < 0.05
** - p < 0.01
1 – PA is the most important in treatment of disease,
2 – PA affects my health
3 – lifestyle changes,
4 – type of PA,
5 – awareness of PA benefits

Table 6 shows that 60% of respondents with CVD and MD were aware of the positive influence of regular PA on their health condition which was in line with our assumption. However, we identified 20% of those who were indecisive and 15% of respondents had never thought about it. Unfortunately, we found individuals (1%) with a negative attitude towards PA. The difference between the CVD and MD groups was found statistically insignificant (p = 0.15).

Table 6. Positive influence of regular PA on health condition

χ^2 = 6.7398, df = 4, p = 0.150297						
Health condition	Definitely yes	Indecisive	Never thought about it	Rather no	Definitely no	n
CVD	94.0802	32.9580	20.9732	7.1908	1.7977	157.0000
MD	62.9198	22.0419	14.0267	4.8091	1.2022	105.0000
Total	157.0000	55.0000	35.0000	12.000	3.0000	262.0000

x^2 - Pearson's chi - squared test, df – degree of freedom
CVD – cardiovascular diseases, MD – metabolic diseases

In Table 7, we present the relationships between the health problem and the type of PA that patients with CVD and MD performed in their spare time. As expected, no statistically significant differences (p = 0.10065) were found between these groups with regard to the PA preferences. It is satisfying that both groups (MD and CVD patients) performed PA daily. They were engaged mainly in housework and gardening (80%), followed by walking and hiking (13%). The remaining activities such as running, swimming, aerobics, strengthening, and other activities accounted for 7%. However, it should be noted that some subjects indicated more types of PA in the questionnaire which suggests that they were physically very active.

Table 7: Relationship between health condition and type of PA

$\chi^2 = 10.626$, df = 6, p = 0.10065								
Health condition	Household chores	Walks	Running Swimming	Aerobics	Strength exercise	Sport games	Other PA	n
CVD	125.2405	21.5725	2.9962	0.5992	4.7939	0.5992	1.1984	157
MD	83.7595	14.4275	2.0038	0.4008	3.2061	0.4008	0.8015	105
Total	209.0000	36.0000	5.0000	1.0000	8.0000	1.0000	2.0000	262

x^2 - Pearson's chi - squared test, df – degree of freedom
CVD – cardiovascular disease, MD – metabolic disease

Furthermore, we did not investigate only the type of PA but also the weekly frequency, daily duration, and intensity of PA. Table 8 compares the frequency, duration, and intensity levels of weekly PA performed by the CVD and MD patients. We found a statistically significant difference between MD patients and CVD patients regarding the weekly frequency of PA. This frequency seems rather low, and the above results also suggest that it was associated mainly with gardening and household chores. The duration of daily PA in our sample ranged from 30 to 45 minutes. However, we found individuals in both groups whose PA exceeded 60 minutes a day but also individuals without any PA.

Table 8: Relationship between health condition and frequency, duration and intensity of PA

	x-CVD	x-MD	t	p	n-CVD	n-CVD	s-CVD	s-CVD	F	p
frequency	4.089	4.59	-2.06	0.04*	157	105	2.086	1.668	1.564	0.015*
time	4.025	4.476	-1.08	0.07	157	105	2.038	1.892	1.161	0.416
intensity	3.293	3.705	-2.22	0.03*	157	105	1.512	1.4	1.166	0.401

CVD – cardiovascular disease, MD – metabolic disease
x – average, n –count, s – standard deviation, t – t-test value, F – F-test value,
* - $p < 0.05$

DISCUSSION

Our subjects were aware that unhealthy nutrition and inactivity in particular are the most serious risk factors that cause heart and vascular diseases and are also the cause of diabetes, which was confirmed by Ramirez-Velez et al. (2015), Kamenský (2010), and Lee et al. (2017).

Avery et al. (2016) show that exercise, along with diet and pharmacotherapy, is one of the cornerstones for the diabetes treatment and management. This study highlights that exercise as medicine for type 2 diabetes represents multifaceted behavioural intervention targeting PA for management of type 2 diabetes developed for delivery in primary care.

The 8-year longitudinal cohort study conducted by Wen et al. (2011) found that more than 30 minutes of PA and up to 100 minutes daily resulted in the decrease in mortality by 4%. Buford (2016) argued

that an insufficient elementary locomotion such as walking is a strong predictor of cardiovascular events.

Studies investigating PA and fitness and their influence on diabetes presented ample evidence that PA as a lifestyle choice is associated with a smaller risk of cardiovascular diseases and deaths caused by type 2 diabetes. Additionally, available data point out that regular PA reduces the risk of diabetes (Meško, 2005).
Newson and Kemps (2007) suggested that having a health condition is the most common barrier for the elderly to perform PA; thus, chronic health issues may be a strong correlate associated with PA in the elderly.
A fundamental element in order for PA to be effective is its frequency, intensity and duration. Regular PA reduces fat storage and builds muscle mass. Generally, MS patients are recommended to perform 30 – 60 minutes of moderate PA on most days of the week (Cho et al., 2009; Thompson et al., 2003).
With regard to intensity, most patients with MD or CVD in our study perform PA with only minimum or little effort. Despite finding statistically significant differences between the groups, the elderly suffering from MD reported a slightly higher effort compared to the CVD patients which is in line with the findings of Kowalska, Cieślińska-Świder (2010) and Sierpowska, Cywińska-Wasilewska (2004), who confirmed that PA decreases insulin resistance and improves the carbohydrate metabolism, which results in the weight loss only when higher intensity exercises are employed. Furthermore, these studies showed that regular PA performed 3 times a week (2 group sessions and 1 individual session) with the duration of 30 – 45 minutes in women with type 2 diabetes is an effective weight management tool and improves overall fitness. After completing a 6 month programme, they recorded: weight loss and BMI improvement, a decrease in resting and arterial pressure, and steady rates of carbohydrate metabolism. This demonstrates the need to adopt and implement programmes for educating patients about the health benefits of PA
General recommendations for the average population and the elderly is to perform moderate PA for at least 30 minutes on most days in a week. The most suitable are aerobic activities (hiking, swimming, gardening, steps workout, household chores, Nordic walking and others) (Mikušová, 2008). The public health insurance company in cooperation with the Public health authority of the Slovak republic have developed the "Diet – PA compass" which aims to provide information on how to substitute empty calories with valuable nutrients and how often to perform PA. It recommends determining a personal level of PA (PAL – physical activity level), thus a daily energy expenditure for PA multiplied by the rate of the baseline metabolism. For 1-3 days of light PA per week, such as working in the garden or at home - PAL = 1.45. For 3-5 days of moderate PA a week (e.g. fast walking) - PAL = 1.65. The compass also suggests that the most effective treatment for obesity is its prevention by performing PA and engaging in proper diet (The Public Health Authority of the Slovak Republic, 2020).
PA is beneficial for patients with high risk of arteriosclerosis and ischemic heart disease, patients after a stroke, as well as patients with chronic heart failure. PA is helpful for patients suffering from metabolic diseases (diabetes, obesity, and osteoporosis) and rheumatic diseases. Regular PA improves cognitive function, reduces depression and is also beneficial for addicts (Al-Sari et al. 2018; Burke et al. 2013, Tuka et al. 2017).
A number of studies showed that PA, especially in middle-aged and elderly people, prolonged life and prevented premature loss of fitness (Spirduso, Francis, MacRae, 2005; Mikušová, 2008; Newson, Kemps 2007).

CONCLUSION

We found similar preferences regarding health prevention among patients with cardiovascular and metabolic diseases. The most common prevention was diet and nutrition, followed by regular check-ups, with sleep and rest at the bottom of the preference list. PA as a preventive tool was indicated only by 6% of the elderly

Due to ample evidence supporting seniors' exercise, we recommend multimodal exercise programmes that include strength training, light to moderate aerobic activities, exercises to maintain and improve upper and lower limb flexibility, as well as breathing exercises and relaxation to help prevent deterioration in the health status or at least maintain the current status.

In any case, PA is a cost-effective and, when performed in line with the recommendations, safe way to reverse the negative influence of obesity, hypertension, dyslipidaemia or insulin resistance. It is necessary to constantly focus on improving the health of the elderly diagnosed with CVD and MD. It is also crucial to monitor PA of

the elderly and their progress to evaluate the efficiency of the existing programmes. These programmes need to be adjusted according the calendar age, health condition, and overall fitness level. In the case of physical disability or chronic illness, we recommend choosing an adequate exercise programme under the guidance of an experienced expert and consulting a specialist before starting physical activity.

REFERENCES

1. Al-Sari, U. A., Tobias, J. H., Clark, E. M. (2018). Self-reported everyday physical activities in older people with osteoporotic vertebral fractures: a systematic review and meta-analysis. Osteoporos Int, 29(1), 19-29. doi: 10.1007/s00198-017-4287-6
2. Avery, L., et al. (2016). Systematic development of a theory informed multifaceted behavioural intervention to increase physical activity of adults with type 2 diabetes in routine primary care: Movement as Medicine for Type 2 Diabetes. Implementation Science, 11, 99. doi: 10.1186/s13012-016-0459-6
3. Buford, T. W. (2016). Hypertension and aging. Ageing Res. Reviews, 26, 96–111. doi.org/10.1016/j.arr.2016.01.007
4. Burke, L., Lee, A. H., Jancey, J., et al. (2013). Physical activity and nutrition behavioural outcomes of a home-based intervention program for seniors: a randomized controlled trial. Int J Behav Nutr Phys Act, 10, 14. https://doi.org/10.1186/1479-5868-10-14
5. Cho, E. R., Shin, A., Kim, J., Jee, S. H., Sung J. (2009). Leisure-time physical activity is associated with a reduced risk for metabolic syndrome. Annals of Epidemiology, 19(11), 784–792. PubMed: http://www.ncbi.nlm.nih.gov/pubmed/19825459.
6. Daďová, K., et al. (2007). Is prescription of physical activity a part of preventive health care in non-communicable diseases: Results of survey research. Časopis lékařů českých, 146 (5), 503-507, ISSN 0008-7335. [In Czech].
7. El Ansari, W., Stock, C., John, J., et al. (2011). Health promoting behaviours and lifestyle characteristics of students at seven universities in the UK. Cent. Eur. Public Health, 19(4), 197-204.
8. Eurostat. (2021). Eurostat regional yearbook 2021 Edition.
9. https://ec.europa.eu/eurostat/documents/3217494/13389103/KS-HA-21-001-EN-N.pdf/1358b0d3-a9fe-2869-53a0-37b59b413ddd?t=1631630029904
10. Grundy, S. M., et al. (2005). Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement Circulation. 112(17), 2735–2752. PubMed: http://www.ncbi.nlm.nih.gov/pubmed/16157765.DOI: 10.1161/CIRCULATIONAHA.105.169404.
11. Kamenský, G. (2010). High blood pressure – a silent killer. Zdravý životný štýl. Bratislava, 9-22. [In Slovak].
12. Kowalska, J., Cieślińska-Świder, J. (2010). Effects of therapeutic management in women over 60 years of age with metabolic disorders. Endokrynol. Otył. Zab. Przem. Mat, 6(2), 72-77. [In Polish].
13. Lee, K. S., Lee, J. K., Yeun, Y. R. (2017). Effect of a 10-day intensive health promotion program combining diet and physical activity on body composition, physical fitness, and blood factors of young adults: A randomised pilot study. Med. Sci Monit, 11(23), 1759-67. doi: 10.12659/msm.900515
14. Meško, M. (2005). Diabetes mellitus and sport activity. Via pract, 2 (11), 472–474. [In Slovak].
15. Mikušová, K. (2008). Dietary recommendations in the treatment of metabolic syndrome or how to change lifestyle? Praha: Edukafarm, 4, 167 -168. Website: http://www.edukafarm.cz. [In Czech].
16. National Active Aging Program 2014-2020. (2013). Website:
17. https://www.minv.sk/swift_data/source/rozvoj_obcianskej_spolocnosti/rada_vlady_pre_mno/rokovania/2013/5_rokovanie/MPSVR_narodny-program-aktivneho-starnutia_material.pdf.
18. Newson, R. S., Kemps, E. B. (2007). Factors that promote and prevent exercise engagement in older adults. J. Aging Health, 19(3), 470–481. [PubMed: 17496245]. doi.org/10,1177/ 0898264307300169.
19. OECD/European Observatory on Health Systems and Policies. (2019). Slovakia: Country Health Profile 2019, State of Health in the EU. https://www.euro.who.int/__data/assets/pdf_file/0010/419473/Country-Health-Profile-2019-Slovakia.pdf
20. Ramirez-Velez, R., Triana, R. H. R., Carrillo, H. A., et al. (2015). A cross sectional study of Colombian University students' self perceived lifestyle. Springerplus, 24(4), 289. doi: 10.1186/s40064-015-1043-24:289
21. Sierpowska, A., Cywińska-Wasilewska, G. (2004). Physical activity and obesity in patients with diabetes mellitus 2. Fizjoterapia, 12, 62–69. Website: http://www.szu.cz/svi/hygiena/show.php?kat=archiv/h2010-1-06. [In Polish].
22. Spirduso, W., Francis, K., & Macrae, P. (2005). Physical Dimensions of Aging (2nd Ed.). Champaign, IL: Human Kinetics, 1-502.
23. Svačina, Š. (2010). Importance of physical activity in diabetic patients. Optimal effect of physical activity and nutrition. 17, 24-28. ISBN 978-80-7435-076-4. [In Czech].
24. The Public Health Authority of the Slovak Republic (2020). Website: http://www.uvzsr.sk/kalendar_hv/index.html.
25. Thompson, P. D., et al. (2003). Exercise and physical activity in the prevention and treatment of atherosclerotic cardiovascular disease: a statement from the Council on Clinical Cardiology and the Council on Nutrition, Physical Activity, and Metabolism. Circulation, 24, 107(24), 3109-16.
26. Tuka, V., et al. (2017). Physical activity - holy grail of modern medicine? Vnitřní lékařství, 63(10), 729-736, ISSN 0042-773X. Website: http://www.prolekare.cz/vnitrni-lekarstvi-clanek/pohybova-aktivita-svaty-gral-moderni-mediciny-62150 [In Czech].
27. Urbánek, R. (2007). Obese patients in a general practitioner´s office. Medicína pro praxi, 4(9), 338-340, ISSN 1214-8687. [In Czech].
28. Wen, C. P., Wai, J. P., Tsai, M. K., et al. (2011). Minimum amount of physical activity for reduced mortality and extended life expectancy: a prospective cohort study. Lancet, 378, 1244–1253. doi.org/10.1016/S0140-6736(11)60749-6

MIŠLJENJE OSOBA STARIJE ŽIVOTNE DOBI O FIZIČKOJ AKTIVNOSTI KAO PREVENCIJI KARDIOVASKULARNIH I METABOLIČKIH BOLESTI

Fizička aktivnost (PA) pozitivno utiče na proces starenja te ga olakšava, poboljšava fiziološke procese u ljudskom tijelu i smanjuje rizik od metaboličkih i kardiovaskularnih bolesti

Problem i cilj: Cilj naše studije je prikupiti i analizirati mišljenja osoba starije životne dobi o važnosti fizičke aktivnosti u prevenciji i liječenju njihovih zdravstvenih problema.

Metode: Uzorak se sastojao od 262 osobe starije životne dobi (dob - 72.03 ± 5.9 godina). Ispitanici su podijeljeni u dvije grupe: pacijenti sa kardiovaskularnim bolestima (CVD, n = 157) i pacijenti sa metaboličkim bolestima (MD, n = 105), a koje ne sprječavaju bavljenje fizičkim aktivnostima. Za prikupljanje podataka smo koristili nestandardizirani upitnik koji je bio dio baterije upitnika osmišljenih za opsežniji istraživački projekat, a uključivao je i čestice IPAQ upitnika. Za ovu studiju smo odabrali neka pitanja koja su korištena za otkrivanje stajališta osoba starije životne dobi o zdravstvenoj prevenciji kroz vježbanje i promjene stila života.

Rezultati: Otkrili smo da su CVD i MD pacijenti u našoj studiji smatrali da su prehrana i hranjive tvari najvažniji faktor u upravljanju i liječenju njihove bolesti (p = 0,046). Nakon toga slijede redovni pregledi, a što je mišljenje i muškaraca i žena. Obje grupe pozitivno percipiraju uticaj PA (p = 0,150). Kada je riječ o njihovom stilu života, oni bi promijenili svoju prehranu i unos hranjivih tvari (p = 0,006). Prioriteti koji se odnose na vrstu fizičke aktivnosti kojom se osobe bave tokom slobodnog vremena su slični i kod muškaraca i kod žena.

Ključne riječi: osobe starije životne dobi, fizičke aktivnosti, bolesti metabolizma, kardiovaskularne bolesti

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NUTRITIONAL AND MOTOR SKILLS STATUS OF THIRD AND FOURTH GRADE STUDENTS

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ABSTRACT

Over the last few years, childhood obesity has increased significantly. One of the proven reasons is reduced physical activity from an early age. Low levels of physical activity in students negatively affect the development of their motor skills, as well as their overall health. The aim of this study was to identify the differences in the level of motor skills in relation to the level of nutrition in students of the third and fourth grade of primary school. The sample included 212 students, 105 of which were boys and 107 girls aged 9.77 ± 0.69 years. Anthropometric measurements including height, weight, triceps skin fold, back skinfold, abdominal circumference, body mass index, and body fat percentage were used to assess body composition. Height was measured with the anthropometer, and weight with a body composition measurement device - Omron BF500 Body Composition Monitor. Skin folds were measured using the Lange Skinfold calliper. Motor skills were tested with standardised and validated tests that are being used in primary education in the Republic of Croatia and Europe (Findak, Metikoš, Mraković, & Neljak, 1996; Eurofit, 1988). Based on the calculated body mass index, and by using tables recommended by the International Obesity Task Force (Cole et al., 2000), subjects were classified into three groups based on their nutritional status: normal weight, overweight, and obese. The results of the study show significant differences between subsamples in motor skills in relation to their level of nutrition. Two discriminant functions were obtained, the first of which was significant at the significance level of p = 0.0000. Variables that significantly differentiate subsamples based on their level of nutrition are standing long jump (p = 0.0049) and sit ups (p = 0.0000). Based on the obtained and analysed results, it can be concluded that students with normal weight have significantly better motor skills results. Well-developed motor skills are one of the prerequisites for the normal physical development of children. Encouraging children to engage in continuous physical exercise is one of the prerequisites for the proper development of motor skills.

Keywords: body mass index (BMI), motor skills, obesity, physical activity, health

INTRODUCTION

Insufficient physical activity, sleep deprivation, and excessive sitting are associated with a higher risk of obesity and other adverse health effects (Carson et al., 2016; Chaput et al., 2016; Poitras et al., 2016). Recent evidence suggests a direct correlation between a decline in physical activity and becoming overweight (Hardy, Reinten-Reynolds, Espinel, Zask, Okely, 2012) along with a decline in children's level of motor skills (Roth et al., 2010), which is a critical determinant of children's general development (Piek, Baynam, Barrett, 2006). Excess body weight causes a decline in physical activities and therefore impairs the development of motor skills, especially the locomotor system (D'Hondt et al., 2011; Pelemiš et al., 2019). On the other hand, there is an evident two-way relationship between body weight status and motor skills. Motor skills, defined as a person's ability to perform a variety of motor activities, are directly related to physical, mental, and social development and may be essential for encouraging an active lifestyle in childhood (Redondo-Tebar et al., 2020). Motor skill competence can be defined as mastery of physical skills and movement patterns, including the coordination between both gross

and fine motor tasks required to manage daily tasks (Riley et al., 2016). Gross motor skills have a particularly important role in growth, development, and the ability to lead an active lifestyle (Haller, 1977). Gross motor skills are often called basic motor skills (e.g., throwing, catching, running) that are mostly acquired during preschool and early school age (Sperling et al., 2015). Basic motor skills are often more accurately described as stable management of objects or locomotor movements involving two or more body parts (Mottillo et al., 2010). The level of children's development of motor skills has a negative correlation with increased body mass index (Lopes, Maia, Rodrigues, Malina, 2012) and with the weight status in childhood and adolescence (Robinson et al., 2015). Over time, this leads to a negative correlation between the level of motor skills and the amount of body fat during childhood and adolescence. Meta-analysis (Barnet et al., 2016) has found that there is strong evidence that higher BMI was in a negative correlation with motor coordination and composite skills. Moreover, other obesity measurements, including higher waist circumference and body fat percentage, were negatively correlated with motor skills. The development of motor skills is most significant in preschool children and continues throughout primary school, but stagnates at a later age (Robinson et al., 2015). New review studies have confirmed a positive correlation between gross motor skills and organised physical activity (Chau, Chey, Burks-Young, Engelen, Bauman, 2017) and physical fitness (Hallal et al., 2012). Some studies have found that well-developed motor skills are a strong predictor of physical activity (Lopes, et al., 2012) and physical fitness (Rodrigues, Stodden, Lopes, 2016). The objective of this research is to determine the level of motor skills and differences in these among primary school students in relation to their level of nutrition.

METHODS

A stratified sample of survey participants selected from the population of primary school students attending the third and fourth grade of primary school was used during this research. The study involved 212 students, 105 of which were boys and 107 were girls. The health status of all students was checked, and it was required that they were healthy at the time of the research, while parental consent for the children's participation in the research was obtained according to the Ethical Guidance for Research Involving Children. The sample of variables consisted of anthropometric measurements including height, weight, triceps skin fold, back skinfold, abdominal circumference, hip circumference, and WHR ratio. All measurements were taken according to the International Biological Program (IBP). Height was measured with the anthropometer and weight with the body composition measurement device - Omron BF500 Body Composition Monitor. Skin folds were measured using a Lange Skinfold calliper. Motor skill were measured by a set of four motor tests. The hand tapping test was used to estimate the speed of simple movements. The explosive power was verified with the standing long jump test. The sit-up test was used to assess repetitive strength, and agility and speed were tested with the 10 x 5m shuttle run test. Motor skills were tested with standardised and validated tests that are being used in primary education in the Republic of Croatia and Europe (Findak, Metikoš, Mraković, & Neljak, 1996; Eurofit, 1988). Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in metres (kg / m2 = weight (kg) / (height (m)2) (Garow & Webster, 1985). Based on the calculated body mass index, using tables recommended by the International Obesity Task Force (Cole et al., 2000), subjects were classified into three groups according to their nutritional status: normal body weight, overweight, and obese. When analysing the data for all the variables in question, the basic descriptive parameters were used: arithmetic mean, standard deviation, minimum and maximum result, and Skewness and Kurtosis. The normality of the distribution of variables was tested by using the Kolmogorov-Smirnov normality test. The significance of differences between the formed subsamples based on the level of nutrition and motor skills was tested by using the canonical discriminant analysis. During the discriminant analysis, the significance of discriminant functions, their factor structure, and centroids projection onto the discriminant function were identified. The statistical significance of the differences was tested at the significance level $p < 0.05$. Data analysis was performed via the program STATISTICA version 13.5.0.17., TIBCO Software Inc.

RESULTS

Table 1: Descriptive indicators in anthropometric characteristics and motor skills for the total sample of third and fourth grade students (N = 212)

	AM±SD	*Min*	*Max*	*Skew*	*Kurt*	*max D*	*K-S*
Weight	144.07 ± 7.92	122.60	166.00	.10	.22	.05	p > .20
Height	38.67 ± 10.37	23.00	87.50	1.37	2.73	.11	p < .01
Body Mass Index	18.48 ± 4.09	12.27	41.60	1.94	6.29	.14	p < .01
% Fat	19.99 ± 8.12	2.00	45.00	.53	-.10	.08	p < .20
Back skinfold	11.18 ± 5.76	3.30	34.60	1.28	1.58	.16	p < .01
Triceps skin fold	15.96 ± 7.12	2.60	36.00	.76	.01	.11	p < .05
Waist circumference	64.48 ± 8.93	45.00	105.00	1.14	1.98	.14	p < .01
Abdominal circumference	78.17 ± 8.86	60.00	115.00	.88	1.38	.09	p < .10
Waist-to-Hip Ratio	.82 ± .05	.61	.97	-.15	1.00	.04	p > .20
Hand tapping	22.77 ± 3.55	12.00	34.00	.20	.32	.09	p < .10
Standing long jump	121.10 ± 27.20	40.00	240.00	.12	1.35	.06	p > .20
Sit-ups	33.55 ± 8.13	10.00	52.00	-.52	.16	.07	p > .20
10 x 5m shuttle run test	25.26 ± 4.82	16.28	39.90	.87	.68	.08	p < .20

AM = arithmetic mean; SD = standard deviation; MIN = minimum score; MAX = maximum score; K-S = Kolmogorov-Smirnov normality test SKEWNESS = asymmetrical distribution; KURTOSIS = elongation of the distribution

Table 1 shows the descriptive parameters for the total sample of subjects in regard to their morphological traits and motor skills. The age of the surveyed students was 9.77 ± 0.69 years of age. The results show that the measurements assessing the level of malnutrition do not deviate from normal values in relation to the studied age. The results for the standing long jump test (121.10) and 10 x 5m shuttle run test (25.26) showed lower values than the results found in the research by Tomkinson et al. (2018). In order to confirm whether it is valid to carry out the discriminant analysis, the normality of the distribution of variables in the field of motor skills was verified, and it was found that these variables are normally distributed, which is one of the prerequisites to carry out the discriminant analysis. The tables in the text below show the results of the homogeneity of variance and the correlation between the size of the group variances and the size of the arithmetic means.

Table 2: Levene's Test results estimating the assumption of homogeneity of variance

	F-value	**p-level**
Hand tapping	1.14	0.32
Standing long jump	0.90	0.41
Sit-ups	2.07	0.13
10 x 5m shuttle run test	0.02	0.98

The results in Table 2 show the values of the Levene's test that assesses the assumption of homogeneity of variance for the group. It is evident that there are no significant results, and it is possible to proceed further to the discriminant analysis.

Table 3: Results of the discriminant analysis of motor skills in relation to the level of nutrition

Function	**Eigenvalue**	**Coefficient of discrimination**	**Wilks' λ**	**X^2**	**Degrees of freedom**	**Error rate**
0	0.25	0.45	0.79	48.24	8	0.0000
1	0.01	0.09	0.99	1.58	3	0.6640

Table 3 shows the results of the canonical discriminant analysis that was used to identify the differences between the examined students. Insight into the results shows that two discriminant functions were obtained, the first of which is significant at the level of significance of $p < 0.05$, and which show a significant difference between the defined subsamples in motor skills in relation to the level of nutrition.

Table 4: Univariate tests with significance levels

N = 212	Wilks' λ: .79256 F (8.412) = 6.3483 p < .0000			
	Wilks' λ	Partial (λ)	F-test ((2.206))	Significance level
Hand tapping	0.80	0.99	1.16	0.3157
Standing long jump	0.83	0.95	5.46	0.0049
Sit-ups	0.88	0.90	11.10	0.0000
10 x 5m shuttle run test	0.79	1.00	0.07	0.9290

The univariate contribution to discrimination based on the level of nutrition and the motor skills variables is shown in Table 4, where a significant influence of the two investigated variables that distinguish the subsamples most is visible. The first variable is the standing long jump ($p = 0.0049$), while the second variable refers to sit-ups ($p = 0.0000$).

Table 5: Discriminant function structure matrix and group centroids

	Factor 1	Factor 2
Hand tapping	-0.13	-0.91
Standing long jump	-0.71	0.02
Sit-ups	-0.87	-0.22
10 x 5m shuttle run test	0.07	-0.38
Centroids of canonical discriminant functions		
G_1:1	-0.22	-0.04
G_2:2	0.08	0.16
G_3:3	1.64	-0.07

The factor structure of the canonical discriminant functions is shown in Table 5, and it shows the prevalence of the standing long jump variable and the sit-ups variable from the aspect of discrimination and in relation to the level of malnutrition. The linear polarisation of these two variables within the factor structure, along with the polarisation of the centroid projection on the canonical discriminant function, shows the prevalence of this system within the group of subjects with normal weight, and especially in the group of obese subjects. The 10 x 5m shuttle run variable shows no difference, both individually and in relation to its impact on the overall discrimination based on the level of nutrition if a significant canonical discrimination function with a discrimination coefficient of 0.45 is taken into account. This confirms the hypothesis that there is a statistically significant difference in motor skills between the studied groups of students from the aspect of their level of nutrition.

DISCUSSION

The results show a significant difference between the defined subsamples in motor skills in relation to the level of nutrition. Similar results have been obtained in some previous studies (Casajús et al., 2007; D'Hondt et al., 2013; Drid et al., 2013; Lopes, Stodden, Bianchi, Maia, Rodrigues, 2012; Riddiford-Harland, Steele, Storlien, 2000; Siahkouhian, Mahmoodi, Salehi, 2011; Yusof, Aiman, Zawi, Hasan, Radzi 2013; Stamatović et al., 2019). Prskalo, Badrić and Kunješić (2015) proved statistically significant differences in favour of boys with normal weight from the aspect of coordination, static strength, and explosive and repetitive strength. Obese students have significantly poorer results, which proves that, in boys between 10 and 11 years of age, differences in the level of motor skills are very much related to the increased percentage of body fat. Poorer motor skills reduce the students' ability to participate in sports or reduce their general physical activity, and thus increase the risk of obesity (Aires et al., 2010; Lubans, Morgan, Cliff, Barnett, Okely, 2010; Lopes et al; 2012a). Longitudinal studies (Dos Santos et al., 2018, and Henrique et al., 2018) show that, over a 4-year period, children with lower BMI and fat percentage had better developed motor skills. Lima, Bugge, Ersbøll, Stodden and Andersen (2019), in a longitudinal study that involved children between 6 and 13 years of age, found that children with higher levels of motor skills in childhood have a lower risk of being overweight, i.e., that being overweight and having low levels of cardiorespiratory fitness during the early education period is associated with a lower level of motor skills throughout childhood. Obese students have significantly poorer results, which proves that, in boys between 10 and 11 years of age, differences in the level of motor skills are closely related to the increased percentage of body fat. Students who have more adipose tissue show

significantly poorer results in performing motor tests because their excessive weight is a limiting factor of movement (Okely et al., 2004. D'Hondt et al., 2013; Morano et al., 2013, Lopes et al., 2012). Motor skills are moderately associated with BMI, and nearly four in five adolescents with low motor skills are overweight or obese. Furthermore, adolescents with low levels of motor skills were six times more likely to be overweight or obese (Chagas et al., 2021). Given that leaner and more physically fit children tended to be more coordinated, physical education should also focus on using those motor skills that are related to muscle strength, speed, agility, and aerobic capacity and, along with eating habits, reduce fat mass (Dos Santos et al., 2018). Research has shown that well-developed motor skills contribute to weight loss in children who were initially classified as overweight or obese. Obese children and those who are overweight have lower levels of explosive and repetitive power compared to children with normal weight. Continuous daily physical exercise significantly affects the development of motor skills. Children who are physically inactive and who do not have properly developed eating habits have a higher BMI and body fat percentage. The combination of a poorly balanced diet and physical inactivity causes children to be in a high-risk health group from an early age.

CONCLUSION

Based on the analysis of the results, it can be concluded that there are statistically significant differences in motor skills of primary school students in relation to different levels of nutrition. Research has shown that well-developed motor skills are one of the prerequisites for the normal physical development of children. The importance of encouraging children to engage in continuous, daily organised physical exercise is one of the prerequisites for the proper development of motor skills, while it also helps the overall growth and development of a human.

REFERENCES

1. Aires, L., Mendonça, D., Silva, G., Gaya, A. R., Santos, M. P., Ribeiro, J. C., Mota, J. (2010). A 3-year longitudinal analysis of changes in Body Mass Index. Int J SportsMed, 3:133–7.

2. Barnett, L. M., Lai, S. K., Veldman, S. L., Hardy, L. L., Cliff, D. P., Morgan, P. J., et al. (2016). Correlates of gross motor competence in children and adolescents: a systematic review and meta-analysis. Sports Med, 46, 1663–1688. doi: 10.1007/s40279-016-0495-z

3. Carson, V., Hunter, S., Kuzik, N., Gray, C. E., Poitras, V. J., Chaput, J.-P., Saunders, T. J., Katzmarzyk, P. T.., Okely, A. D., Connor Gorber, S., Kho, M. E., Sampson, M., Lee, H., Tremblay, M. S. (2016). Systematic review of sedentary behaviour and health indicators in school-aged children and youth: An update. Applied Physiology, Nutrition, and Metabolism, 41, 240–S265.

4. Casajús, J. A., Leiva M. T., Villarroya A., Legaz A., Moreno L. A. (2007). Physical Performance and School Physical Education in Overweight Spanish Children. Annals of Nutrition and Metabolism, 288–296

5. Chagas, D. V., Coutinho, A., Joia, M. C., Marinho, B., Ribeiro, M., Michel, C. (2021). Do Adolescents with Low Motor Competence Have Increased Risk for Overweight and Obesity? Child Obes, 17(5):322-328. doi: 10.1089/chi.2020.0344.

6. Chaput, J.-P., Gray, C. E., Poitras, V. J., Carson, V., Gruber, R., Olds, T., Tremblay, M. S. (2016). Systematic review of the relationships between sleep duration and health indicators in school-aged children and youth. Applied Physiology, Nutrition, and Metabolism, 41(6 [Suppl. 3]), S266–S282.

7. Chau, J., Chey, T., Burks-Young, S., Engelen, L., Bauman, A. (2017). Trends in prevalence of leisure time physical activity and inactivity: Results from Australian National Health Surveys 1989 to 2011. Aust. N. Z. J. Public Health, 41, 617–624.

8. Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standarddefinition for child overweight and obesity worldwide: International survey. British Medical Journal, 320, 1–6.

9. Council of Europe. (1988). Eurofit: handbook for the Eurofit tests of physical fitness. Rome: Council of Europe,

10. D'Hondt, E., Deforche, B., Vaeyens, R., Vandorpe, B., Vandendriessche, J., Pion, J., Philippaerts, R., de Bourdeaudhuij, I., Lenoir, M. (2011). Gross motor coordinationin relation to weight status and agein 5- to 12- year-old boys and girls: a cross-sectional study. Int J Pediatr Obes, 6:e556–64.

11. D'Hondt, E., Deforche, B., Gentier, I., De Bourdeaudhuij, I., Vaeyens, R., Philippaerts, R. Lenoir, M. (2013). A longitudinal analysis of gross motor coordination in overweight and obese children versus normal-weight peers. Int J Obes (Lond), 37, pp. 61–67.

12. Dos Santos, M. A. M., Nevill, A. M., Buranarugsa, R., Pereira, S., Gomes, T., Reyes, A., et al. (2018). Modeling children's development in gross motor coordination reveals key modifiable determinants. An allometric approach. Scand J Med Sci Sports, 28(5):1594–603. https:// doi. org/ 10. 1111/ sms. 13061.

13. Drid, P., Vujkov, S., Jaksić, D., Trivić, T., Marinković, D., Bala, G. (2013). Differences in motor and cognitive abilities of children depending on their body mass index and subcutaneous adipose tissue. Coll Antropol, 37 Suppl 2:171-7.

14. Findak, V., Metikoš, D., Mraković, M., Neljak, B. (1996). Applied kinesiology in schools -Norms. Croatian pedagogical-literary association (Primjenjena kineziologija u školstvu – Norme. Hrvatski pedagoški-književni zbor). Zagreb.

15. Garow, J. S., Webster, J. D. (1985). Quetelet's indeks (W/H2) as a measure of fatness. Int J Obes Relat Metab Disord, 9, 147-53.

16. Hallal, P. C., Andersen, L. B., Bull, F. C., Guthold, R., Haskell, W., Ekelund, U. (2012). Global physical activity levels: Surveillance progress, pitfalls, and prospects. Lancet, 380, 247–257.

17. Haller, H. (1977). Epidemiology and associated risk factors of hyperlipoproteinemia. Zeitschrift für Sie Gesamte Innere Medizin und Ihre Grenzgebiete, 32, 124–128

18. Hardy, L. L., Reinten-Reynolds, T., Espinel, P., Zask, A., Okely, A. D. (2012). Prevalence and correlates of low fundamental movement skill competency in children. Pediatrics, 130:e390–98.

19. Henrique, R. S., Bustamante, A. V., Freitas, D. L., Tani, G., Katzmarzyk, P. T., Maia, J. A. (2018). Tracking of gross motor coordination in Portuguese children. J Sports Sci, 36(2):220–8. https:// doi. org/ 10. 1080/02640 414. 2017. 12975 34.

20. Lima, R. A., Bugge, A., Ersbøll, A. K., Stodden, D. F., Andersen, L. B. (2019). The longitudinal relationship between motor competence and measures of fatness and fitness from childhood into adolescence. Jornal de Pediatria (Versão em Português), 95(4):482–8.

21. Lopes, V. P., Maia, J. A. R., Rodrigues, L. P., Malina, R. (2012). Motor coordination, physical activity and fitness as predictors of longitudinal change in adiposity during childhood. Eur. J. Sport Sci, (12), 384-391.

22. Lopes, V. P., Stodden, D. F., Bianchi, M. M., Maia, J. A., Rodrigues, L. P. (2012). Correlation between BMI and motor coordination in children. J Sci Med Sport, 38-43.

23. Lubans, D. R., Morgan, P. J., Cliff, D. P., Barnett, L. M., Okely, A. D. (2010). Fundamental movement skills in children and adolescents: review of associated health benefits. Sports Med, 40:1019–35.

24. Mottillo, S., Filion, K. B., Genest, J., Joseph, L., Pilote, L., Poirier, P., Rinfret, S., Schiffrin, E. L., Eisenberg, M. J. (2010). The metabolic syndrome and cardiovascular risk. A systematic review and meta-analysis. J. Am. Coll. Cardiol, 56, 1113–1132.

25. Piek, J. P., Baynam, G. B., Barrett, N. C. (2006). The relationship between fineandgrossmotorability,self-perceptionsandself-worth inchildren and adolescents. Hum Mov Sci, 25:65–75.

26. Poitras, V. J., Gray, C. E., Borghese, M. M., Carson, V., Chaput, J.-P., Janssen, I., Salome Aubert ,S., Faulkner, G., Goldfield, G. S., Reilly J. J., Sampson M., Tremblay, M. S. (2016). Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. Applied Physiology, Nutrition, and Metabolism, 41(6 [Suppl. 3]), S197–S239.

27. Pelemiš, V., Prskalo, I., Badrić, M., & Madić, D. (2019). Latent dimensions of morphological characteristics of preschool children. Acta Kinesiologica, 13(2), 28-36.

28. Prskalo, I., Badrić, M., Kunješić, M. (2015). The Percentage of Body Fat in Children and the Level of their Motor Skills. Collegium antropologicum, 39, 1; 21-28.

29. Redondo-Tebar, A., Fatouros, I. G., Martinez-Vizcaino, V., Ruíz-Hermosa, A., Notario-Pacheco, B., & Sanchez-Lopez, M. (2020). Association between gross motor competence and health-related quality of life in (pre)schoolchildren: the mediating role of cardiorespiratory fitness. Physical Education and Sport Pedagogy. doi:10.1080/17408989.2020.1800618

30. Riddiford-Harland, D. L., Steele, J. R., Storlien, L. H. (2000). Does obesity influence foot structure in prepubescent children? Int J Obes Relat Metab Disord, 24(5):541-4.

31. Riley, L. Guthold, R. Cowan, M. Savin, S. Bhatti, L. Armstrong, T. Bonita, R. (2016). The World Health Organization STEPwise Approach to Noncommunicable Disease Risk-Factor Surveillance: Methods, Challenges, and Opportunities. Am. J. Public Health, 106, 74–78.

32. Robinson, L. E., Stodden, D. F., Barnett, L. M., Lopes, V. P., Logan, S. W., Rodrigues, L. P., D'Hondt, E. (2015). Motor competence and its effect on positive developmental trajectories of health. Sports Med, 45(9):1273-1284.

33. Rodrigues, L. P., Stodden, D. F., Lopes, V. P. (2016). Developmental pathways of change in fitness and motor competence are related to overweight and obesity status at the end of primary school. J. Sci. Med. Sport, 19(1):87-92.

34. Roth, K., Ruf, K., Obinger, M., Mauer, S., Ahnert, J., Schneider, W., Graf, C. (2010). Hebestreit, H., Is there a secular decline in motor skills in preschool children? Scand J Med Sci Sports, 20(4):670–8.

35. Siahkouhian, M., Mahmoodi, H., & Salehi, M. (2011). Relationship between fundamental movement skills and body mass index in 7-to-8 year-old children. World Applied Sciences Journal, 15(9), 1354-1360.

36. Sperling, L. S.,Mechanick, J. I., Neeland, I. J., Herrick, C. J., Després, J. P., Ndumele, C. E., Vijayaraghavan, K., Handelsman, Y., Puckrein, G. A., Araneta, M. R., Blum., Q. K., Collins, K. K., Cook, S., Dhurandhar, N. V., Dixon, D. L., Egan, B. M., Ferdinand, D. P., Herman, L. M., Hessen, S. E., Jacobson, T. A., Pate, R. R., Ratner, R. E., Brinton, E. A., Forker, A. D., Ritzenthaler, L. L., Grundy, S. M. (2015). The CardioMetabolic Health Alliance: Working toward a new care model for the metabolic syndrome. J. Am. Coll. Cardiol,

66, 1050–1067

37. Stamatović, M., Šekeljić, G., Martinović, D., & Pelemiš, V. (2019). Comparative study of motor performances of the boys with different body mass indices. Croatian Journal of Education, 21(2), 511-537. doi.org/10.15516/cje.v21i2.3088.

38. Tomkinson, G. R., Carver, K. D., Atkinson, F., Daniell, N. D., Lewis, L. K., Fitzgerald, J. S., Lang, J. J., Ortega, F. B. (2018). European normative values for physical fitness in children and adolescents aged 9-17 years: results from 2 779 165 Eurofit performances representing 30 countries. Br J Sports Med, 52:1445–1456.

39. Yusof, S. M., Aiman, S., Zawi, M. K., Hasan, H., Radzi A. A. M. (2013). Body Composition Index Predict Children's Motor Skills Proficiency. International Journal of Medical, Health, Pharmaceutical and Biomedical Engineering, 7, (7), 177.

NUTRITIVNI STATUS I MOTORIČKE VJEŠTINE UČENIKA TREĆEG I ČETVRTOG RAZREDA

U zadnjih nekoliko godina pretilost kod djece se značajno povećala. Jedan od dokazanih razloga je i smanjena fizička aktivnost već od najmlađe dobi. Nizak nivo fizičke aktivnosti kod učenika negativno utiče na razvoj njihovih motoričkih vještina, ali i na njihov cjelokupni zdravstveni status. Cilj ovog istraživanja je bio utvrditi razlike u nivou motoričkih vještina prema stepenu uhranjenosti kod učenika trećeg i četvrtog razreda osnovne škole. Uzorak ispitanika se sastojao od 212 učenika, od čega 105 dječaka i 107 djevojčica dobi 9,77 ± 0,69 godina. Za procjenu tjelesne građe korištene su antropometrijske mjere tjelesna visina, tjelesna masa, kožni nabor nadlaktice, kožni nabor leđa, opseg trbuha, indeks tjelesne mase i udio postotka masti u tijelu. Tjelesna visina izmjerena je uz pomoć antropometra, a tjelesna masa uz pomoć uređaja za mjerenje tjelesne građe – Omron BF500 Body Composition Monitor. Kožni nabori su izmjereni pomoću Langeovog Skinfold kalipera. Motoričke vještine su ispitane standardiziranim i provjerenim testovima koji se koriste u osnovnom obrazovanju u Republici Hrvatskoj i Europi (Findak, Metikoš, Mraković i Neljak, 1996; Eurofit, 1988). Na osnovu izračunatog indeksa tjelesne mase, a koristeći tabele preporučene od strane Međunarodne radne grupe za pretilost (Cole i sur., 2000), ispitanici su svrstani u tri grupe prema stepenu uhranjenosti: normalna tjelesna masa, prekomjerna tjelesna masa i pretili. Rezultati istraživanja pokazuju značajne razlike između poduzoraka u motoričkim vještinama prema stepenu uhranjenosti. Dobivene su dvije diskriminacijske funkcije od kojih je prva značajna na nivou značajnosti od p = 0,0000. Varijable koje značajno ističu poduzorke prema stepenu uhranjenosti su skok u dalj s mjesta (p = 0,0049) i podizanje trupa (p = 0,0000). Na osnovu dobivenih i analiziranih rezultata se može zaključiti da učenici koji pripadaju grupi normalno uhranjenih imaju značajno bolje rezultate u motoričkim vještinama. Dobro razvijene motoričke vještine su jedan od preduslova za normalan tjelesni razvoj djece. Važnost poticanja djece na neprekidno vježbanje je jedan od preduslova za pravilan razvoj motoričkih vještina.

Ključne riječi: indeks tjelesne mase (BMI), motoričke vještine, pretilost, fizička aktivnost, zdravlje

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CHANGES IN THE SITUATIONAL MOTOR ABILITIES OF KARATE ATHLETES IN THE PREPARATORY AND PRE-COMPETITION PERIOD

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ABSTRACT

The development of modern karate is associated with the growing presence of science whose research results have been widely used in the training processes of karate athletes. All this research has contributed to building the scientific basis in sports. Achieving top sports re-sults is conditioned by a number of predispositions that modern competitors should possess.

The research was conducted on a stratified sample of 16 male karate athletes, potential members of the national team of the Republic of Kosovo, in the period of preparation before participation in the World Cup for U21, juniors and cadets in Chile 2019. The main goal of the research is to determine the changes in situational-motor abilities in karate athletes after ten weeks of programmed training. The basic descriptive statistical parameters were calculated for each variable, for example: arithmetic mean (Mean), standard deviation (SD), lower (min) and upper (max) limit of the results. Multivariate analysis of variance (MANOVA) and univariate analy-sis of variance (ANOVA) were used to determine the intergroup differences in arithmetic means as well as the differences within the groups. The LSD test post hoc analysis was applied to de-termine the specific impact of each variable in the creation of group differences. The analysis of the obtained research results revealed statistically significant differences between the three time sequences in the three variables.

Keywords: training, karate, situational motor abilities

INTRODUCTION

The impact of motor abilities, such as: speed, explosiveness, agility, coordination, muscle strength, endurance, and flexibility, along with all functional abilities are certainly the priority and most important conditions for achieving top sports results. Due to its structural complexity, karate belongs to the group of polystructural acyclic sports. Kara-te as a polystructural acyclic sport dominat-ed by acyclic unpredictable movements has only a symbolic destruction of the oppo-nent. This positive

destruction the karate athlete strives to perform by delivering con-trolled blows to the head and body of the opponent, although the movements repre-sent a combination of maximum and sub-maximal intensity. It is exactly such sym-bolism that gives a special place and mean-ing to this sport. As a sport and martial art, karate encourages self-discipline and de-velops focus and awareness. (Kostovski et al., 2014).

The development of modern karate is associated with the growing presence of science, whose research results have been widely used in the training processes of karate athletes (Korpanovski, Jovanovic, Dopsaj, 2007). All this research has contrib-uted to building the scientific basis in sports. Achieving top sports results is con-ditioned by a number of predispositions that modern competitors should possess. Great importance is given to the high tech-nical performance, the performed tech-niques, motor and functional abilities, men-tal readiness, and anthropometric and mor-phological predispositions (Lehmann & Jed-liczka, 1998). Assessment of the success achieved by athletes, who participate and compete in the big competitions, can be analysed only through scientific monitoring and using the knowledge from the compre-hensive analyses of the way and time of the movements in the "kumite" - sports com-bat. In its development, karate has evolved from a traditional martial art into a modern global martial art. Karate combat consists of a number of repetitions of blows and de-fence techniques, separated by high-intensity rhythmic jumping movements during the 3-minute fight in men (Beneke et al., 2004). Thus, karate combats are clearly characterised by an alternating pat-tern of activities (Chaabene, Hachana, Franchini, et al., 2012). From the analysis of karate competitions at the national level, it has been noticed that the activity phases contain 16 ± 5 actions with high intensity after the fight, which last for 1-3 seconds each (Beneke et al., 2004), and at the in-ternational level, karate athletes perform 17 ± 7 high-intensity actions lasting 1-5 sec-onds, each using predominantly specific upper extremity techniques (76.19% of all techniques used) (Chaabene, Franchini, Miarka, et al., 2013). Athletes, coaches and scientists in sports have a great interest in monitoring and measuring the adaptations of the body produced as a result of training.
Situational motor abilities in modern karate are perhaps a crucial factor in solving sports tasks and achieving sporting suc-cess. Hand and leg blows in karate are the dominant techniques by which a karate athlete gains points or fights (Kostovski, 2005).

This research is focused on the changes of the situational motor abilities in karate athletes throughout the pro-grammed training process during the pre-paratory and pre-competition period. The need to evaluate these parameters is due to the fact that they are the dominant techniques for winning a match.

MATERIALS AND METHODS

THE SAMPLE OF RESPONDENTS

The research was conducted on a stratified sample of 16 male karate athletes, potential members of the U21 category, from the Republic of Kosovo, in the period of prepa-rations before the participation in the World Cup for U21, juniors and cadets in Chile 2019. The measurement was conducted in three time sequences during the period of preparations (Initial, Control and Final).

THE SAMPLE OF VARIABLES

The sample of variables consists of:

1. Kizame cuki đodan - đako cuki đodan - mawashi geri ćudan - (KJGJCMJ)

2. Kizame cuki đodan - đako cuki ćudan - mawashi geri đodan with rear leg - (KJGJCM)

3. Kizame cuki đodan - đako cuki ćudan - ashimawashi geri đodan - (KJGJC)

- The assessment of the situational motor abilities was performed according to the methodology of Zaborski B. (2013)

STATISTICAL PROCESSING

The basic descriptive statistical pa-rameters were calculated separately for each variable; arithmetic mean (Mean), standard deviation (SD), lower (min) and upper (max) limit of the results. One-way repeated measures MANOVA/ANOVA were used to determine the intergroup differ-ences in the arithmetic means. The impact of each variable in the creation of group differences was determined by applying the LSD test post hoc analysis. The research was conducted without a control group due to the fact that we are talking about top athletes, younger seniors with an average age of 20 years, which indicates the fact that the human development curve enters a phase of stagnation, and in the men-tioned period, they did not have any other physical activities except the training pro-cess. These data are sufficient confirmation that the changes in athletes are a result of the training process.

RESULTS

The results of this study, which refer to the situational motor abilities of karate athletes in different time sequences, are shown in Table 1.

Table 1: Basic statistical indicators of variables from the situational motor abilities for the U-21 group of respondents

	N	Min	Max	Mean	SD	Skew	Kurt
KJGJMGC	16	8	14	11.31	1.66	-0.37	0.03
KJGJCMJ	16	8	13	11.63	1.41	-1.19	1.48
KJGJAMJ	16	8	10	9.00	0.73	0.00	-0.91
KJGJMGC K	16	10	14	12.31	1.08	-0.35	0.12
KJGJCMJ K	16	10	15	12.19	1.11	0.59	2.31
KJGJAMJ K	16	9	11	9.56	0.81	1.04	-0.55
KJGJMGC F	16	11	16	13.38	1.09	0.19	2.26
KJGJCMJ F	16	11	14	12.69	0.70	-0.77	1.18
KJGJAMJ F	16	10	11	10.44	0.51	0.28	-2.22
Valid N (listwise)	16						

For the purpose of this research, the following were calculated: arithmetic mean (Mean), minimum result (Min), maxi-mum result (Max), standard deviation (SD). The coefficient of asymmetry of the results (Skew) and the coefficient of elongation (flatness) of the results (Kurt) were used to test the normality of the distribution of the results.

Analysing the results of the initial measurement, it can be said that in the calculated parameters of the applied varia-bles, the standard deviation (SD) is within the limits of normal values, and no devia-tion from the normal values of the standard deviation was observed in any of the varia-bles. The maximum and minimum values are expected, i.e., the grouping of the re-sults revolves around their own arithmetic means.

From the performed analysis of the Gaussian curve (Skew), which determines the symmetry of the distribution of results, it can be concluded that the displayed coef-ficients are within the recommended values (-1 + 1) with the exception of the variable Kizame cuki đodan - đako cuki ćudan - mawashi geri đodan with rear leg - (KJGJCMJ, Skew = -1.19). From the values of the degree of curvature for the Gaussian curve (Kurt), all variables show flatness, and no statistically significant deviation is rec-orded.

By analysing the results of the con-trol measurement, it is concluded that in the calculated parameters of the applied variables, the standard deviation (SD) is within the limits of normal values, i.e., no deviation from the normal values of the standard deviation was found. Maximum and minimum values are also expected and logical, and the grouping of the results re-volves around their own arithmetic means.

Analysing the Gaussian curve (Skew), in order to determine the sym-metry of the distribution of results, it can be concluded that the displayed coefficients are within the recommended values (-1 + 1) only for the variable Kizame cuki đodan - đako cuki ćudan ashimawashi geri đodan - (KJGJAMJ, Skew = 1.04). Analysing the cur-vature of the Gaussian curve (Kurt), all vari-ables show cohesiveness, and no statisti-cally significant deviation was recorded.

By analysing the results of the final measurement, it can be concluded that in the calculated parameters from the applied variables, the standard deviation (SD) is within the limits of normal values, and no deviation from the normal values of the standard deviation was found in any of the variables. The maximum and minimum val-ues are expected and logical, i.e., the grouping of the results revolves around their own arithmetic means.

Analysing the Gaussian curve (Skew), in order to determine the sym-metry of the distribution of the results, it was concluded that the displayed coeffi-cients range within the recommended val-ues (-1 + 1). From the values of the degree of curvature for the Gaussian curve (Kurt), all variables show flatness, and no statisti-cally significant deviation is recorded.

From above presented data, it can be concluded that the karate athletes, in their programmed training process, achieved the best results in the arithmetic means of the variables for the assessment of the situational motor abilities in the third time sequence. The evident difference in the results between the initial, control and final measurement is due to

the well-programmed training in the preparatory period of the karate athletes and indicates the improvement of their situational motor readiness. If these results are compared with the results from the available litera-ture, it can be said that they move in similar frames.

From the values shown in Table No. 2, and referring to the statistically signifi-cant differences between the time se-quences of the measurements, it can be concluded that: based on the results ob-tained from the three measurements of each variable separately and from the val-ues of Rao's F approximation, there is a statistically significant difference between the three time sequences (measurements) in the three variables for the assessment of situational motor techniques at the level of p = 0.00.

Table 2: Multivariate differences of variables from the situational motor techniques for the U-21 group of respondents

U21	Initial		Control		Final		F	Sig
	Mean	SD	Mean	SD	Mean	SD		
KJGJCMJ	11.31	1.66	12.31	1.08	13.38	1.09	35.28	**0.000**
KJGJCM	11.63	1.41	12.19	1.11	12.69	0.70	12.94	**0.003**
KJGJC	9.00	0.73	9.56	0.81	10.44	0.51	83.52	**0.000**

Table 3: Univariate differences of variables from the situational motor techniques for the U-21 group of respondents

Pairwise Comparisons KJGJCM

(I) Time		Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	(1.000)*	.376	.018	-1.802	-.198
	3	(2.063)*	.347	.000	-2.803	-1.322
2	1	1.000*	.376	.018	.198	1.802
	3	(1.063)*	.143	.000	-1.368	-.757
3	1	2.063*	.347	.000	1.322	2.803
	2	1.063*	.143	.000	.757	1.368

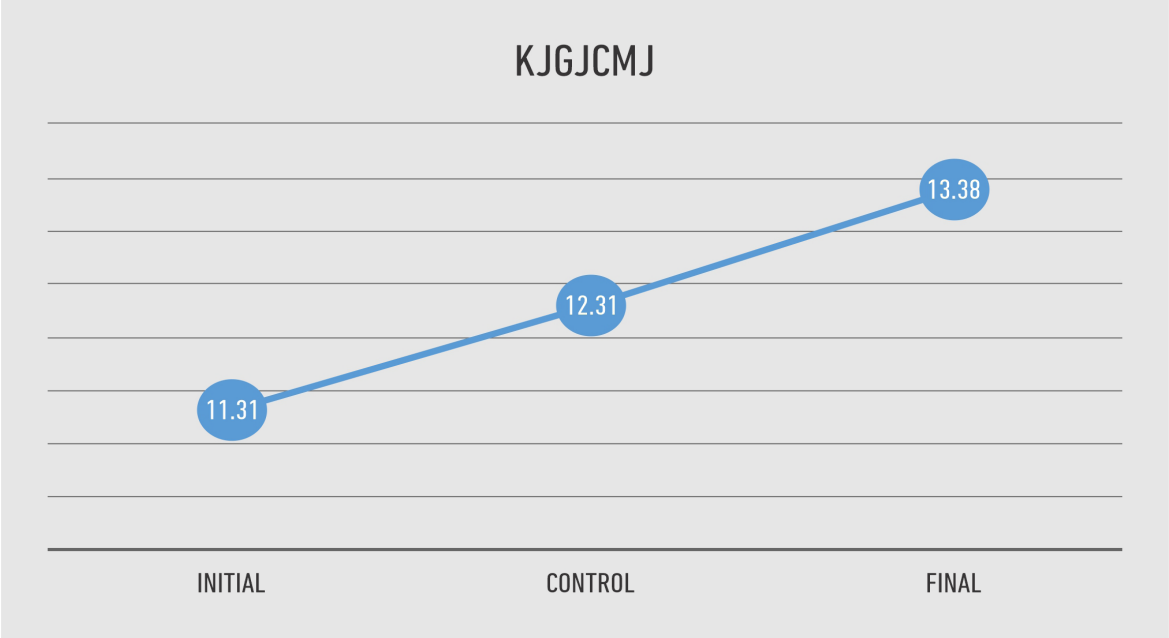

Table 3 presents the differences at the univariate level, i.e., the time sequenc-es that contribute to the creation of the statistically significant difference within the measurements. From the same table, it can be seen that in the variable Kizame cuki đodan đako cuki đodan - mawashi geri ću-dan (KJGJCMJ), the determined numerical differences are also statistically significant differences in all three measurements at the level of p = 0.000 to p = 0.018. The biggest statistically significant difference is determined between the initial measure-ment and the other two (control and final) measurement at the level of p = 0.000

Table No. 4 presents the differences at the univariate level, i.e., the time se-quences that contribute to the creation of the statistically significant difference within the measurements. From the same table, it can be seen that in the variable Kizame cuki đodan - đako cuki ćudan - mawashi geri đodan with rear leg (KJGJCM), numerical differences were determined between the measurements, which are also statistically significant differences in all three meas-urements at the level of p = 0.003 to p = 0.045. The largest statistically significant difference is determined between the initial and final measurement (p = 0.003), and the control and final measurement (p = 0.015), while the smallest statistically significant difference occurs between the initial and control measurement (p = 0.045).

Table 4: Univariate differences of variables from the situational motor techniques for the U-21 group of respondents

Pairwise Comparisons KJGJCM

(I) Time		Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	(.563)*	.258	.045	-1.112	-.013
	3	(1.063)*	.295	.003	-1.692	-.433
2	1	.563*	.258	.045	.013	1.112
	3	(.500)*	.183	.015	-.889	-.111
3	1	1.063*	.295	.003	.433	1.692
	2	.500*	.183	.015	.111	.889

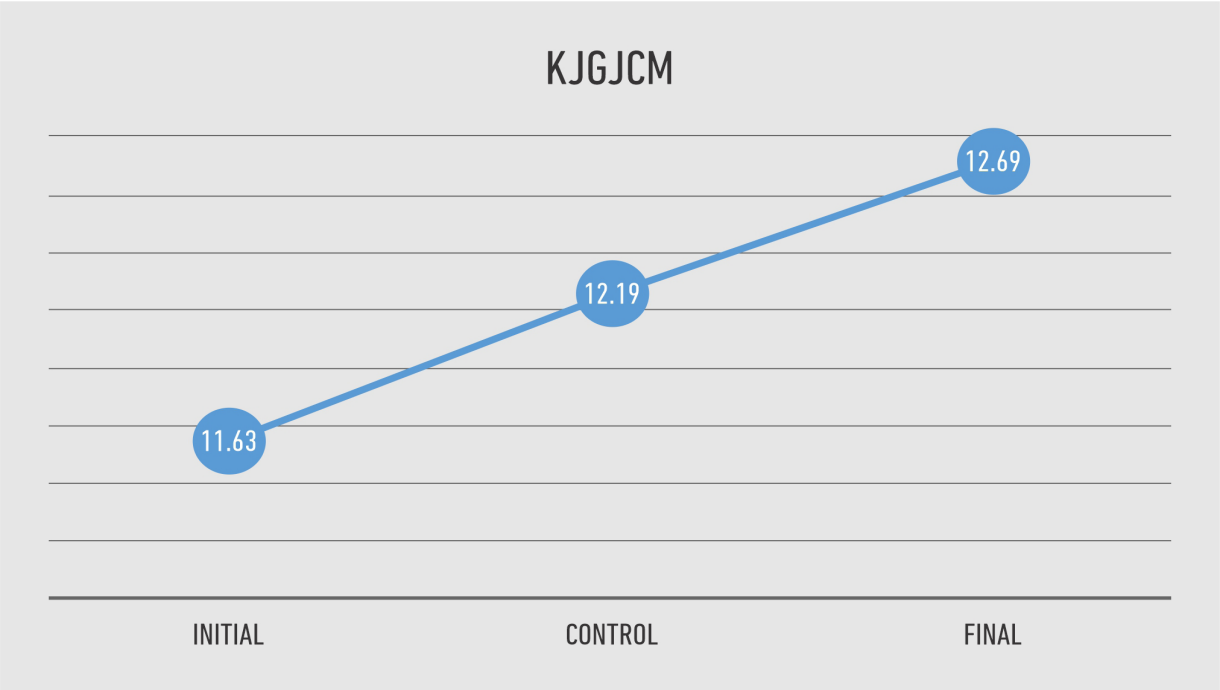

Table 5: Univariate differences of variables from the situational motor techniques for the U-21 group of respondents

Pairwise Comparisons KJGJCM

(I) Time		Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	(.563)*	.182	.007	-.950	-.175
	3	(1.438)*	.157	.000	-1.773	-1.102
2	1	.563*	.182	.007	.175	.950
	3	(.875)*	.180	.000	-1.258	-.492
3	1	1.438*	.157	.000	1.102	1.773
	2	.875*	.180	.000	.492	1.258

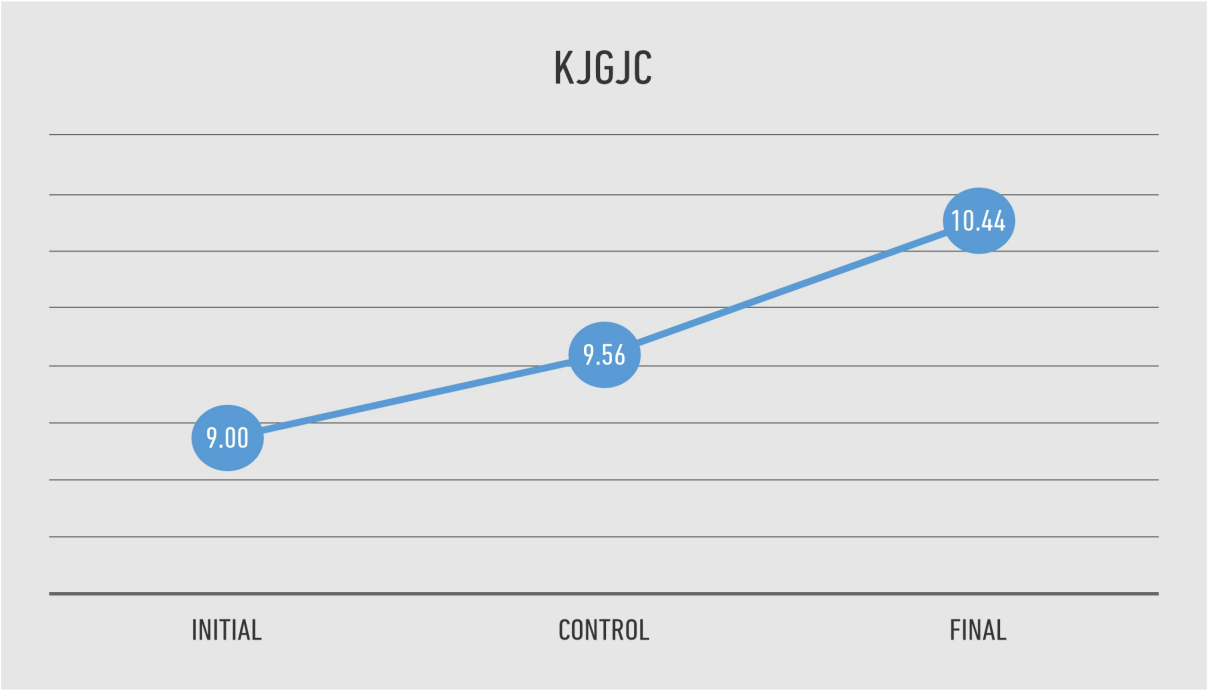

Table 5 presents the differences at the univariate level, i.e., the time sequenc-es that contribute to the creation of the statistically significant difference within the measurements. From the same table, it can be seen that in the variable Kizame cuki đodan - đako cuki ćudan - ashimawashi geri đodan (KJGJC), numerical differences were determined between the measurements, which are statistically significant differences in all three measurements at the level of p = 0.000 to p = 0.007. The largest statisti-cally significant difference is determined between the initial and final measurement (p = 0.000), and the control and final measurement (p = 0.000), while the small-est statistically significant difference occurs between the initial and control measure-ment (p = 0.007).

DISCUSSION

Due to its structural complexity, ka-rate belongs to polystructural acyclic sports, which are dominated by acyclic un-predictable movements, and has only a symbolic destruction of the opponent. This positive destruction the karate athlete strives to achieve by delivering controlled blows to the head and body of the oppo-nent, although the movements represent a combination of maximum and submaximal intensity (Kostovski, et. al., 2015), and en-ergy is drawn from both aerobic and anaer-obic metabolism. In indoor sports (gyms), the physical performance of athletes is generally determined by the duration and pace of the competition. In response to this, training programmes aim to slow down the formation of fatigue and improve en-durance (Kaya et al., 2013).

Hand and foot techniques in karate are the dominant techniques by which competitors score points or win the fight. Previous research on modern technical and tactical indices in karate fighting suggests that hand techniques have a very large im-pact (Vidranski, 2011). Also, according to Mattias (1999), one can see their connec-tion from the dominance of manual tech-niques in scoring and the blow ashi mawashi geri. Mawashi geri is a very useful shot when the fight is close range or in hand combination because it is difficult for the opponent to see the blow coming due to his roundabout. In this situation, either the front or rear leg can be used, although hitting with the front leg is faster and virtu-ally impossible for the opponent to block.

The research of Wąsik (2010), which was performed on a 17-year-old karate ath-lete, determined the blow time to be 0.75 seconds. He points out that the roundabout blow (Ashi Mawashi Gerry) is the most commonly used blow in combat.

In case there is a medium or long distance, these kicks can be easily com-bined with the hands and legs. According to the theoretical arguments taken from pre-vious research (Mattias, 1999), these tech-niques can be used as quick combinations, which is vital for sparring. Also, due to the rotation of the hip, which allows greater reach than the mae-geri, the body is well positioned in relation to the opponent, for which it will be more difficult to reach a counter-blow (which is impossible with a linear blow such as a mae-geri)

Hand blows are more natural than kicks, they are faster, easier to control and harder to block or avoid, which can easily explain why they are more commonly used in karate than kicks (Vidranski, 2011). Ac-cording to the current literature, these hand and leg techniques are one of the most commonly used when it comes to sports combat. Karate athletes used more upper limbs (76.19%) as opposed to lower limb techniques (23.80%). Kizame cuki was the most commonly used technique with 29.1% of all other techniques used accord-ing to Chaabène et al. (2014). Hence the conclusion that hand and leg blows can be easily combined including short, medium and long distance. According to the results of a study conducted by Vidranski, et al. (2015), the results in the technical and tac-tical combat concept were influenced by fast techniques that were used by the fighters as a means of tactical surprise to gain an advantage in the attack phase, i.e., karate combats were primarily won using simple techniques.

Karate competitions are character-ised by a complex technical structure and specific competitive abilities in the field of combined attack techniques (Kostovski et. al., 2013). Different techniques, such as kizame zuki and đako zuki, are the most applied competition techniques, which are structurally simple and safe movements and therefore the most commonly used. Research results indicate that direct hand blows are the most effective attack tech-niques where blows have an advantage over leg blows. These types of attacks can be used as: one attack, counter attack or a combination of both (Vidranski, 2011).

According to the aforementioned study conducted by Kostovski et al. (2014), it can be concluded that the competitors and the winners of the competitions achieved higher values of situational effi-ciency of the mawashi geri chudan tech-nique in the attack phase. It could also be noticed that the group of winning competi-tors differed the most from the group of defeated competitors in the situational effi-ciency of the stated leg technique. It could be concluded that the winners of the com-petitions perform complex and difficult techniques, while those who were motor inferior to their opponents could not per-form these techniques. In addition to the above reasons, the "mawashi geri ćudan" technique is often used as a second and third choice technique in composite combi-nations. The reasons for such classification are: the lowest biomechanical complexity among all observed leg techniques and the transfer of the zone to achieve body points (Vidranski, 2011). Each individual variable with different intensity is related to the ob-tained factor, i.e., the grouping of the varia-bles unequally represents the obtained factor. Therefore, the variable that carries the most information about it stands out (Perić, 2001) as is the case with the ob-tained latent dimension.

The results of the research con-ducted by Kostovski Et al. (2013), regarding the measurement of the performance of the applied variable and above all, the factor of its validity, sensitivity and reliability, indi-cate that the test "Mawashi geri" is charac-terised by a high degree of sensitivity and satisfaction of the coefficients of reliability.

CONCLUSION

Specific motor abilities in modern karate sport are perhaps a crucial factor in solving sports tasks and achieving sport success. Hand and leg blows in karate are the dominant techniques by which a karate athlete gains points or fights (Kostovski, 2005). This was an additional reason to conduct the research with 16 male karate athletes, potential members of the national team of the Republic of Kosovo.

Achieving top sports results is condi-tioned by a number of predispositions that modern competitors should possess. Great importance is given to the high technical performance, given techniques, motor and functional abilities, mental readiness and

anthropometric and morphological predis-positions (Lehmann & Jedliczka, 1998). As-sessment of the success achieved by ath-letes, who participate and compete in the big competitions, can be analysed only through scientific monitoring and using the knowledge from the comprehensive anal-yses of the way and time of the move-ments in the "kumite" - sports combat. If we take into account that our study was related to karate athletes, and that the ka-rate federation of Kosovo is a member of the European and World Federation, more recently, it can be said that the results achieved by a good number of karate ath-letes are satisfactory in terms of compara-tive results from the literature. During the competition, the karate athletes do not reach the maximum level of load, and in one tournament, the karate athletes can have 4-5 fights during the day for which they need energy resources to be able to withstand at least 5 fights during the day.

Based on the well-programmed training process and its monitoring during the preparation and pre-competition period, as well as other factors that affect the suc-cess of the athletes, the Kosovo national team at the World Cup in Chile achieved the highest results so far at this age (one fifth and two seventh places)

The main limitation of our study is the relatively small number of respondents, which reduces the power of statistics. How-ever, it should be borne in mind that this is mainly due to the specificity of the disci-pline as the number of karate athletes who make up the core of the national team, and who train under the supervision of one coach and in the same conditions, is always limited and rarely any national team as Ko-sovo (per capita) have a larger number of potential members of this age category. Therefore, it is advisable to conduct other research that will include karate athletes from other age categories, and which will be conducted according to our research methodology. This type of research is de-sirable to conduct, by expanding the seg-ments of the research, in other macro cy-cles of the training process.

REFERENCES

1. Beneke, R., Beyer, T., Jachner, C., et al. (2004). Energetics of karate kumite. Eur J Appl Phys-iol, 92(4-5):518-523.
2. Chaabene, H., Hachana, Y., Franchini, E., et al. (2012). Physical and physiological profile of elite karate athletes. Sports Med, 1; 42(10):829-843.
3. Chaabene, H., Franchini, E., Miarka, B., et al. (2013). Time-Motion Analysis, Physiological and Rate of Perceived Exertion Responses to Karate Official Combats: Is There a Difference Be-tween Winners and Defeated Karatekas? Int J Sports Physiol Perform.
4. Chaabène, H., et al. (2014). Physiological Responses and Performance Analysis Difference be-tween Official and Simulated Karate Combat Conditions. Asian J Sports Med, 5(1): 21–29.
5. Kaya, I., Kalkavan, A., Senturk, A., Harmanci, H., Karavelioglu, M. B., Yuksel, O., Savasli, M. (2013). Analysis of blood lactate and heart rate of indoor sports athletes as a response to various loads. Turkish Journal of Sport and Exercise, Volume: 15 - Issue: 3 - Pages: 86-89.
6. Korpanovski, N., Jovanovich, S., Dopsaj, M. (2007). Quantitative indicators representation of scoring techniques among top karate athletes, [Квантитативни показатељи заступљености поентирајучих техника код врхунских каратиста]. International scientific conference. Physi-cal Activity Analytics and Diagnostics. Belgrade
7. 7. Kostovski. (2005). Karate Heian kati [Карате Хеиан кати]. Pakung, Skopje.
8. Kostovski, Ž., Mikic, B., Georgiev, G., Djuknovic, N., Ahmeti, V., & Masic, Z. (2013). Anthropo-logical dimensions as predictors of a competition efficiency in elite
9. karate athletes. Technic Technologies Education Management-TTEM, 8 (3), 1164-1172. Im-pact Factor: 0.414
10. Kostovski, Ž. Mikic, B., Ahmeti, V., Zelkovic, M., Stankovic, N. (2014). Validity of the test in two-hand successive attack techniques with top karate athletes. Technics technologies edu-cation management - TTEM, 9 (2), Impact factor: 0.414
11. Kostovski, Ž., Đukanović, N., Gligoroska, P. J., Mašić, Z., & Blažević, S. (2015). The
12. Effects of the Six-Week Preparation Period on the Indicators of Body Composition and Physio-logical Characteristics in Top Karate Fighters from the Republic Of Macedonia.
13. Lehmann, G., Jedliczka, G. (1998). Investigations about the event specific profile of karate. Leistungssport, 28(3), 56–61
14. Mattias, B. (1999). Mawashi-geri. Godan Examination Report. Montréal, Québec, Canada

15. Vidranski, T. (2011). Analysis of the point value and outcomes karate fight (In Croatian). Zbornik radova 20. ljetnu školu kineziologa Republike Hrvatske, Poreč, 21-25 6 532-536.

16. Vidranski, T., et al. (2015). Differences in technical and tactical indicators of attacks and counterattacks in elite male karate fighters. Acta Kinesiologica, 9 1: 19-24.

17. Peric, D. (2001). Statistics used in sports and physical education [Statistika primenjena u sportu i fizickom vaspitanju]. Beograd. Ideaprint

18. Tabben, M., Chaabène, H., Franchini, E., Tourny, Chamari, K., Coquart, J. (2014). The Influence of karate practice level and sex on physiological and perceptual responses in three modern karate training modalities. Biol. Sport, 31:201-207.

19. Wąsik, J. (2010). The structure of the roundhouse kicks on the example of a European Champion of taekwon-do. Institute of Physical Education, Jan Długosz University of Często-chowa, Czestochowa, Poland.

20. Zaborski, B. (2012). Measurement characteristics of situational motor stereotypes in kumite [Мерни карактеристики на ситуационо моторичките стереотипи во кумите], Скопје (Магистерски труд)

PROMJENE SITUACIONO-MOTORIČKIH SPOSOBNOSTI KARATE SPORTISTA U PRIPREMNOM I PREDTAKMIČARSKOM RAZDOBLJU

Razvoj modernog karatea je povezan sa sve većim prisustvom nauke čiji su rezultati istraživanja naširoko korišteni u trenažnim procesima karatista. Sva ova istraživanja su doprinijela izgradnji naučne osnove u sportu. Postizanje vrhunskih sportskih rezultata je uslovljeno nizom predispozicija koje bi savremeni takmičari trebalo da posjeduju. Istraživanje je provedeno na stratificiranom uzorku od 16 karatista, potencijalnih članova reprezentacije Republike Kosovo, u periodu priprema prije učešća na Svjetskom kupu za U21, juniore i kadete u Čileu 2019. Glavni cilj istraživanja je utvrditi promjene u situaciono-motoričkim sposobnostima karatista nakon deset sedmica programiranog treninga. Osnovni deskriptivni statistički parametri su izračunati za svaku varijablu, na primjer: aritmetička sredina (srednja vrijednost), standardna devijacija (SD), donja (minimalna) i gornja (maksimalna) granica rezultata. Multivarijantna analiza varijanse (MANOVA) i univarijantna analiza varijanse (ANOVA) su korištene za utvrđivanje međugrupnih razlika u artimetičkim sredinama, kao i razlike unutar grupa. Analiza post hoc LSD testa je primijenjena kako bi se utvrdio specifični uticaj svake varijable u stvaranju grupnih razlika. Analiza dobijenih rezultata istraživanja je otkrila statistički značajne razlike između tri vremenske sekvence u tri varijable.

Ključne riječi: trening, karate, situaciono-motoričke sposobnosti

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AGILITY OF FOOTBALL PLAYERS FROM DIFFERENT LEVELS OF COMPETITION

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ABSTRACT

The research was conducted with the aim of determining the level of agility of football players from three football teams that are in different ranks of the competition (Super League, First Division and Second Regional Division). 60 football players (20 from each team) participated in the testing. The Hexagon agility test, Zig-zag test, Illinois agility run test, "T" test, Balsom agility test, and Arrowhead agility test were used to assess agility. In addition to descriptive parameters, the analysis of variance for independent samples (one-way ANOVA) and Post hoc analysis (Scheffe) were used in the analysis. After the data were processed, the obtained results showed a significant difference between the players of the three teams in all tests. By further analysis, the results showed that the players of the team from the Super League differ significantly (they are better) in all tests than the players who play in the Second Division. Compared to the team from the First Division, Super League players do not differ significantly only in the Hexagon agility test ($p = .163$), while in other tests, they are significantly better. If the relation between the players from the team of the First and Second Divisions is observed, the significance of the differences is recorded only in the Zig-zag test ($p = .013$) in favour of the team from the First Division. It can be concluded that the results of agility are significantly influenced by the rank of the competition (primarily at the highest in relation to the lower ones), which requires an appropriate level of physical and technical-tactical preparation that football players must possess. As a conclusion, it can be reported that the differences between football players in lower leagues are much smaller.

Keywords: agility, football, competition rank, footballers

INTRODUCTION

With each new football season, great progress can be noticed in the physical performance of players because a large part of the training of professional football teams is dedicated to physical preparation and the importance of its improvement (Dellal et al., 2015; Folgado et al., 2015; Lockie et al., 2018). Trends in world sports, as well as in football, emphasise the need for better physical preparation because fitness training is essential for top preparation and performance (Wong et al., 2010). Each player has specific requirements based on which the appropriate method, work contents and load intensity are programmed. Physical preparation correlates with the playing position (Bloomfield, Polman, & O'Donoghue, 2007; Di Salvo et al., 2007; Martín-García et al., 2018; Gai et al., 2019), body constitution (Sutton et al. al., 2009), and the level of technical knowledge (Dellal et al., 2010), but also the rank of the competition (Gissis et al., 2006; Turgut, Nurtekin, & Halil, 2009).
Midfielders cover the greatest distance, and professional players run more than amateur players (Mohr, Krustrup, Bangsbo, 2003; Stølen et al., 2005). High-intensity running involves sprints that are repeated for approximately 90 seconds for 2-4 seconds (Stølen et al., 2005), with the distance covered in the second halftime being significantly reduced by about 5% compared to the first halftime (Rienzi et al., 2000). But speed alone is not the only important fitness component. Speed in football can be defined as speed of movement, speed of reaction and speed of acceleration during the first step (explosiveness) (Chapman, Derse, & Hansen, 2008). However, another important component relates to agility.

Agility in football is the ability to quickly change direction in unpredictable and changing game situations, but it is not only efficiency in movements, but also the ability to limit the time between deciding on a new movement and executing that movement (Schmid & Alejo 2004). This motor ability is a very complex ability that correlates with other factors: coordination, strength, speed, endurance, and balance (Sekulić et al., 2013; Köklü et al., 2015). Bompa (2006) treats agility as a combined ability of fundamental abilities of speed and coordination. Football is considered to be a sport of agility (Weineck, 1999), so agility for football is one of the most important motor abilities from the aspect of its contribution to achieving top sporting achievements (Graham, 2000; Bompa, 2006; Pojskić et al., 2018), especially the cognitive element of agility (Young, Dawson, & Henry, 2015).

In recent years, agility has very often been viewed in the professional literature as part of the SAQ block (speed, agility, quickness), which also involves speed and explosiveness (Graham, 2000; Pearson, 2001; Brown & Ferrigno, 2005; Köklü et al., 2015). This method of joint training of the mentioned three abilities has become very popular and widely used (Jovanović et al., 2011; Milanović et al., 2013; Karthick, Radhakrishnan, & Kumar, 2016; Trecroci et al., 2016; Kumar, 2018). The connection between these three abilities is supported by the fact that most tests that assess agility are related to the speed of performing and explosiveness of movement (Pauole et al., 2000; Sporiš et al., 2010a; Sporiš et al., 2011). However, there are also scientific views that claim that despite the significant correlation between these three abilities, there are certain characteristics sufficiently authentic and indigenous for each of the above, so it is considered that specific testing and training procedures should be used for each of them (Little & Williams, 2005), which can help coaches when planning training sessions.

METHOD

PARTICIPANTS

In this paper, the difference in the level of agility between the three football teams that are in different ranks of the competition was being determined. The testing involved 60 players from three football teams of different rankings: 20 players from the team competing in the Super League, which represents the first rank of the competition, then 20 players from the team competing in the First Division, which represents the second rank of the competition, and 20 players from the team competing in the Second Regional Division representing the third rank of the competition. At the time of testing, the Super League football team occupied the middle of the table comprising 20 clubs. The team from the First Division was in the lower part of the table comprising 18 clubs, while the team from the Second Regional Division took the leading position on the table also comprising 18 clubs. Before the testing was performed, the written consent of the players of all three teams was obtained, as well as the official permission of the club management. The research was organised in accordance with the recommendations for clinical research given by the World Health Organisation (WHO) within the Helsinki Declaration (2013).

DESIGN AND TESTING PROCEDURE

In order to ensure the accuracy of the experimental testing, two trials were organised on two different days in order for the players to get acquainted with the way the testing was conducted. Two days after the last trial testing, an experimental testing was performed. Each of the tests was repeated three times, so the best value was taken for further analysis. To assess the level of agility of football players from three football teams of different competition ranks, six tests were used (Topend Sports) for which previous research has determined to be reliable and valid for agility assessment: Hexagon agility test (Beekhuizen et al., 2009), Zig-zag test (Kutlu & Doğan, 2018), Illinois agility run test (Hachana et al., 2014; Kutlu, Yapici, & Yilmaz, 2017), Agility "T" test (Pauole et al., 2000; Fessi et al., 2016), Balsom agility test (Wrigley, 2016), and Arrowhead agility test (Lockie & Jalilvand, 2017; Rago et al., 2020). Both trial and experimental testing was conducted on grassy terrain with natural grass in full sports equipment. After completing each test and before moving on to the next, there was a rest period of 10 minutes to avoid the negative effects on testing caused by fatigue.

STATISTICAL ANALYSES

A statistical package IBM SPSS Statistics v. 21. was used for data processing. From the statistical descriptive parameters, the arithmetic mean from the measures of central tendencies and the standard deviation from the measures of dispersion were used in the analysis. From the domain of comparative statistics, in order to obtain possible differences between the players of the three clubs, an analysis of variance for independent samples (one-way ANOVA) and post hoc analysis (Scheffe) were used to determine the specific difference between groups. The significance level is $p < 0.05$.

RESULTS

Table 1: Basic statistics of the examined groups and significance of differences (ANOVA)

	Descriptives			ANOVA	
Agility tests	*Super league*	*1. division*	*2. division*	F	Sig.
Hexagon agility test	10.97 (±0.22)	11.07 (±0.12)	11.15 (±0.13)	6.52	.003*
Zig-zag test	6.13 (±0.14)	6.34 (±0.23)	6.5 (±0.1)	26.25	.000*
Illinois agility run test	15.04 (±0.18)	15.24 (±0.11)	15.34 (±0.09)	25.19	.000*
"T" test	9.13 (±0.17)	9.33 (±0.07)	9.41 (±0.09)	29.12	.000*
Balsom agility test	11.93 (±0.11)	12.18 (±0.16)	12.26 (±0.09)	41.84	.000*
Arrowhead agility test	15.01 (±0.18)	15.25 (±0.16)	15.33 (±0.07)	26.36	.000*

Group data represent the Mean (± Std. Deviation); *Significance level is $p < 0.05$

In addition to the descriptive statistics of all three football teams, Table 1 presents an analysis of variance for independent samples (one-way ANOVA) which calculated the differences in agility tests. In all six tests, there is a significant difference between football teams of different competition ranks. In order to precisely determine the existence of a significant difference between the football teams, an additional Post hoc analysis has been conducted using the Scheffe procedure.

Table 2: Post hoc results (Scheffe)

Hexagon agility test		Sig.	Zig-zag test		Sig.
Super league	*1. division*	.163	*Super league*	*1. division*	.001*
	2. division	.003*		*2. division*	.000*
1. division	*Super league*	.163	*1. division*	*Super league*	.001*
	2. division	.255		*2. division*	.013*
2. division	*Super league*	.003*	*2. division*	*Super league*	.000*
	1. division	.255		*1. division*	.013*
Illinois agility run test		Sig.	"T" test		Sig.
Super league	*1. division*	000*	*Super league*	*1. division*	000*
	2. division	000*		*2. division*	000*
1. division	*Super league*	000*	*1. division*	*Super league*	000*
	2. division	.081		*2. division*	.104
2. division	*Super league*	000*	*2. division*	*Super league*	000*
	1. division	.081		*1. division*	.104
Balsom agility test		Sig.	Arrowhead agility test		Sig.
Super league	*1. division*	000*	*Super league*	*1. division*	000*
	2. division	000*		*2. division*	000*
1. division	*Super league*	000*	*1. division*	*Super league*	000*
	2. division	.089		*2. division*	.196
2. division	*Super league*	000*	*2. division*	*Super league*	000*
	1. division	.089		*1. division*	.196

Table 2 shows the results of Post hoc analyses (Scheffe) for agility tests that show possible differences between each individual group. The players of the team from the Super League are significantly different (they are better) from the players of the team from the Second Division in all agility tests. If the Super League players are compared to the players from the First Division, the difference does not exist only in the Hexagon agility test ($p = .163$), while in other tests they are significantly better than their lower league counterparts. If the football players from the First and Second Division teams are compared, the significance of the differences is recorded only in the Zig-zag test ($p = .013$) in favour of the First Division team.

DISCUSSION AND CONCLUSION

The results of this research showed that there is a difference in the level of agility between the players of the elite football team (Super League) and the football players from the teams of lower ranks of the competition. It should be noted that the players from the Super League football team have a long sports experience in the elite rank of the competition, so it was expected that, given the necessary physical and technical-tactical performance for that level of football, they will be better in all agility indicators than lower league teams. These results confirm the already existing research on this topic (Kaplan, Erkmen, & Taskin, 2009; Slimani & Nikolaidis, 2017;

Peña-González et al., 2021), which also indicate a higher level of physical performance, which includes agility, with elite football players in relation to those from lower, amateur or semi-amateur ranks of the competition.

On the other hand, the two lower league teams did not differ too much in the agility tests regardless of the fact that they are in different ranks of the competition (second and third rank, respectively). The only statistically significant difference appeared in the Zig-zag test ($p = .013$) in favour of the team from the First Division. The explanation can be found in the fact that the general quality between the lower leagues is quite uniform, as well as in the fact that the sports form of the team from the First Division was in decline at the time of testing because the team was in the lower part of the rank list. Unlike this team, the team from the Second Regional Division was at the top of its group's table in the regional competition, thus expressing a high level of sports form and general physical and technical-tactical readiness. We should also not neglect the psychological state of the football players of both lower league teams in the moments of different competitive success in which they were at the time the testing was conducted.

The results in physical performance in lower football leagues are generally at the same or similar level (Sæterbakken et al., 2019), while elite footballers are at a higher level than those of lower rank, especially when it comes to fast and explosive movements (agility factors) which require maximum oxygen consumption (VO2 max), which indicates a strong connection between aerobic capacity and anaerobic strength with the performance in elite-level football (Ostojić, 2004). A high level of agility in athletes (football players) is often the decisive factor for achieving result efficiency, i.e. it is justifiably classified as a key element for success (Pearson, 2001; Rampinini et al., 2007; Adil, Tangkudung, & Hanif, 2018). The development of the dynamics of the football game places new demands on the development of the specific condition of football players; therefore, agility has an increasingly important function in modern football (Milanović et al., 2013; Sermaxhaj et al., 2018; Krolo et al., 2020). More attention should be paid to that ability in fitness preparation by creating situational conditions of the modern football game. Training is mainly based on learning the technique of changing the direction of movement that is needed in attack situations, when you need to feint the opponent out of the game, or in defence, when you need to follow the opposing player (Karthick, Radhakrishnan, & Kumar, 2016). Regarding agility training, Young & Farrow (2006) believe that it is necessary to identify specific movement patterns used by successful football players in the game and conduct agility training under time-limited situations from the game.

Agility training provides a quality basis for technical-tactical training, training in specific endurance and for the football game itself (Sermaxhaj, 2017). Since the basic goal of a football game is to outplay the opponent and score a goal, the exercises used in training must elicit a quick reaction, good observation and tactical outplay from the player (Nimmerichter et al., 2016). Also, for more efficient performance of various actions related to the football game, which requires a high level of agility, dynamic stability is needed, the level of which increases with the rank of the competition (Paillard et al., 2006; Jadczak et al., 2019; Pau et al., 2019).

Agility is an ability that is highly correlated with other factors that affect success in football, primarily physical performance (Sporiš et al., 2010b; Milanović et al., 2013), and also the level of technical performance (Forsman et al., 2015). When talking about physical performance, it has earlier been said that agility is most associated with speed and explosiveness (Pandey & Chaubey, 2015; Matlák, Tihanyi & Rácz, 2016), which can be explained by the existence of the same energy systems necessary to meet the requirements of already mentioned skills, specifically the phosphagen system (ATP-PC) used in movements for up to 10 seconds (Köklü et al., 2015). The results of this research, as well as the previous analysis of the literature on this topic, clearly indicate the importance of motor skills for success in football, and thus the place of the team in the competition level, as well as the position on the table. Football teams that count on good placement and progress in the result must pay attention to the development of agility, individually or as part of SAQ training.

REFERENCES

1. Adil, A., Tangkudung, J., & Hanif, A. S. (2018). The influence of speed, agility, coordination of foot, balance and motivation on skill of playing football. Journal of Indonesian Physical Education and Sport, 4(1), 19–34. https://doi.org/10.21009/JIPES.041.02

2. Beekhuizen, K. S., Davis, M. D., Kolber, M. J., & Cheng, M. S. (2009). Test-retest reliability and minimal detectable change of the hexagon agility test. Journal of Strength and Conditioning Research, 23(7), 2167–2171. 10.1519/JSC.0b013e3181b439f0

3. Bloomfield, J., Polman, R., & O'Donoghue, P. (2007). Physical demands of different positions in FA Premier League soccer. Journal

of Sports Science and Medicine, 6(1), 63–70. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3778701/

4. Bompa, T. (2006). Periodization: Theory and methodology of training. Champaign, IL: Human Kinetics.

5. Brown, L., & Ferrigno, V. (eds) (2005). Training for speed agility and quickness - 2nd edition. Champaign, IL: Human Kinetics.

6. Chapman, S., Derse, E., & Hansen, J. (2008). Soccer Coaching Manual. Los Angeles: LA84 Foundation.

7. Dellal, A., Lago-Peñas, C., Rey, E., Chamari, K., & Orhant, E. (2015). The effects of a congested fixture period on physical performance, technical activity and injury rate during matches in a professional soccer team. British Journal of Sports Medicine, 49(6), 390–394. 10.1136/bjsports-2012-091290

8. Dellal, A., Wong, D. P., Moalla, M., & Chamari, K. (2010). Physical and technical activity of soccer players in the French First League – with special reference to their playing position. International SportsMed Journal, 11(2), 278–290. https://hdl.handle.net/10520/EJC48393

9. Di Mascio, M., & Bradley, P. S. (2013). Evaluation of the most intense period of high-intensity running in English FA Premier League soccer matches. Journal of Strength and Conditioning Research, 27(4), 909–915. 10.1519/JSC.0b013e31825ff099

10. Di Salvo, V., Baron, R., Tschan, H., Calderon Montero, F. J., Bachl, N., & Pigozzi, F. (2007). Performance Characteristics According to Playing Position in Elite Soccer. International Journal of Sport Medicine, 28(3), 222–227. 10.1055/s-2006-924294

11. Di Salvo, V., Gregson, W., Atkinson, G., Tordoff, P., & Drust, B. (2009). Analysis of high intensity activity in Premier League soccer. International Journal of Sports Medicine, 30(3), 205–212. 10.1055/s-0028-1105950

12. Fessi, M. S., Makni, E., Jamni, M., Elloumi, M., Chamari, K., Nabli, M. A., Padulo, J., & Moalla, W. E. (2016). Reliability and criterion-related validity of a new repeated agility test. Biology of Sport, 33(2), 159–164. 10.5604/20831862.1198635

13. Folgado, H., Duarte, R., Marques, P., & Sampaio, J. (2015). The effects of congested fixtures period on tactical and physical performance in elite football. Journal of Sports Sciences, 33(12), 1238–1247. doi.org/10.1080/02640414.2015.1022576

14. Forsman, H., Gråstén, A., Blomqvist, M., Davids, K., Liukkonen, J., & Konttinen, N. (2015). Development of perceived competence, tactical skills, motivation, technical skills, and speed and agility in young soccer players. Journal of Sport Sciences: Science and Medicine in Football, 34(14), 1311–1318. https://doi.org/10.1080/02640414.2015.1127401

15. Gai, Y., Leicht, A. S., Lago, C., & Gómez, M-A. (2019). Physical and technical differences between domestic and foreign soccer players according to playing positions in the China Super League. Research in Sports Medicine, 27(3), 314–325. https://doi.org/10.1080/15438627.2018.1540005

16. Gissis, I., Papadopoulos, C., Kalapotharakos, V. I., Sotiropoulos, A., Komsis, G., & Manolopoulos, E. (2006). Strength and Speed Characteristics of Elite, Subelite, and Recreational Young Soccer Players. Research in Sports Medicine, 14(3), 205–214. https://doi.org/10.1080/15438620600854769

17. Graham, J. F. (2000). Agility training. In L. E. Brown, V. A. Ferrigno, & J. C. Santana (Eds.), Training for speed, agility, and quickness (pp. 79–144). Champaign, IL: Human Kinetics.

18. Hachana, Y., Chaabène, H., Ben Rajeb, G., Khlifa, R., Aouadi, R., Chamari, K., & Gabbett, T. J. (2014). Validity and Reliability of New Agility Test among Elite and Subelite under 14-Soccer Players. PLOS One, 9(4), e95773. 10.1371/journal.pone.0095773

19. Jadczak, L., Grygorowicz, M., Dzudziński, W., & Śliwowski, R. (2019). Comparison of Static and Dynamic Balance at Different Levels of Sport Competition in Professional and Junior Elite Soccer Players. Journal of Strength and Conditioning Research, 33(12), 3384–3391.10.1519/JSC.0000000000002476

20. Jovanović, M., Sporiš, G., Omrčen, D., & Fiorentini, F. (2011). Effects of Speed, Agility, Quickness Training Method onPower Performance in Elite Soccer Players. Journal of Strength and Conditioning Research, 25(5), 1285–1292. 10.1519/JSC.0b013e3181d67c65

21. Kaplan, T., Erkmen, N., & Taskin, H. (2009). The Evaluation of the Running Speed and Agility Performance in Professional and Amateur Soccer Players. Journal of Strength and Conditioning Research, 23(3), 774–778. 10.1519/JSC.0b013e3181a079ae

22. Karthick, M. Radhakrishnan, T., & Kumar, S. K. (2016). Effects of saq training on selected physical fitness parameters and kicking ability of high school level football players. International Journal of Applied Research, 2(7), 600–602. https://www.allresearchjournal.com/archives/?year=2016&vol=2&issue=7&part=I&ArticleId=2332

23. Köklü, Y., Alemdaroğlu, U., Özkan, A., Koz, M., & Ersöz, G. (2015). The relationship between sprint ability, agility and vertical jump performance in young soccer players. Science & Sports, 30(1), e1-e5. doi.org/10.1016/j.scispo.2013.04.006

24. Krolo, A., Gilić, B., Foretić, N.., Pojskić, H., Hammami, R., Spasić, M., Uljević, O., Versić, Š., & Sekulić, D. (2020). Agility Testing in Youth Football (Soccer) Players; Evaluating Reliability, Validity, and Correlates of Newly Developed Testing Protocols. International Journal of Environmental Research and Public Health, 17(1), 294. https://doi.org/10.3390/ijerph17010294

25. Kumar, P. (2018). Impact of S.A.Q. training protocol on selected physical fitness variables of male soccer players. International

Journal of Physiology, Nutrition and Physical Education, 3(1), 1280–1281. https://www.journalofsports.com/pdf/2018/vol3issue1/PartW/3-1-279-970.pdf

26. Kutlu, M., & Doğan, Ö. (2018). Test-Retest Reliability and Validity of Three Different Agility Tests for Various Team Sports in Young Male Athletes. Central European Journal of Sport Sciences and Medicine, 22(2), 33–38. 10.18276/cej.2018.2-04

27. Kutlu, M., Yapici, H., & Yilmaz, A. (2017). Reliability and Validity of a New Test of Agility and Skill for Female Amateur Soccer Players. Journal of Human Kinetics, 56(1), 219–227. 10.1515/hukin-2017-0039

28. Little, T., & Williams, A. G. (2005). Specificity of acceleration, maximum speed, and agility in professional soccer players. The Journal of Strength and Conditioning Research, 19(1), 76–78. https://e-space.mmu.ac.uk/3518/1/williams%20-%20specificity%20of%20acceleration.pdf

29. Lockie, R. G., & Jalilvand, F. (2017). Reliability and criterion validity of the arrowhead change-of-direction speed test for soccer. Facta Universitatis Series: Physical Education and Sport, 15(1), 139–151. 10.22190/FUPES1701139L

30. Lockie, R. G., Moreno, M. R., Lazar, A., Orjalo, A. J., Giuliano, D. V., Risso, F. G., Davis, D. S. L., Crelling, J. B., Lockwood, J. R., & Jalilvand, F. (2018). The physical and athletic performance characteristics of division I collegiate female soccer players by position. Journal of Strength and Conditioning Research, 32(2), 334–343. 10.1519/JSC.0000000000001561

31. Martín-García, A., Gómez Díaz, A., Bradley, P. S., Morera, F., & Casamichana, D. (2018). Quantification of a professional football team's external load using a microcycle structure. Journal of Strength and Conditioning Research, 32(12), 3511–3518. 10.1519/JSC.0000000000002816

32. Matlák, J., Tihanyi, J., & Rácz, L. (2016). Relationship between reactive agility and change of direction speed in amateur soccer players. Journal of Strength and Conditioning Research, 30(6), 1547–1552. 10.1519/JSC.0000000000001262

33. Milanović, Z., Sporiš, G., Trajković, N., James, N., & Šamija, K. (2013). Effects of a 12 Week SAQ Training Programme on Agility with and without the Ball among Young Soccer Players. Journal of Sports Science and Medicine, 12(1), 97–103. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3761749/

34. Mohr, M., Krustrup, P., Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. Journal of Sports Sciences, 21(7), 519–528. https://doi.org/10.1080/0264041031000071182

35. Nimmerichter, A., Weber, N. J. R., Wirth, K., & Haller, A. (2016). Effects of Video-Based Visual Training on Decision-Making and Reactive Agility in Adolescent Football Players. Sports, 4(1), 1. https://doi.org/10.3390/sports4010001

36. Ostojić, S. (2004). Elite and Nonelite Soccer Players: Preseasonal Physical and Physiological Characteristics. Research in Sports Medicine, 12(2), 143–150. https://doi.org/10.1080/15438620490460495

37. Paillard, T., Noé, F., Rivière, T., Marion, V., Montoya, R., & Dupui, P. (2006). Postural Performance and Strategy in the Unipedal Stance of Soccer Players at Different Levels of Competition. Journal of Athletic Training, 41(2), 172–176. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1472651/

38. Pandey, A. K., & Chaubey, D. K. (2015). Relationship between explosive strength and agility of Football male players. International Journal of Applied Research, 1(10), 303–305. https://www.researchgate.net/profile/Pandey-2/publication/301889357_Relationship_between_explosive_strength_and_agility_of_Football_male_players/links/572b27d608aef7c7e2c6aa7d/Relationship-between-explosive-strength-and-agility-of-Football-male-players.pdf

39. Pau, M., Porta, M., Arippa, F., Pilloni, G., Sorrentino, M., Carta, M., Mura, M., & Leban, B. (2019). Dynamic postural stability, is associated with competitive level, in youth league soccer players. Physical Therapy in Sport, 35, 36–41. https://doi.org/10.1016/j.ptsp.2018.11.002

40. Pauole, K., Madole, K., Garhammer, J., Lacourse, M., & Rozenek, R. (2000). Reliability and Validity of the T-Test as a Measure of Agility, Leg Power, and Leg Speed in College-Aged Men and Women. Journal of Strength and Conditioning Research, 14(4), 443–450. http://www.cepcometti.com/wp-content/uploads/2018/02/testT.pdf

41. Pearson, A. (2001). Speed Agility and Quickeness for Soccer. London: A&Block.

42. Peña-González, I., Javaloyes, A., Sarabia, J. M., & Moya-Ramón, M. (2021). Relative age-related differences between different competitive levels and field positions in young soccer players. Research in Sports Medicine, 29(3), 254–264. https://doi.org/10.1080/15438627.2020.1853540

43. Pojskić, H., Aslin, E., Krolo, A., Jukić, I., Uljević, O., Spasić, M., & Sekulić, D. (2018). Importance of Reactive Agility and Change of Direction Speed in Differentiating Performance Levels in Junior Soccer Players: Reliability and Validity of Newly Developed Soccer-Specific Tests. Frontiers in Physiology, 9, 506. https://doi.org/10.3389/fphys.2018.00506

44. Rago, V., Brito, J., Figueiredo, P., Ermidis, G., Barreira, D., & Rebelo, A. (2020). The Arrowhead Agility Test: Reliability, Minimum Detectable Change, and Practical Applications in Soccer Players. Journal of Strength and Conditioning Research, 34(2). 483–494. 10.1519/JSC.0000000000002987

45. Rampinini, E., Coutts, A. J., Castagna, C., Sassi, R., & Impellizzeri, F. M. (2007). Variation in top level soccer match performance.

International Journal of Sports Medicine, 28(12), 1018–1024. 10.1055/s-2007-965158

46. Rienzi, E., Drust, B., Reilly, T., Carter, J. E. L., & Martin, A. (2000). Investigation of anthropometric and work-rate profiles of elite South American international soccer players. Journal of Sports Medicine and Physical Fitness, 40(2), 162–169. https://www.proquest.com/openview/2551d101c1d291c6338b136ed9945285/1?pq-origsite=gscholar&cbl=4718

47. Sæterbakken, A., Haug, V., Fransson, D., Grendstad, H. N., Gundersen, H. S., Moe, V. F., Ylvisaker, E., Shaw, M., Riiser, A., & Andersen, V. (2019). Match Running Performance on Three Different Competitive Standards in Norwegian Soccer. Sports Medicine International Open, 3(3), E82–E88. 10.1055/a-0943-3682

48. Schmid, S., & Alejo, B. (2002). Complete Conditioning for Soccer. Champaign, IL: Human Kinetics.

49. Sekulić, D., Spasić, M., Mirkov, D., Cavar, M., & Sattler, T. (2013). Gender-specific influences of balance, speed, and power on agility performance. Journal of Strength and Conditioning Research, 27(3), 802–811. 10.1519/JSC.0b013e31825c2cb0

50. Sermaxhaj, S. (2017). The impact of regular training programme on the speed and agility performance of the young football players. Sport Science, 10(1), 117–121. 10.26773/smj.180608

51. Sermaxhaj, S., Arifi, F., Iber, A., Bahtiri, A., Havolli, J., & Sermaxhaj, S. (2018). The Effect of Static Stretching in Agility and Isokinetic Force at Football Players. Sport Mont, 16(2), 45–49. 10.26773/smj.180608

52. Slimani, M., & Nikolaidis, P. T. (2017). Anthropometric and Physiological Characteristics of Male Soccer Players According to their Competitive Level, Playing Position and Age Group: A Systematic Review. The Journal of Sports Medicine and Physical Fitness, 10.23736/S0022-4707.17.07950-6

53. Sporiš, G., Jukić, I., Milanović, L., & Vučetić, V. (2010a). Reliability and Factorial Validity of Agility Tests for Soccer Players. Journal of Strength and Conditioning Research, 24(3), 679-686. 10.1519/JSC.0b013e3181c4d324

54. Sporiš, G., Milanović, L., Jukić, I., Omrčen, D., & Molinuevo, J. S. (2010b). The effect of agility training on athletic power performance. Kinesiology, 42(1), 65–72. https://hrcak.srce.hr/file/82642?lang=en

55. Sporiš, G., Milanović, Z., Trajković, N., & Joksimović, A. (2011). Correlation between speed, agility and quickness (SAQ) in elite young soccer players. Acta Kinesiologica, 5(2), 36–41. http://www.actakin.com/PDFS/BR0502/SVEE/04%20CL%2006%20GS.pdf

56. Stølen, T., Chamari, K., Castagna, C., & Wisløff, U. (2005) Physiology of soccer: an update. Sports Medicine, 35(6), 501–536. https://link.springer.com/article/10.2165/00007256-200535060-00004

57. Sutton, L., Scott, M., Wallace, J., & Riley, T. (2009). Body composition of English Premier League soccer players: Influence of playing position, international status, and ethnicity. Journal of Sports Sciences, 27(10), 1019–1026. doi.org/10.1080/02640410903030305

58. Topend Sports. The complete FITNESS TEST list. https://www.topendsports.com/testing/tests/index.htm

59. Trecroci, A., Milanović, Z., Rossi, A., Broggi, M., Formenti, D., & Alberti, G. (2016). Agility profile in sub-elite under-11 soccer players: is SAQ training adequate to improve sprint, change of direction speed and reactive agility performance? Research in Sports Medicine, 24(4), 331–340. doi.org/10.1080/15438627.2016.1228063

60. Verstegen, M., & Marchelo, B. (2010). Agility and Coordination. In B. Forran (ed), Top Fitness Training (pp. 141–168). Belgrade: Datastatus.

61. Weineck, J. (1999). Optimales fussballtraining. Nürnberg: Spitta-Veri.

62. Wong, P., Chaouachi, A., Chamari, K., Dellal, A., & Wisloff, U. (2010). Effect of Preseason Concurrent Muscular Strength and High-Intensity Interval Training in Professional Soccer Players. Journal of Strength and Conditioning Research, 24(3), 653–660. 10.1519/JSC.0b013e3181aa36a2

63. World Medical Association Declaration of Helsinki (2013). Ethical Principles for Medical Research Involving Human Subjects, 64th WMA General Assembly, Fortaleza, Brazil, October 2013. Retrieved November 25, 2020 from the World Wide Web: http://www.wma.net/en/30publications/10policies/b3/index.html

64. Wrigley, J. M. (2016). A study to validate the use of; The Modified Balsom Run as an accurate measurement of repeated sprint ability in U18 elite soccer players. Bsc dissertation. Leeds: Leeds Beckett University, Carnegie Faculty.

65. Young, W., & Farrow, D. (2006). A review of agility: practical applications for strength and conditioning. Strength and Conditioning Journal, 28(5), 24–29. https://www.proquest.com/openview/3791519d35b1765524168d2745fa843c/1?pq-origsite=gscholar&cbl=44253

66. Young, W. B., Dawson, B., & Henry, G. J. (2015). Agility and Change-of-Direction Speed are Independent Skills: Implications for Training for Agility in Invasion Sports. International Journal of Sports & Coaching, 10(1), 159–169. doi.org/10.1260/1747-9541.10.1.159

MOTORIČKA AGILNOST FUDBALERA RAZLIČITOG NIVOA TAKMIČENJA

Istraživanje je izvršeno sa ciljem da se utvrdi nivo motoričke agilnosti fudbalera tri fudbalske ekipe koje se nalaze u različitim rangovima takmičenja (Superliga, Prva divizija i Druga regionalna divizija). U testiranju je učestvovalo 60 fudbalera (po 20 iz svake ekipe). Za procjenu motoričke agilnosti korišteni su Hexagon agility test, Zig-zag test, Ilinois agility run test, „T" test, Balsom agility test i Arrowhead agility test. Osim deskriptivnih parametara u analizi je korištena analiza varijanse za nezavisne uzorke (one-way ANOVA) i Post hoc analiza (Scheffe). Nakon obrađenih podataka dobijeni rezultati pokazali su statistički značajnu razliku između fudbalera tri ekipe u svim testovima. Daljom analizom, rezultati su pokazali da se fudbaleri ekipe iz Super lige statistički značajno razlikuju (bolji su) u svim testovima od fudbalera koji nastupaju u Drugoj diviziji. U odnosu na ekipu iz Prve divizije, superligaški fudbaleri statistički značajno se ne razlikuju samo u Hexagon agility testu (p = ,163), dok su u ostalim testovima statistički značajno bolji. Ako se posmatra odnos između fudbalera iz ekipe Prve i Druge divizije, statistička značajnost razlika bilježi se samo kod Zig-zag testa (p = ,013) u korist ekipe iz Prve divizije. Može se zaključiti da na rezultate motoričke agilnosti značajno utiče rang takmičenja (prvenstveno kod najvišeg u odnosu na niže) koji zahtjeva i odgovarajući nivo fizičke i tehničko-taktičke pripremljenosti koju fudbaleri moraju da posjeduju. Kao zaključak se može izvesti i to da su razlike između fudbalera u nižim ligama mnogo manje.

Ključne riječi: agilnost, fudbal, rang takmičenja, fudbaleri

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BARRIERS TO PHYSICAL ACTIVITY IN THE ELDERLY

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ABSTRACT

Based on previous research, the aim of this systematic review research was to determine which barriers to physical activity occur in the elderly. For collecting literature, the following data bases were searched: Google Scholar, PubMed, Web of Science and Research Gate, using all available papers in the period from 2002 to 2017. A descriptive method was used to analyse the obtained data, and all the titles and abstracts were reviewed for potential papers that were included in this systematic review research. A total of 20 studies met the pre-defined criteria and were included in the quantitative analysis. The results were obtained after analysing the questionnaires that the responders filled in to evaluate the barriers. This systematic review research shows that there are still a large number of barriers that occur in the elderly. The health condition, lack of time and fear of injury are not the only barriers, but there are also a large number of barriers that prevent the practice of PA. Some of these barriers can be affected and the attitude towards them can be changed, improving the conditions in which elderly people can practice PA, such as transport, the environment, the lack of training facilities, and the lack of professional assistance.

Keywords: physical activity, barriers, seniors, elderly people

INTRODUCTION

As an inevitable progressive process, the general decline in physiological functions and all motor abilities is one of the main characteristics of aging (Lopez, Mathers, Ezzati, Jamison, & Murray, 2006). Physical activity (PA) is important for healthy aging, and as a complex and dynamic process, it contributes to reducing all-cause mortality and preventing many chronic conditions, including coronary heart disease, colon and breast cancer, as well as type II diabetes (Cress et al., 2004; Friedenreich, 2001; Physical Activity Guidelines Advisory Committee, 2008). Physical activity is thought to improve body fat distribution, physical functioning, and mental health (Friedenreich, 2001). Physical activity has the potential to preserve and improve physical and mental health as well as the quality of life even in older adults who have previously led a sedentary lifestyle and have chronic diseases (Chodzko-Zajko et al., 2011; Nelson et al., 2007; Physical Activity Guidelines Advisory Committee, 2008). The focus of previous research has been on healthy young and middle-aged people (King, 1997), but researchers have recently highlighted recommendations for PA in populations such as the elderly. Recently published recommendations for physical activity suggest that the elderly should engage in moderate PA for at least 30 minutes five times a week or 20 minutes with more intense PA for 3 days; 8-10 strength exercises for 2 days; and flexibility exercises for at least 10 min (Nelson et al., 2007). However, practicing PA in most elderly people is not in line with the current guidelines (Australian Institute of Health, 2012; Roth, Millett, and Mindell, 2012; Haley & Andel, 2010). A national survey of adults in Germany (Bratan, 2013) found that 72.8% of elderly women and 65.3% of elderly men (over 65 years of age) did not reach the recommendation for PA of at least 2.5 hours per week of moderate-intensity. One of the solutions for engaging in PA and maintaining it is to develop an awareness of the positive factors that are good for an individual's health. Engaging in PA results in an improvement of

the health status, leading to a reduction in the need for health services in the elderly (Brawley, Rejesk, & King, 2003). As an outdoor physical activity, walking is one of the activities that are most accessible to the elderly and most applicable (Lim & Taylor, 2005), and at the same time, it is very useful for health and functioning (Simonsick et al., 2005). However, as there are barriers in all people, they occur daily in the elderly, which is the reason for the reduction of PA in them. Obstacles can be related to a person's health condition, such as illness and mobility difficulties, or the environment, inaccessibility to facilities, lack of footpaths, and lack of transport to certain places (Hovbrandt et al., 2007). Poor health is presented as the most commonly reported barrier (Newson & Kemps, 2007; Rasinaho et al., 2007; Schutzer & Graves, 2004; Cohen-Mansfield et al., 2003). The lack of facilities, lack of interest, lack of time, and various external barriers are also presented as obstacles (Dawson et al., 2007, Kowal & Fortier, 2007) where the lack of time refers to the time required to perform activities and the time required for transport (Booth et al. 1997, 2002; Chogahara et al. 1998; King et al. 2000; O'Brien Cousins 2003; Wilcox et al. 2000). Age, gender and socioeconomic differences, as well as obesity, depression, mobility limitations, and chronic health conditions affect the nature of barriers to physical activity experienced by elderly people (Patel et al., 2012; Sallinen et al., 2009; Rosqvist et al., 2009; Rasinaho et al., 2007). In a study conducted by Chao et al. (2000), the results showed that elderly people need time to adopt the habit of practicing moderate PA. One of the few studies in this area that deals with barriers to PA - measured as global ones - predicts a decline in physical activity in women and men (Steptoe, Rink, & Kerry, 2000). These results show that barriers have an impact on the smooth functioning of PA.
Based on previous research, the aim of this systematic review is to determine which barriers to physical activity occur in the elderly.

SUBJECT AND PROBLEM

RESEARCH SUBJECT

The research subject are the PA barriers that occur in the elderly.

RESEARCH PROBLEM

Based on the set subject of the research, and within the research problem, it was necessary to answer the question - what are the barriers for PA in the elderly?

RESEARCH METHOD

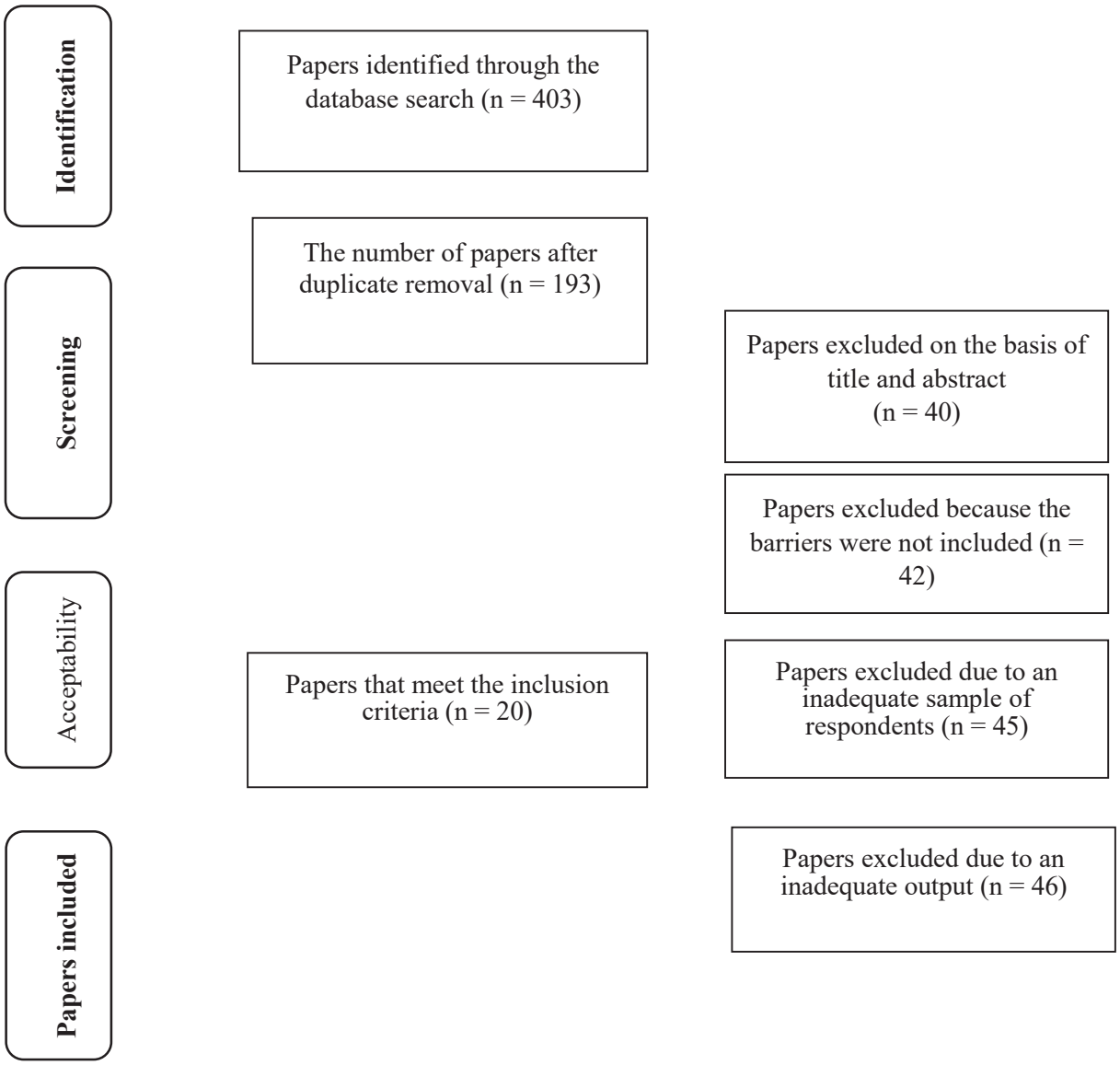
The following databases were searched for the collection of literature: Google Scholar, PubMed, Web of Science, and Research Gate, using all available papers from 2002 to 2017. The following keywords were used: physical activity, barriers, elderly people, and old people.

The search was exclusively concerned with transversal studies and original scientific papers from the available journals. In the first phase of the search, the relevance of the titles and abstracts of the identified papers was checked. In the second phase of the search, complete papers were downloaded and considered for inclusion.

References from all collected papers were reviewed to obtain more research that studied this area. Papers included in the systematic review survey had to have respondents over 60 years of age, and the study dealt with barrier testing for PA and excluded studies that were longitudinal in nature, written in languages other than Serbian and English, as well as studies in which respondents were younger than 60. A descriptive method was used to analyse the obtained data.

RESULTS

A total of 403 relevant studies were identified by searching the database. After removing the duplicates, 193 studies remained. Based on the title and abstract review, 40 studies were rejected (17 after title analysis and 23 after abstract analysis), 42 studies were excluded because they did not include barriers to PA, 45 studies were excluded due to an inadequate sample of respondents, 46 studies were excluded due to a lack of output data, while 20 studies that met the inclusion criteria were included in the systematic review.



The collected surveys used for this paper are shown in Table 1. In Table 1, each survey is presented using the following parameters: the survey (first author and year of publication), country, the sample of respondents (number of respondents N, groups, years, and PA involvement), methods, and results.

Table 1:

Authors and year	Country	The sample of respondents			Methods	Results
		Number and groups	Age	PA involvement		
Booth et al. (2002)	Australia	N = 402	≥ 60 years	Exercisers and non-exercisers	Questionnaire, 18 barriers	SA = 60% E, 42% NE LT = 19% E, 14% NE LC = 3% E, 6% NE NE = 7% E, 7% NE PA = 11% E, 18% NE FI = 23% E, 29% NE HC = 7% E, 17% NE LE = 2% E, 4% NE LM = 6% E, 5% NE

Cohen-Mansfield et al. (2003)	USA	N = 227	74-85 years	Sedentary lifestyle	Questionnaire, 7 barriers	WB = 89% HC = 53% LT = 25% LM = 29% LE = 12% WC = 11% LC, D, LI = 16%
Dergance et al. (2003)	USA	MA = 63 EA = 37	71-74 years	Sedentary lifestyle	SDHEQ	LI = 19% MA and 45% EA LC = 11.1% MA and 45.9% EA SA = 18.9% EA LC = 6.3% MA, 21.6% EA LK = 1.6% MA, 16.2% EA
Grossman and Stewart (2003)	USA	M = 15 F = 18	≥ 75 years	Sedentary lifestyle	Questionnaire, 15 questions	HC = 66% LT = 33% PA = 20% WC = 85%
Kalavar et al. (2005)	USA	M = 5 F = 5	66-79 years	Sedentary lifestyle	Questionnaire, 10 questions	WC, HC, FI, LT, LM, LI, LD, PA, BE, LS
Less et al. (2005)	USA	E = 37 NE = 29	≥ 65 years	Exercisers and non-exercisers	Questionnaire, 12 barriers	LM = 35% E, 16% NE HC = 18% E, 14% NE D = 24.5% E, 45% NE LD = 13.5%, 7% NE SA = 11%, 17% NE WB = 8%, 0% NE PA = 5%, 10% NE WC = 3%, 24% NE NeE = 3%, 31% NE FI = 0%, 48% NE
Kolt et al. (2006)	New Zealand	M = 12 F = 12	60-79 years	Sedentary lifestyle	Questionnaire, 10 questions	LM, LK, HC, C, E
Kowal and Fortier (2007)	North America	F = 21	≥ 60 years	Physically active	Questionnaire, 14 questions	LI = 5% D = 5% LT = 38% HC = 19%
Ayiesah (2007)	Asia	M = 24 F = 16	≥ 60 years	Exercisers and non-exercisers	CHAMPS	LD = 13% LK = 7% OO = 27% LT = 27% HC = 27%
Mathews et al. (2010)	USA	AA = 95 AI = 34 CA = 36 L = 10 VA = 26 W = 195	60-75 years		Questionnaire,	HC = AA, AI, W FI = AA, AI, W D = AI, L, W E = AA, AI, L, W NZ = AI, W F = AA WC = AA, W LT = AA, V SA = AI PA = W T = AI, W

Moschny et al. (2011)	Germany	N = 286	72-93 years	Insufficiently active	Questionnaire, 7 questions	LT = 16% T = 18% FI = 22% F = 23% LI = 36% LD = 43% HC = 58%
Abolfazl et al. (2011)	Iran	N = 16	65-86 years	Exercisers and non-exercisers	Interview	LT, LH, HC, LD
Manaf (2013)	Asia	E = 19 NE = 41	≥ 60 years	Exercisers and non-exercisers	BPEP, 45 questions	LE = 52% LM = 38% D = 33% LK = 37% LI = 23% LT = 48% LC = 28% HC = 20% C =13% T = 17% LH = 25% F = 5% OO = 23% SuA = 38% FI = 13%
Patel et al. (2013)	USA	N = 80	65-76 years	Physically active	BMPAQ, 13 questions	LM = 16% PA = 16% OO = 13%
Bethancourt et al. (2014)	USA	N = 52	70 years	Sedentary lifestyle	IPAQ	HC, LH, LK
Eroner et al. (2014)	Finland	MB = 399 AC = 220 PH = 135 I = 39 ML = 55	75-90 years	Sedentary lifestyle	BOPA, 17 questions	WB = 46% WC = 69 MB, 76% PH, 77% I, HC = 95.6% PH, 69% I, 89% ML FI = 55%. PH, 87% I, 44% ML PA = 64% I, 78% ML
Macniven et al. (2014)	Australia	N = 2225	≥ 65 years	Exercisers and non-exercisers	Questionnaire, 18 barriers	HC = 52% FI = 33% LH = 29% LT = 15% LM = 14% LI = 14% WB = 12% IF = 9% ZB = 6% LC = 4% WC = 3% F = 3% E = 4% T = 3%

Sjörs et al. (2014)	Sweden	E = 104 NE = 46	50-86 years	Exercisers and non-exercisers	EBBS	SuA = 48% E, 37% NE LM = 50% E, 24% NE LC = 35% E, 18% NE
Gothe and Kendall (2016)	USA	AA = 20	63 years	Exercisers and non-exercisers	Questionnaire, 2 questions	LT, HC, IF
Aily et al. (2017)	Brazil	F = 61	61 years	Exercisers	QBPAFI, 22 questions	LM, LE, LT, LI = 43% FI, PE, = 12% SA, IF, En = 9% F = 8%

Legend: MA - Mexican Americans, **EA** - European Americans, **SDHEQ** - The San Diego Health and Exercise Questionnaire, **HC** - Health Condition, **PE** - Prohibited Exercise, **SuA** - Sufficient Activity, **LM** - Lack of Motivation, **LE** - Lack of Energy, **LT** - Lack of time, **WB** - without barriers, **LI** - lack of interest, **F** - finance, **T**-transport, **LD** - lack of discipline, **SA** - self-awareness, **LC** - lack of company, **LK** - lack of knowledge, **AP** - aging process, **WC** - weather conditions, **FI** - fear of injury, **BE** - bad experience, **LS** - lifestyle, **E** - exercisers, **NE** - non-exercisers, **D** - discomfort, **NeE** - negative effect, **LH** - lack of help, **C** - culture, **IF** - inaccessibility of facilities, **En** - environment, **OO** - other obligations, **AA** - African American, **AI** - American Indian, **W** - non-Hispanic White, **L** - Latino, **VA** - Vietnamese American, **CA**- Chinese American, **BMPAQ**- Barriers and Motivators to Physical Activity Questionnaire, **BOPA** - The Barriers to Outdoor Physical Activity Questionnaire, **MB** - Minor barriers, **AC** - Ambient conditions, **PH** - Poor health, **I** - Insecurity, **ML** - Mobility limitations, **QBPAFI** - the Barriers Questionnaire to Physical Activity Practice in the Elderly, **BPEP** - The Barriers in Physical Activity and Exercise Participation, **EBBS** - The Exercise Benefits / Barriers Scale, **CHAMPS** Activities Questionnaires for Older Adults.

RESULTS WITH DISCUSSION

A systematic review of the papers determined which barriers to PA occur in the elderly. The results were obtained after analysing the questionnaires that the respondents filled in to assess the barriers. Some of the questionnaires used were: QBPAFI (Aily et al., 2017), EBBS (Sjörs et al., 2014), IPAQ (Bethancourt et al., 2014), BMPAQ (Patel et al., 2013), SDHEQ (Dergance et al., 2003), and BPEP (Manaf, 2013). Most studies have been done in the United States (Cohen-Mansfield et al., 2003; Dergance et al., 2003; Grossman and Stewart, 2003; Kalavar et al., 2005; Less et al., 2005; Mathews et al., 2010; Patel et al., 2013; Bethancourt et al., 2014; Gothe and Kendall, 2016), two studies in Australia (Macniven, 2014; Booth et al., 2002), two in Asia (Ayiesah, 2007; Manaf , 2013), one in Brazil (Aily et al., 2017), one in Sweden (Sjörs et al., 2014), one in Germany (Moschny et al., 2011), one in Iran (Abolfazl et al., 2011), one in Finland (Eroner et al., 2014), and one in New Zealand (Colt et al., 2006). The age of the respondents ranged from 50-90 years. The results obtained from the analysis of the data showed that there is a large number of barriers to PA that occur in the elderly. The most common barriers were lack of time, poor health, lack of motivation, lack of energy, and lack of company. The poor health barrier is characterised as the most common barrier (Gothe & Kendall, 2016) by as many as 66% in Grossman and Stewart (2003), 58% and 53% of respondents in Moschny et al. (2011) and Cohen-Mansfield et al. 2003), and 27% in the Ayiesah study (2007). Similar results were obtained in Kowal and Fortier (2007), with 19% and 18% in Less et al. (2005). Lack of time is a barrier that has emerged in all studies except Colt et al. (2006) and Dergance et al. (2003). 48% of respondents (Manaf, 2013) said that lack of time is a barrier to PA.

The most common barrier concerning external factors was weather conditions. 77% of respondents in the study conducted by Eroner et al. (2014) consider weather conditions as a barrier. In the studies of Mathews et al. (2010), Less et al. (2005), Kalavar et al. (2005), Grossman and Stewart (2003) and Cohen-Mansfield et al. (2003), weather conditions prevented the respondents from engaging in PA. Most barriers occurred in the studies of Less et al. (2005) (10), in the study of Ayiesah (2007) (16), Manaf (2013) (15), and Macniven et al. (2014) (14). In addition to the most common barriers, these papers also included the following barriers: transport, environment, lack of interest, finances, discomfort during exercise, inaccessibility to facilities, lifestyle, culture, and lack of help. One of the barriers was the financial problem of the respondents, where their answer to the question: "I do not have enough money to practice PA" was positive in the study of Mathews et al. (2010), 23% of respondents answered that in the study conducted by Moschny et al. 2011), 8% in the study of Aily et al. (2017), and 5% in the study of Manaf (2013). In respondents who lead a sedentary lifestyle, the barriers that occurred were: fear of injury, health,

aging conditions, lack of knowledge and professional assistance, lack of energy, and lack of motivation (Eroner et al., 2014; Bethancourt et al., 2014; Colt et al., 2006; Kalavar et al., 2005; Grossman & Stewart, 2003; Dergance et al. et al., 2003; Cohen-Mansfield et al., 2003.) In the study of Cohen-Mansfield et al. (2003), 89% stated that they have no barriers preventing them to engage in PA, 46% in the study of Eroner et al. (2014), 12% in Macniven et al. (2014), and 8% in Less et al. (2005). The barriers that were reported by the respondents which can be affected are transport, lack of knowledge, lack of exercise facilities, the environment in which they are located, and lack of professional assistance. By providing better conditions, transport and a better environment for engaging in PA, elderly people are encouraged to show interest and motivation for PA. It is also very important to provide them with some kind of education and assistance in exercising by professionals. Most studies have shown that there are more external than internal barriers occurring in the elderly concerning their PA engagement. The barriers that make it impossible to practice PA are not significant to a large extent because respondents will always find a reason not to engage in PA from a subjective point of view. Subjectively perceived barriers, apart from poor health, are not adequate indicators of why someone is not able to engage in a certain form of PA. There is a great impact of physical activity on physical and mental health. In the elderly, physical activity can: improve health, slow down aging, improve cardiorespiratory and muscular form, reduce body fat levels, and reduce the symptoms of depression. Despite that, the number of elderly people who have daily physical activity is decreasing. Personal, social, economic and environmental factors play a role in the degree of physical activity in which the youth, adults and the elderly participate. It is important to understand the barriers and factors that stimulate physical activity in order to ensure the effectiveness of various programmes aimed at improving the level of physical activity of the population. With adequate organisation of daily activities, 60 minutes can be set aside for engaging in some physical activity. A very important factor is the motivation and sense of security of the elderly. Support is also an important factor in avoiding barriers.

CONCLUSION

The significance of this research is that it provides information on barriers in respondents who belong to the group of elderly people, who practice or do not practice PA, i.e., the reasons why their physical activity is reduced or why they do not engage in physical activity at all. The results of this systematic review show that there are still a large number of barriers that occur in the elderly. The health condition, lack of time and fear of injury are not the only barriers, but there are also a large number of barriers that prevent the practice of PA. Some of these barriers may be affected by changing attitudes about them, improving the conditions in which elderly people can practice PA, such as transport, the environment, the lack of a training facility, and the lack of professional assistance. It is very important to know the positive impact that engaging in some form of recreation has on aging. It is necessary to know that PA has a positive effect on the physical and psychophysical condition of people.

REFERENCES

1. Abolfazl, R., Monireh, A., Fazlollah, A., & Mahshid, F. (2011). Exercise and physical activity among healthy elderly Iranians. Southeast Asian Journal of Tropical Medicine and Public Health, 42(2), 444.

2. Aily, J. B., Carnaz, L., Farche, A. C. S., & Takahashi, A. C. D. M. (2017). Perception of barriers to physical exercise in women population over 60. Motriz: Revista de Educação Física, 23(2).

3. Australian Institute of Health. (2012). Australia's health 2012: the thirteenth biennial health report of the Australian Institute of Health and Welfare. AIHW.

4. Ayiesah, R. (2007). The level of physical activities amongst elderly in a community. Journal of Health and Translational Medicine, 10(1), 29-33.

5. Ayotte, B. J., Margrett, J. A., & Hicks-Patrick, J. (2010). Physical activity in middle-aged and young-old adults: the roles of self-efficacy, barriers, outcome expectancies, self-regulatory behaviors and social support. Journal of health psychology, 15(2), 173-185.

6. Bethancourt, H. J., Rosenberg, D. E., Beatty, T., & Arterburn, D. E. (2014). Barriers to and facilitators of physical activity program use among older adults. Clinical medicine & research, 12(1-2), 10-20.

7. Booth, M. L., Bauman, A., & Owen, N. (2002). Perceived barriers to physical activity among older Australians. Journal of aging and physical activity, 10(3), 271-280.

8. Booth, M. L., Bauman, A., & Owen, N. (2002). Perceived barriers to physical activity among older Australians. Journal of Aging and Physical Activity, 10, 271–280.

9. Booth, M. L., Bauman, A., Owen, N., & Gore, C. J. (1997). Physical activity preferences, preferred sources of assistance and perceived barriers to increased activity among physically inactive Australians. Preventive Medicine, 26, 131-137.

10. Bratan, T., Engelhard, K., Ruiz, V., Mora, E. V., & Talaya, B. Z. (2013). Strategic Intelligence Monitor on Personal Health Systems, Phase 2.

11. Canadian Fitness and Lifestyle Research Institute. (1996). Barriers to physical activity. Progress in Prevention, Bulletin no. 4.

12. Chao, D., Foy, C. G., & Farmer, D. (2000). Exercise adherence among older adults: challenges and strategies. Controlled clinical trials, 21(5), S212-S217.

13. Chinn, D. J., White, M., Harland, J., Drinkwater, C., & Raybould, S. (1999). Barriers to physical activity and socioeconomic position: Implications for health promotion. Journal of Epidemiology and Community Health, 53, 191–192.

14. Chodzko-Zajko, W. (2004). Physical activity programs and behavioral counseling in older adult populations. Medicine and Science in Sports and Exercise, 36(11), 1997-2003.

15. Chodzko-Zajko, W. J., Proctor, D. N., Singh, M. A. F., Minson, C. T., Nigg, C. R., Salem, G. J., & Skinner, J. S. (2009). Exercise and physical activity for older adults. Medicine & science in sports & exercise, 41(7), 1510-1530.

16. Chogahara, M., O'Brien Cousins, S., & Wankel, L. (1998). Positive and negative social influences on physical activity in older adults: A review of concepts. Journal of Aging and Physical Activity, 6, 1-17.

17. Cohen-Mansfield, J., Marx, M. S., & Guralnik, J. M. (2003). Motivators and barriers to exercise in an older community-dwelling population. Journal of aging and physical activity, 11(2), 242-253.

18. Dawson J., Hillsdon M., Boller I., Foster C. (2007). Perceived barriers to walking in the depressive symptoms. Scand. J. Med. Sci. Sports 19, 398-405.

19. Dergance, J. M., Calmbach, W. L., Dhanda, R., Miles, T. P., Hazuda, H. P., & Mouton, C. P. (2003). Barriers to and benefits of leisure time physical activity in the elderly: differences across cultures. Journal of the American Geriatrics Society, 51(6), 863-868.

20. Eronen, J., von Bonsdorff, M. B., Törmäkangas, T., Rantakokko, M., Portegijs, E., Viljanen, A., & Rantanen, T. (2014). Barriers to outdoor physical activity and unmet physical activity need in older adults. Preventive medicine, 67, 106-111.

21. Friedenreich, C. M. (2001). Physical activity and cancer: lessons learned from nutritional epidemiology. Nutrition Reviews, 59(11), 349–357.

22. Gothe, N. P., & Kendall, B. J. (2016). Barriers, motivations, and preferences for physical activity among female African American older adults. Gerontology and Geriatric Medicine, 2, 2333721416677399.

23. Grossman, M. D., & Stewart, A. L. (2003). "You aren't going to get better by just sitting around": physical activity perceptions, motivations, and barriers in adults 75 years of age or older. The American journal of geriatric cardiology, 12(1), 33-37.

24. Haley, C., & Andel, R. (2010). Correlates of physical activity participation in community-dwelling older adults. Journal of aging and physical activity, 18(4), 375-389.

25. Hovbrandt, P., Fridlund, B., & Carlsson, G. (2007). Very old people's experience of occupational performance outside the home: possibilities and limitations. Scandinavian journal of occupational therapy, 14(2), 77-85.

26. Kalavar, J. M., Kolt, G. S., Giles, L. C., & Driver, R. P. (2005). Physical activity in older Asian Indians living in the United States: Barriers and motives. Activities, Adaptation & Aging, 29(1), 47-67.

27. King, A. C. (1997). Intervention strategies and determinants of physical activity and exercise behavior in adult and older adult men and women. World Review of Nutrition and Dietetics, 82, 148-158.

28. King, A. C., Castro, C., Wilcox, S., Eyler, A. A., Sallis, J. F., & Brownson, R. C. (2000). Personal and environmental factors associated with physical inactivity among different racial-ethnic groups of U.S. middle-aged and older-aged women. Health Psychology, 19, 354–364.

29. Kolt, G. S., Paterson, J. E., & Cheung, V. Y. (2006). Barriers to physical activity participation in older Tongan adults living in New Zealand. Australasian Journal on Ageing, 25(3), 119-125.

30. Kowal, J., & Fortier, M. S. (2007). Physical activity behavior change in middle-aged and older women: the role of barriers and of environmental characteristics. Journal of Behavioral Medicine, 30(3), 233-242.

31. Lees, F. D., Clark, P. G., Nigg, C. R., & Newman, P. (2005). Barriers to exercise behavior among older adults: a focus-group study. Journal of aging and physical activity, 13(1), 23-33.

32. Lim K., Taylor L. (2005). Factors associated with physical activity among older people--a population-based study. Prev. Med. 40, 33-40.

33. Lopez, A. D., Mathers, C. D., Ezzati, M., Jamison, D. T., & Murray, C. J. (2006). Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. The lancet, 367(9524), 1747-1757.

34. Macniven, R., Pye, V., Merom, D., Milat, A., Monger, C., Bauman, A., & Van Der Ploeg, H. (2014). Barriers and enablers to physical activity among older Australians who want to increase their physical activity levels. Journal of physical activity and health, 11(7), 1420-1429.

35. Manaf, H. (2013). Barriers to participation in physical activity and exercise among middle-aged and elderly individuals. Singapore Med J, 54(10), 581-586.

36. Mathews, A. E., Laditka, S. B., Laditka, J. N., Wilcox, S., Corwin, S. J., Liu, R., ... & Logsdon, R. G. (2010). Older adults' perceived physical activity enablers and barriers: a multicultural perspective. Journal of aging and physical activity, 18(2), 119-140.

37. Moschny, A., Platen, P., Klaaßen-Mielke, R., Trampisch, U., & Hinrichs, T. (2011). Barriers to physical activity in older adults in Germany: a cross-sectional study. International Journal of Behavioral Nutrition and Physical Activity, 8(1), 121.

38. Nelson, M. E., Rejeski, W. J., Blair, S. N., Duncan, P. W., Jusge, J. O., King, A. C., . . . Castaneda Sceppa, C. (2007). Physical activity and public health in older adults: Recommendation from the American College of Sports Medicine and the American Heart Association. Medicine and Science in Sports and Exercise, 39(6), 1435-1445.

39. Newson, R. S., & Kemps, E. B. (2007). Factors that promote and prevent exercise engagement in older adults. Journal of aging and health, 19(3), 470-481.

40. O'Brien Cousins, S. (2003). Grounding theory in self-referent thinking: Conceptualizing motivation for older adult physical activity. Psychology of Sport and Exercise, 4, 81-100.

41. Patel, A., Schofield, G. M., Kolt, G. S., & Keogh, J. W. (2013). Perceived barriers, benefits, and motives for physical activity: two primary-care physical activity prescription programs. Journal of aging and physical activity, 21(1), 85-99.

42. Physical Activity Guidelines Advisory Committee. (2008). Physical activity guidelines advisory committee report, 2008. Washington, DC: US Department of Health and Human Services, 2008, A1-H14.

43. Rasinaho, M., Hirvensalo, M., Leinonen, R., Lintunen, T., & Rantanen, T. (2007). Motives for and barriers to physical activity among older adults with mobility limitations. Journal of aging and physical activity, 15(1), 90-102.

44. Rosqvist, E., Heikkinen, E., Lyyra, T. M., Hirvensalo, M., Kallinen, M., Leinonen, R., ... & Rantanen, T. (2009). Factors affecting the increased risk of physical inactivity among older people with depressive symptoms. Scandinavian Journal of Medicine & Science in Sports, 19(3), 398-405.

45. Roth, M. A., Millett, C. J., & Mindell, J. S. (2012). The contribution of active travel (walking and cycling) in children to overall physical activity levels: a national cross sectional study. Preventive medicine, 54(2), 134-139.

46. Simonsick E. M., Guralnik J. M., Volpato S., Balfour J., Fried L. P. (2005). Just get out the door! Importance of walking outside the home for maintaining mobility: findings from the women's health and aging study. J. Am. Geriatr. Soc. 53, 198-203.

47. Sjörs, C., Bonn, S. E., Lagerros, Y. T., Sjölander, A., & Bälter, K. (2014). Perceived reasons, incentives, and barriers to physical activity in Swedish elderly men. Interactive Journal of Medical Research, 3(4), e15.

48. Steptoe, A., Rink, E., & Kerry, S. (2000). Psychosocial predictors of changes in physical activity in overweight sedentary adults following counseling in primary care. Preventive Medicine, 31, 183-194.

49. Wilcox, S., Castro, C., King, A. C., Housemann, R., & Brownson, R. C. (2000). Determinants of leisure-time physical activity in rural compared to urban older and ethnically diverse women in the United States. Journal of Epidemiology and Community Health, 54, 667-672.

BARIJERE ZA FIZIČKU AKTIVNOST KOD STARIJIH OSOBA

Cilj ovog sistematskog preglednog rada bio je da na osnovu predhodnih istraživanja utvrdi koje se barijere za fizičku aktivnost javljaju kod starih osoba. Za prikupljanje literature pretražene su sljedeće baze podataka: Google Scholar, PubMed, Web of Science i Research Gate, koristeći sve dostupne radove u periodu od 2002. do 2017. godine. Za analizu dobivenih podataka primjenjena je deskriptivna metoda, a svi naslovi i sažeci su pregledani za potencijalne radove koji su bili uključeni u ovo sistematsko pregledno istraživanje. Ukupno je 20 studija zadovoljilo unapred definisane kriterije i uključeno u kvantitativnu analizu. Rezultati su dobiveni nakon analize upitnika koji su ispitanici popunjavali za procjenu barijera. Ovo sistematsko pregledno istraživanje pokazuje da i dalje postoji veliki broj barijera koje se javljaju kod starih osoba. Da nisu samo zdravstveno stanje, nedostatak vremena i strah od povreda jedine barijere, već postoji i veliki broj barijera koje sprječavaju bavljenje FA. Na neke od tih barijera može da se utiče i promijeni stav o njima, poboljšavajući uslove u kojima stare osobe mogu da se bave FA, kao što su transport, okruženje, nedostatak objekata za vježbanje i nedostatak stručne pomoći.

Ključne riječi: fizička aktivnost, barijere, stariji, stari ljudi

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THE EFFECTS OF PROGRAMME CONTENTS ON BODY COMPOSITION, FUNCTIONAL ABILITIES AND SPEED OF PERFORMING TECHNICAL ELEMENTS IN KARATE

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ABSTRACT

The aim of this research is to determine the effects of programme contents on body composition, functional abilities and speed of performing technical elements in karate. The sample on which the research was carried out consists of 15 male subjects aged between 15 and 18 years, with at least three years of practicing karate. The sample of variables for this study consisted of the following variables: height, weight, flexibility, abdominal skinfold, biceps skinfold, triceps skinfold, back/subscapular skinfold, body fat mass in %, lean body mass, body fat mass, kizami tsuki, gyaku tsuki, left mawashi geri, right mawashi geri, maximum heart rate, running speed at which the anaerobic threshold is broken, heart rate recovery, and TT time - overall Conconi test time. The training programme lasted 6 weeks with a total of 18 training sessions. During the five weeks, 3 training sessions were performed per week, with 4 training sessions being performed during the sixth week. The following methods were used: continuous, discontinuous and interval. The programme was conducted with strict load control via polar pulsimetry. The results of the multiple analysis of variance showed that due to the implemented six-week-long programme, there were statistically significant effects of positive transformations for body composition and the speed of performing individual movements in karate, while these changes were not noted in functional abilities. Based on the results of this research, the implemented plan and programme had a positive effect on the transformation of karate athletes as well as the effects that should be taken into account in the process of planning and programming karate training.

Keywords: martial arts, performance, programming, transformation

INTRODUCTION

Olympic karate is described as a modern martial art that is constantly evolving, and whose performance requires athletes to develop and maintain a high level of physical fitness as part of their preparation. It is therefore important to understand the characteristics of the components involved in physical performance in this sport so as to apply appropriate training incentives in the preparation of athletes. Karate has a complex structure, and the physical fitness, technique, tactics, and mental state of the competitors affect successful performance. Anthropological measurements provide information about body proportions and characteristics of an individual, and they are important for the development of

the overall profile of an athlete (Ratamess, 2012). Karate belongs to the group of polystructural acyclic sports but differs from the other sports in such a way that its basic intention - symbolic destruction of the opponent - is achieved by simultaneous or strictly controlled kicks and punches (Kapo, 2011). Karate practicing develops general and situational motor skills as well as intellectual and functional abilities; it acts on the formation of a specific structure of personality traits, motivation and the value system (Kapo, 2010). The most important factors that determine the morphological characteristics and body composition are: genetic factor and environmental factor (diet and exercise). The amount of adipose and muscle tissue increases rapidly in the first 6 months after birth and in early adolescence (Haywood, & Getchell, 2019). It is especially important to emphasise that, in the period from 10 14 years of age, active boys (who have 6 hours of training per week) significantly increase muscle and total mass within 4 years, while their adipose tissue remains at the same level in contrast to inactive boys (Pařízková & Roth, 1972). Thus, physical activity has a positive effect on the quality of body composition during the period of growth and development. Body composition is one of the five components of health fitness that describes the body tissue components. Body composition, also known as kinanthropometry, comprises an assessment of body composition and body components. This includes muscles, bones and fat, paying attention to the size, shape and proportions of each tissue. It gives us an insight into the relationship between the two components, fat and non-fat mass. Karate training is recommended for a group of younger children because it improves body position and fat distribution symmetry. Karate training should be introduced as one of the forms of physical activity in physical education during initial school years (Tomasz et al., 2020). Under the influence of programmed trainings, positive transformations within the body indicators may be expected (Kapo et al., 2015). By practicing karate, it is possible to initiate transformational processes causing development or maintaining the functional ability at the achieved level, morphological characteristics and motor skills, among which the development of strength is dominant (Kapo, 2010). Maintaining an appropriate training system is crucial to build a top competitor. Training should be optimised to achieve the best results and simultaneously aimed at the rationalisation of the improvement pertaining to the functions and skills of competitors at each stage of their biological and sporting development. Solutions are still being sought to develop the best selection criteria and overcome constraints. Performance outcomes have always represented such criteria, while limitations have been a major determinant of biological development and functional abilities of the body. High-level sports performance can only be achieved by competitors in the right circumstances. The selection of appropriate morphological criteria for a particular sport is vital because the somatic structure of the body is strongly determined by genetics, which can only be modified to a limited extent by training. Karate training has a large effect on body fat and overall energy consumption (Imamura et al., 1998). The number of scoring has increased, motives for climbing the podium as the first-place winner have improved discipline, sportsmanship, knowledge of techniques, refereeing rules, and the coach-competitor-arena relationship. The heart rate during the fight is between 170-180 beats per minute, which corresponds to aerobic and anaerobic effort (Marques, 2014). Functional abilities in the equation of specifying the success of karate practitioners occupy a special place, so karate as a competitive sport (kumite) belongs to the mixed aerobic-anaerobic sports. Endurance is considered by many to be a functional ability (aerobic, anaerobic or mixed type) because the dominant role in its manifestation is played by cardiovascular and respiratory abilities and motivation (Kuleš, 1998). The training planning process is a complex management action which determines the goals and tasks of training, terms for their implementation, terms of control, election and main competitions, the time necessary to reach peak physical condition, and the necessary technical, material and personnel conditions. The aim of this research is to determine the effects of programme contents on body composition, functional abilities and speed of performing technical movements in karate.

METHODS

SAMPLE OF PARTICIPANTS

The sample of participants in this research consisted of 15 male participants of all weight categories from the Karate Club "Bushido" Sarajevo and Karate Club "Mai" Prača, aged between 15 and 18 years, with at least three years of practicing karate. All participants were clinically healthy.

SAMPLE VARIABLES

In this study, 17 variables of 9 body composition variables were used, being as follows:
1. Height – Athlete's height; 2. Weight - Athlete's weight; 3. T1 – Abdominal skinfold; 4. T2 - Biceps skinfold; 5. T3 – Triceps skinfold; 6. T4 - Back-subscapular skinfold; 7. Body Fat Mass % - Body fat mass in %; 8. LBM - Lean body mass and 9. BFM - Body fat mass.
Four variables related to the speed of performing technical elements in karate, being as follows:
1. Kiz - Kizami tsuki; 2. Gyaku - Gyaku tsuki; 3. LM - Left mawashi geri and 4. DM - Right mawashi geri
Four variables for functional abilities, being as follows:
1. Max FS - Maximum heart frequency; 2. Vd - Running speed at which the anaerobic threshold is broken; 3. Hr Recovery – Heart rate recovery and 4. TT time - The total time of the Conconi test

DATA COLLECTION METHOD

The testing lasted four days. Initial testing was performed during the first two days. On the first day, body composition was measured (by anthropological instrumentation and Tanita scales), and a test to assess functional abilities, i.e., the Conconi test was performed, followed by a day off (due to recovery and obtaining more accurate data). On the second day, tests were performed to assess the speed of performing technical movements in karate, modified according to (Kuleš, 1998). Based on the results obtained in the initial testing and measurement, a plan and programme of activities was developed, which was implemented in 6 weeks. After the implemented programme, the final testing and measurement were performed during two days in accordance with the protocol of activities, similar to the initial data collection.

BODY COMPOSITION MEASURING INSTRUMENTS

The body composition of karate practitioners was measured with a Tanita scale (Tanita BC-418, Tokyo, Japan) which is a bioelectric scale that uses a bioelectrical impedance to measure the conductivity of the body through hydrated muscle. When it passes to adipose tissue, it creates resistance. This resistance, known as impedance, is measured and entered into scientifically validated Tanita equations to calculate body composition measurements (Kelly et al., 2012). Preparation for the measurement required the students to remove metal ornaments because the lack of metal improves the accuracy of the analysis, and to avoid exercise or other activity that leads to perspiring at least 8 hours before the test, which is important to get accurate results regarding body fluid content. The athletes were required to be in their underwear and to stand barefoot on Tanita scales. A Myprotein skinfold calliper was used to measure the skinfolds, which includes a measuring table that can be used as a guideline for calculating body fat. A dedicated metre, placed on the wall, was used to measure the body height.

FUNCTIONAL ABILITY ASSESSMENT TEST

The functional ability assessment test used in this study was the Conconi test. In 1982, an Italian physiologist Conconi Francesco perfected a simple test, which is not based on blood tests. That test can give an indication of the health condition status, the fitness of the athlete and training status. This is a reliable indicator of the effects of aerobic exercise. Also, this test is very popular because it is a simple, inexpensive and non-invasive method of determining the anaerobic threshold.

CONCONI TREADMILL TEST PROCEDURE

After the usual 15-30 minutes of warm-up, the subject begins testing. The testing is of weak to moderate intensity in relation to his abilities. However, depending on the physical condition of the subject, the initial running speed should be neither too low nor too high (less than 70% HRmax).
Testing equipment: Treadmill "LIFE FITNES 9500 HR" 2,5kw; Cardio running computer "Polar RS 800sd multi"; Stopwatch; Conconi test form; PolarProTrainer.

THE TESTING PROCEDURE IS AS FOLLOWS:

1. perform 5-10 minutes of warm-up (hear rate up to 120 beats per minute); 2. record HR in 5-second intervals; 3. start the treadmill at the speed required to start; 4. record time and heart rate at every 200 m; 5. increase speed of the treadmill at every 200 meters by 0.5 km/h; 6. end the test after MHR is achieved or when the subject voluntarily requests an interruption; 7. stop HR recording and 8. turn on the cooling or HR lowering programme.
After the test, the recorded "Polar" file from the heart rate monitor is transferred to a computer into the "Polar Pro Trainer 5" program which indirectly calculates the VO^2max, anaerobic threshold and running speed at the anaerobic threshold. The testing was conducted twice - in the initial state and in the final state after the implemented programme.

TESTS FOR ASSESSING MOVEMENT SPEED IN KARATE

The tests used to estimate the speed of performing technical movements in karate were modified according to (Kuleš, 1998):

1. the number of hand punches in 60 seconds (kizami tsuki); 2. the number of hand punches in 60 seconds (gyaku tsuki); 3. the number of kicks in 60 seconds (left mawashi geri to the head) and 4. the number of kicks in 60 seconds (right mawashi geri to the head).
The tests for assessing movement speed were performed on a punching bag. The test lasted for 60 seconds. The goal of the test is for the athlete to perform a certain technique with the maximum number of repetitions in 60 seconds.

TRAINING PLAN

The plan of the karate training process was made on the basis of the data obtained by the Conconi test for each athlete (individual training zones for the development of aerobic and anaerobic endurance). The training plan for this study lasted six weeks, divided into six microcycles. The training plan and programme was performed in the preparatory period in which, in addition to specific training, an additional training regarding the development of functional abilities was also implemented. The running training sessions were conducted three times a week.

In the first microcycle, the work was done in an extensive aerobic zone for 40 minutes, and the work method was continuous. In the second microcycle, the duration of the activity was increased from 40 to 60 minutes. The work method and the training zone remained the same. The third microcycle was performed in an extensive aerobic zone, for 20-30 minutes with a continuous work method. The fourth microcycle was done in the aerobic-anaerobic zone, with a discontinuous work method lasting between 15 and 20 minutes. The fifth microcycle was done in the anaerobic threshold zone, in the interval method. At the end of the sixth microcycle, a combination of anaerobic and regenerative zones was performed. The interval method was used in the anaerobic zone. The programme was conducted with strict load control via polar pulsimetry for each athlete.

RESEARCH ETHICS

All procedures were performed in accordance with the recommendation of the Helsinki Committee and ethical standards of the University of Sarajevo Ethics Committee.

STATISTICS

After the normalisation of nominal variables, the following parameters that characterise the sample were determined at the elementary level: minimum value, maximum value, range, arithmetic mean, standard deviation, coefficient of variance; skewness, kurtosis, with the Kolmogorov-Smirnov test that will be used to determine the form of data distribution. In order to determine the relations of functional abilities and specific variables, the Kolmogorov-Smirnov Z-value, Parson's correlation coefficient and multiple analysis of variance were applied. The statistical programme SPSS 22.0 was used for data analysis.

RESULTS

Table 1 shows the average values and measures of deviation for individual variables before and after training. With the exception of body height, all variables show some change in their average values after the programme activities, which can be seen from the values of the arithmetic mean.

Table 1: Average values of deviation measures for individual variables before and after training and Kolmogorov-Smirnov Z-values, curvature index and flatness

Measure	Situation	Min	Max	AS	SD	Kolmogorov-Smirnov Z-value	The significance level of deviation from normality	Flatness Index	Curvature Index
Height	Before the programme	162.0	194.0	175.9	8.7	0.72	0.66	0.48	-0.33
	After the programme	162.0	194.0	175.9	8.7	0.72	0.66	0.48	-0.33
Weight	Before the programme	55.0	89.0	66.4	9.3	0.79	0.55	1.08	1.00
	After the programme	53.5	87.5	65.2	9.2	0.77	0.58	1.05	0.90
T1	Before the programme	3.5	6.5	4.4	0.8	1.42	0.03 *	1.47	1.55
	After the programme	3.5	5.5	4.3	0.5	1.39	0.04 *	1.21	0.60
T2	Before the programme	4.0	19.0	8.1	3.3	1.03	0.23	2.59	8.69

T3	**Before the programme**	**5.0**	**10.5**	**7.0**	**1.6**	**0.90**	**0.38**	**0.81**	**-0.17**
	After the programme	4.5	10.0	6.6	1.6	0.55	0.91	0.68	-0.35
T4	Before the programme	5.0	25.5	9.5	5.0	0.95	0.32	2.50	7.71
	After the programme	5.0	20.5	8.6	3.9	0.80	0.53	1.99	5.16
Kiz	Before the programme	44.0	102.0	76.6	19.7	0.90	0.38	-0.59	-1.34
	After the programme	53.0	103.0	84.7	19.0	1.29	0.06	-0.78	-1.37
Gyaku	Before the programme	46.0	98.0	76.6	17.8	0.76	0.60	-0.55	-1.22
	After the programme	56.0	109.0	88.3	18.6	0.84	0.47	-0.57	-1.35
LM	Before the programme	33.0	70.0	51.8	11.0	0.50	0.95	0.17	-0.96
	After the programme	54.0	74.0	62.5	7.4	0.64	0.80	0.32	-1.55
DM	Before the programme	34.0	65.0	49.4	11.5	0.75	0.61	0.18	-1.76
	After the programme	48.0	73.0	61.6	9.1	0.93	0.34	-0.41	-1.55
Body Fat Mass %	Before the programme	8.3	21.7	12.1	3.2	0.91	0.37	1.80	5.08
	After the programme	7.4	19.9	11.3	3.0	0.83	0.49	1.49	3.91
LBM	Before the programme	47.7	77.0	58.1	8.1	0.87	0.42	0.98	0.56
	After the programme	47.4	76.2	57.7	8.1	0.80	0.53	0.86	0.39
BFM	Before the programme	5.4	13.7	8.3	2.4	0.58	0.88	0.72	0.31
	After the programme	4.6	12.0	7.5	2.3	0.59	0.87	0.46	-0.54
Max FS	Before the programme	186.0	209.0	196.9	7.0	0.52	0.94	-0.24	-0.84
	After the programme	186.0	209.0	197.6	6.7	0.61	0.83	-0.29	-0.82
Vd	Before the programme	10.0	16.0	12.6	1.4	0.53	0.93	0.40	1.46
	After the programme	12.5	16.5	13.6	0.9	1.20	0.10	1.82	4.34
Hr Recovery	Before the programme	1.3	6.5	2.9	1.6	0.79	0.55	1.02	0.28
	After the programme	1.0	4.3	2.3	1.1	0.66	0.77	0.62	-0.85
TT time	Before the programme	11.3	20.0	15.7	2.1	0.795	0.55	-0.32	1.23
	After the programme	14.3	20.3	17.0	1.2	0.838	0.48	0.62	3.10

* Kolmogorov-Smirnov Z-value is statistically significant at the level of less than 5%.

Table 1 shows the values and level of significance of the Kolmogorov-Smirnov Z-values as well as the curvature and flatness index of individual dependent variables. One of the assumptions that must be met to use any parametric procedure, such as Pearson's correlation coefficient and analysis of variance, is the normality of the results distribution in target variables. Table 2 clearly shows that there is a correlation that is statistically significant at the level of less than 5% between the variables: kizami tsuki (Kiz) and left mawashi geri (LM) before; gyaku tsuki (Gyaku) and right mawashi geri (DM); left mawashi

geri (LM) and kizami tsuki (Kiz); right mawashi geri (DM) and gyaku tsuki (Gyaku) after the programme activities, while a correlation that is statistically significant at the level of less than 1% is visible between the variables: kizami tsuki (Kiz) and gyaku tsuki (Gyaku) before; kizami tsuki (Kiz) and gyaku tsuki (Gyaku); kizami tsuki (Kiz) and left mawashi geri (LM); kizami tsuki (Kiz) and right mawashi geri (DM) after the programme activities. Additionally, the correlation at this level is visible between the variables: gyaku tsuki (Gyaku) and kizami tsuki (Kiz); gyaku tsuki (Gyaku) and left mawashi geri (LM) before; gyaku tsuki (Gyaku) and kizami tsuki (Kiz); gyaku tsuki (Gyaku) and left mawashi geri (LM), and gyaku tsuki (Gyaku) and right mawashi geri (DM) after the programme. The significance of correlations at the level of less than 1% also exists between the variables: left mawashi geri (LM) and right mawashi geri (DM) before; left mawashi geri (LM) and kizami tsuki (Kiz), left mawashi geri (LM) and gyaku tsuki (Gyaku), and left mawashi geri (LM) and right mawashi geri (DM) after the programme contents, as well as between the variables right mawashi geri (DM) and left mawashi geri (LM) before and left mawashi geri (LM) and kizami tsuki (Kiz); right mawashi geri (DM) and gyaku tsuki (Gyaku), and right mawashi geri (DM) and left mawashi geri (LM) after the programme contents.

Table 2: Values and significance levels of Pearson's correlation coefficients between different speed indexes of individual movements in karate before and after the programme activities

Variable	Situation		Kiz	Gyaku	LM	DM
Kiz	Before	Correlation	1	0.937 **	0.631 *	0.481
		Significance level	-	0.000	0.012	0.069
	After	Correlation	1	0.969 **	0.687 **	0.802 **
		Significance level	-	0.000	0.005	0.000
Gyaku	Before	Correlation	0.937 **	1	0.733 **	0.621 *
		Significance level	0.000	-	0.002	0.013
	After	Correlation	0.969 **	1	0.701 **	0.852 **
		Significance level	0.000	-	0.004	0.000
LM	Before	Correlation	0.631 *	0.733 **	1	0.772 **
		Significance level	0.012	0.002	-	0.001
	After	Correlation	0.687 **	0.701 **	1	0.867 **
		Significance level	0.005	0.004	-	0.000
DM	Before	Correlation	0.481	0.621 *	0.772 **	1
		Significance level	0.069	0.013	0.001	-
	After	Correlation	0.802 **	0.852 **	0.867 **	1
		Significance level	0.000	0.000	0.000	-

*The correlation is statistically significant at the level of less than 5%. **The correlation is statistically significant at the level of less than 1%

Table 3. Body fat mass (BFM) significantly and negatively correlates with the variables gyaku tsuki (Gyaku) and left mawashi geri (LM), which means that the values of body fat mass (BMF) are higher and the values in gyaku tsuki (Gyaku) and the left mawashi geri (LM) are lower, and vice versa. These correlations were found in the pre-programme situation. The variable body fat mass (BFM) significantly and negatively correlates only with the variables left mawashi geri (LM) and right mawashi geri (DM) in the post-programme situation. The higher the value in body fat mass (BFM), the lower the values in the variables left mawashi geri (LM) and right mawashi geri (DM), and vice versa. Correlations are significant at the level of less than 5%.

Table 3: Values and significance levels of Pearson's correlation coefficients between body composition, on the one hand, and the speed of individual movements in karate, on the other, before and after the programme activities.

Variable	Situation		Kiz	Gyaku	LM	DM
Body Fat Mass %	Before	Correlation	-0.339	-0.401	-0.349	-0.237
		Significance level	0.217	0.139	0.202	0.396
	After	Correlation	-0.390	-0.362	-0.389	-0.441
		Significance level	0.150	0.185	0.152	0.100
LBM	Before	Correlation	-0.192	-0.254	-0.456	-0.375
		Significance level	0.493	0.362	0.087	0.168
	After	Correlation	-0.196	-0.219	-0.256	-0.333
		Significance level	0.484	0.433	0.357	0.226
BFM	Before	Correlation	-0.481	-0.548 *	-0.524 *	-0.383
		Significance level	0.069	0.034	0.045	0.159
	After	Correlation	-0.503	-0.493	-0.515*	-0.617 *
		Significance level	0.056	0.062	0.049	0.014

*The correlation is statistically significant at the level of less than 5%.

Values and significance levels of Pearson's correlation coefficients between functional ability variables, Body Fat Mass %, body fat in %, LBM - lean body mass, BFM - body fat mass before and after the programme activities, showed that there were no statistically significant correlations at the lower level of 5% and the level of 1%.

Table 4 shows the results of the multiple variance analysis with repeated measurements, showing that all F-ratios are statistically significant at the levels far less than 1%, and the chance of their random occurrence is practically 0. This means that changes in the average values of dependent variables are significant before and after the programme activities. Based on all the above mentioned, it is clear that the programme activities have a significant effect on the following dependent variables: Kiz - kizami tsuki, Gyaku - gyaku tsuki, LM - left mawashi geri, DM - right mawashi geri, Body Fat Mass % - body fat mass in %, LBM - lean body mass, BFM - body fat mass. As for the morphological characteristics: Height - height of the athlete, Weight - weight of the athlete, T1 – abdominal skinfold, T2 – biceps skinfold, T3 – triceps skinfold, T4 – back-subscapular skinfold, the results of the analysis of multiple variance with repeated measurements showed that F -ratios are not statistically significant at the level of 1%. While in the functional ability variables Max FS - maximum heart rate, Vd - running speed at which the anaerobic threshold is broken, Hr Recovery - heart rate recovery, TT time - total time of the Conconi test, the results of multiple variance analysis with repeated measurements showed that F-ratios are not statistically significant at the 1% level.

Table 4: Final multiple analysis of variance with repeated measurements

Source of variability	Dependent variables	Sum of squares	Degree of freedom	Variance between situations	F-ratio	Significance level p
Programme activity	Kiz	488.033	1	488.033	29.391	0.000 **
	Gyaku	1032.533	1	1032.533	68.683	0.000 **
	LM	864.033	1	864.033	57.203	0.000 **
	DM	1128.533	1	1128.533	45.340	0.000 **
	Body Fat Mass %	4.485	1	4.485	63.131	0.000 **
	LBM	1.121	1	1.121	4.314	0.000 **
	BFM	4.961	1	4.961	33.097	0.000 **

** The F-ratio is statistically significant at the level of less than 1%.

DISCUSSION

Top results can no longer be achieved on the basis of individual experiences, intuition and random factors. Procedures in the training process must be extremely rational and established on the results of interdisciplinary professional and scientific research. It is therefore important to understand the characteristics of the components involved in physical performance in karate sports so as to apply appropriate training incentives in the preparation of athletes. Diagnostic procedures in sports are carried out with the aim of determining the initial condition of athletes, evaluating the effects achieved in specific cycles of sports preparation, as well as to plan and programme the further course of the training process. Top sports results at today's level of development of technology and methodology of sports preparation occur as a product of a planned, programmed and controlled process of sports training. It is an extremely complex process which must have predefined goals, means and training methods. The purpose of diagnostic procedures is to collect relevant and objective parameters of athlete preparation. Interconnected systems enable us to analyse psychomotor abilities and control motor structures. Such a strategy of training diagnostics gives us the opportunity to determine the quantitative and qualitative characteristics of athletes' preparation. A successful training process will be one at the expense of which the athlete will achieve a level of sports fitness that is identical or close to the model characteristics of the best athletes. The transformation process generally signifies change. Any change in the state of system inputs or outputs takes place in such a way that some input over time turns into an output, i.e., some initial state is transformed into the next newly formed (transitive, final) state (Malacko & Radjo, 2004).

The aim of this research was to determine the effects of the implemented plan and programme on body composition, functional abilities and speed of performing technical elements in karate.
The research showed that the plan and programme of preparation during 6 weeks of training caused changes that are statistically significant in body composition and speed of performing technical elements in karate. The results of the research are not unexpected considering the structure and combinations of movements in karate. In order for change to follow, it is important to know what, how and how much to train as well as how to control variability in both qualitative and quantitative terms. The final multiple analysis of variance with repeated measurements in this research shows that the changes in the average values of the dependent variables before and after the programme activities are statistically significant.

It is obvious that programme activities in karate have a significant effect on body composition: (Body Fat Mass %), body fat mass in %, (LBM) lean body mass, and (BFM) body fat mass. These data are confirmed by research (Kapo et al., 2015) on a sample of young female karate athletes (n = 22) (13.6 ± 2.1 years) where, during a total of 12 weeks, 60 minutes of specific karate training sessions with exercises for the development of motor skills conducted 3 times a week were performed. The aim of the study was to evaluate the effects of a three-month karate programme on body composition. The results indicate that there was a statistically significant decrease in the results in the following variables: body mass, adipose tissue percentage, BMI; while with the body water percentage variable, there was a statistically significant increase in results. More intense forms of physical activity provide greater benefits regarding weight reduction and individual health status than moderate-type activities (Bompa, 2009). This primarily refers to reducing the risk of cardiovascular diseases (Swain et al., 2006), as well as an increase in the functions of the locomotor system (Wojtek et al., 2009). Also, the positive effects of high-intensity activity on reduction and maintenance of optimal body weight in both women and men are known (Donnelly et al., 2009).

Knowing the anthropometric characteristics of karate can provide us with an insight into the most favourable biotypes for this martial art. However, despite the fact that karate is a very popular and widespread individual sport, and that knowledge of the morphological characteristics and body composition of competitors, both fighters and practitioners, is necessary, research in the field of karate morphology is not so numerous (Chaabène et al., 2012; Gloc et al., 2012). For example, according to the study conducted by Sterkowicz (1992), karate is characterised by a harmonious body constitution and a low percentage of adipose tissue, where the percentage of adipose tissue of 13 kyokushin karate athletes was 12.16 ± 2.31% while the percentage without fat tissue was 87.84 ± 2.22%. Similar results were confirmed by the Sterkowicz-Przybycień's study (2005) when the sample of participants, in addition to karate, was extended to other martial arts (judo, wrestling, boxing, fencing and ju-jitsu). High-intensity intermittent exercise has the potential to be classified into a group of exercises that have more economical and effective benefits for reducing adipose tissue, body weight, and improving functional-motor abilities, and it consists of a warm-up period, submaximal and maximum loads period, and all this was applied during the implementation of the karate plan and programme, which was done on the basis of measuring and testing karate practitioners (Tabata et al., 1996; Shaw et al., 2009). Warming-up in martial arts increases the rate of muscle contraction and transmission of neural impulses and stimulates the economy of movement by improving muscle strength and kinetic energy while hitting (Costa et al., 2011; Chaabene et al., 2012).

Active warm-up has been shown to be more beneficial than the passive one (Kapo et al., 2016), which was not the case in this study. Even if higher power peak values were observed after the dynamic procedure, this undoubtedly represents an insignificant trend and can be described as random fluctuation (Kapo et al., 2017). If we talk about the comparison of karate competitors of different competitive levels, the research of Giampietro et al. (2003) found that there is no difference in body composition between intermediate and high level competitors, although the percentage of adipose tissue was much lower in top competitors. According to Fritzsche and Raschka (2007), who conducted their research under the assumption that continuous karate training causes changes in body composition, a typical top karate competitor is characterised by athletic build and lower body weight than recreational karate practitioners. In regard to the relationship of anthropometric characteristics and sports performance, a very small number of research has been done so far. In his research, Abdel-Baser (2010) came to the conclusion that, in addition to technique, the longitudinal dimensionality of the skeleton, accompanied by a lower percentage of adipose tissue, also plays an important role for sports success.

For morphological characteristics in this study, the results of multiple variance analysis do not show statistically significant effects in the variables: Height - height of the athlete, Weight - weight of the athlete, T1 – abdominal skinfold, T2 – biceps skinfold, T3 – triceps skinfold, and T4 – subscapular back skinfold. The obtained results most likely indicate that the time period of six weeks was short and that the sample of subjects was minor, as well as that the diet was not adequately adjusted to this training process and age. In every sports branch, there are those morphological characteristics as well as motor and functional abilities that are of decisive influence on sports success. Morphological characteristics represent an important segment in defining the profiles of top karate competitors (Gloc et al., 2012; Jukić et al., 2012).

In order to be able to perform the necessary diagnosis of the athletes' training condition, it is necessary to know, among others, the physiological requirements of sport and its energy capacity. Given that competitive activity takes place in sports fights and katas, which differ in their structural basis, so the approach to previous research and physiological responses to competitive discipline can be roughly divided into research of energy requirements, aerobic and anaerobic capacity that predominantly occur in katas (Bussweiler & Hartmann, 2012; Francescato et al. 1995) and sport fighting - in particular (Beneke et al., 2004) or in comparison (Doria et al., 2009). In addition, a number of studies have been done that have dealt with profiling aerobic capacity (Ravier et al., 2003; Imamura et al., 1998; Ravier et al., 2006; Doria et al., 2009; Koropanovski et al., 2011; Francescato et al., 1995) and the anaerobic capacity of karate competitors (Beneke et al., 2004; Francescato et al., 1995; Ravier et al., 2009).

The results of this study in the analysis of multiple variance with repeated measurements did not give statistically significant results in the variables of functional abilities Max FS - Maximum heart rate, Vd - Running speed at which the anaerobic threshold is broken, Hr Recovery - Heart rate recovery, and TT time - Total time Conconi test. The obtained results indicate that the participants were active in karate and that their characteristics of morphologically functional and motor structures were adapted to the rank of well-trained karate athletes of cadet age, and that the plan and programme of activities with the tested sample of cadet age probably could not give significant results. This assumption is confirmed by research (Hadžović-Džuvo & Kapur, 2011) where it is said that trained people achieve a stable state at the same level of load with a much lower heart rate, and untrained people achieve it at much lower frequencies. High aerobic capacity allows the athlete to stay vigorous, and his efficiency remains at a high level in the last part of training (Škof, 2003). If the aerobic part of the training is skipped and if anaerobic stimuli are started immediately, overtraining and the risk of injuries can occur. In karate sports, due to the use of energy from anaerobic sources at the beginning of the match, a maximum oxygen deficit is created (Ravier et al., 2006) and it is a parameter that indicates the size of anaerobic energy capacity, which, in top karate fighters, can reach up to 20 litres. A maximum of one third of the energy needs in combat are met from anaerobic sources, while further energy processes take place from aerobic capacities. Although individual punches and kicks are predominantly anaerobic-lactate and depend on muscle strength, for the repetition of these motor actions that occur during combat, the share of aerobic metabolism is 77.8% ± 5.8% while anaerobic lactate is 16.4 ± 4.6 of total energy produced during the match (Beneke et al., 2004).

Earlier research has concluded that karate kumite (fighting) requires anaerobic metabolism as the dominant energy source (Lehmann & Jedliczka, 1998; Baker & Bell, 1990); thus, karate is ranked as a high-intensity activity.

However, recent research has shown that the overall metabolic profile of karate fighting is, in fact, aerobically dominant (Beneke et al., 2004; Doria et al., 2009). This fact is supported by a description of the structure of activities during the fight, where the profile of acyclic movement in all directions and jumps in the posture between actions alternate with short-term and explosive techniques of high energy requirements, followed by short interruptions of the fight (for awarding points, warnings and penalties). The energy characteristics of karate indicate that the share of the aerobic component in kumite athletes is

about 70%, the aerobic lactate component is about 20% while the lactate component is about 10% (Beneke et al., 2004). Cicović (2014) investigated the effects of fitness training on the development of anaerobic-lactate endurance and functional abilities in judo competitors where significant effects were shown in the final testing compared to the initial one.

If we summarise the previous research of energy sources in karate, we can conclude the following: regardless of the competitive discipline (kata and kumite), the aerobic system is the main source of energy, especially in longer katas (Chaabène et al., 2015).

Aerobic capacity is necessary to prevent the occurrence of fatigue during work as well as for faster recovery between katas and fights, and short breaks within the fight (e.g., referee interruptions) (Imamura et al., 1998; Beneke et al., 2004). All indicators in this study indicate that there was an increase in the speed of performing technical movements of karate in the variables: Kiz - kizami tsuki, Gyaku - gyaku tsuki, LM - left mawashi geri, DM - right mawashi geri, which indicates that the planned training provided effects and that this way of diagnosing, planning and monitoring these activities with the help of modern diagnostics has given evident results. Polystructural movement characteristics of karate fighting (kumite) largely define the movement structures having the most important motor skills in the background: agility, explosiveness and speed. A research of model technical-tactical indicators of karate fighting indicates that the largest share of a total of 83.02% is made up of hand techniques (Koropanovski, Dopsaj, Jovanović, 2008; Vidranski, 2009).

Accurate assessment of the effects of movement stimulation depends on making accurate and reliable diagnoses of an individual's physical and psychomotor development at different stages of ontogenesis and karate training. Such diagnostic outcomes enable the development of optimal programming of various elements pertaining to sports training and coordination of athletes' motor skills, according to the goals set for each phase of sports progress. Out of all of the above mentioned, it is clear that the assessment of body composition, functional ability and speed of performing technical elements in karate in younger categories may be a useful resource for determining future success in karate.

CONCLUSION

The implemented programme contents gave effects on the improvement of body composition and speed of performing technical movements in karate after the conducted six-week-long programme, which have a significant role in the equation of specifying success in karate sport.

Coaches in karate sports should pay special attention to the quality of body composition, functional abilities and situational efficiency shown by their athletes because these dimensions are those that could be indicators of future sports success.

The recommendation for the Karate Federation of Bosnia and Herzegovina is to develop plans and programmes in the future for all age categories and genders using modern technologies for diagnosing the performance of athletes and applying the results of scientific research in the training process.

REFERENCES

1. Abdel-Baser, E. A. (2010). Using the Length and Weight of the Body and Some Dynamic Parameters to Perform Ura Mawshi Geri Skill to Predict Kumite Players' Performance. World 3: 127-131.
2. Baker, J. S., & Bell, W. (1990). Energy expenditure during simulated karate competition. J Hum Mov Stud, 19: 69–74.
3. Beneke, R., Beyer, T., Jachner, J., Erasmus, J., & Hütler, M. (2004). Energetics of Karate Kumite. Eur J Appl Physiol, 92: 518-523.
4. Bompa, T. (2001). Periodization - training theory and methodology. Toronto: York University.
5. Bussweiler, J., & Hartmann, U. (2012). Energetics of basic Karate Kata. European Journal of Applied Physiology, 112(12), 3991-3996.
6. Chaabène, H., Franchini, E., Sterkowicz, S., Tabben, M., Hachana, Y., & Chamari, K. (2015). Physiological responses to karate specific activities. Science & Sports.
7. Chaabène, M. H., Hachana, Y., Franchini, E., Mkaouer, B., & Chamari, K. (2012). Physical and Physiological Profile of Elite Karate Athletes. Sports Medicine, 42(10), 829-843.
8. Cicović, B. (2014). Efekti kondicionog treninga na razvoj anaerobno-alaktatne izdržljivosti i funkcionalnih sposobnosti kod džudista. Sport i zdravlje.

9. Conconi, F., Ferrari, M., Ziglio, P. G., Droghetti, P., & Codeca, L. (1982). Determination of the anaerobic threshold by a non-invasive field test in runners. Journal of Applied Physiology, 52 (4): 869–73.
10. Costa, P. B., Medeiros, H. B., & Fukuda, D. H. (2011). Warm-up, stretching, and cool-down strategies for combat sports. Strength & Conditioning Journal, 33(6), 71-79.3.
11. Doria, C., Veicsteinas, A., Limonta, E., Maggioni, M.A., Aschieri, P., Eusebi, F., Fanò, G., & Pietrangelo, T. (2009). Energetics of Karate (Kata and Kumite Techniques) in top-level Athletes. Eur J Appl Physiol, 107:603-610.
12. Donnelly, J. E., Blair, S. N., Jakicic, J. M., Manore, M. M., Rankin, J. W., & Smith, B. K. (2009). American College of Sports Medicine Position Stand. Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults. American College of Sports Medicine. Medicine and Science in Sports and Exercise, 41(2):459-471
13. Fritzsche, J., & Raschka, C. (2007). Sportanthropologische Untersuchungen zur Konstitutionstypologie von Elitekarateka/Sports anthropological investigations on somatotypology of elite karateka. Anthropologischer Anzeiger, 317-329.
14. Francescato, M. P., Talon, T., & Di Prampero, P. E. (1995). Energy cost and energy sources in karate. European Journal of Applied Physiology and Occupational Physiology, 71(4), 355-361.
15. Gloc, D., Plewa, M., & Nowak, Z. (2012). The effects of kyokushin karate training on the anthropometry and body composition of advanced female and male practitioners. Journal of Combat Sports and Martial Arts 1(2); Vol. 3, 63-71.
16. Giampietro, M., Pujia, A., & Bertini, I. (2003). Anthropometric feature and body composition of young athletes practicing karate at high and medium competitive level. Acta Diabetol 40: 145-148.
17. Hadžović-Džuvo, A., & Kapur, E. (2011). Osnove anatomije i fiziologije čovjeka sa fiziologijom sporta, Fakultet sporta i tjelesnog odgoja, Univerzitet u Sarajevu.
18. Haywood, K.M., & Getchell, N. (2019). The synergetic, probabilistic pathways of typical motor development. Book Understanding Motor Behaviour in Developmental Coordination Disorder, p. 17.
19. Imamura, H., Yoshimura, Y., Uchida, K., Nishimura, S., & Nakazawa, A.T. (1998). Maximal Oxygen Uptake, Body Composition and Strength of Highly Competitive and Novice Karate Practitioners. Journal of Physiological Anthropology, Apll Human Sci, 17(5): 215-218.
20. Jukić, J., Katić, R., & Blaţević, S. (2012). Impact of Morphological and Motor Dimensions on Success. Coll Antropol, 36(4): 1247–1255.
21. Kapo, S., Čović, N., Doder, I., Kajmović, H., Smajlović, N., & Radjo, I. (2017). Muscle peak force output effected by different warmup procedures in combat sports athletes. 8th International Scientific Conference on Kinesiology, 2017, Opatija, Croatia 366
22. Kapo, S., Smajlović, N., Kajmović, H., Čović, N., Ćirić, A., Ćutuk, M., & Bejdić, A. (2016). Effects of different stretching protocols on knee muscles strength and power parameters measured by Biodex dynamometer. Tehnical Gazzete, 23(1).
23. Kapo, S., Radjo, I., Kajmović, H., Čović, N., & Kovač, S. (2015). Programmed training effects on body composition indicators of female karate athletes from 12 to 14 years of age. Archives of Budo Science of Martial Arts and Extreme Sports, 11(1):163-168.
24. Kapo, S., Covic, N., Smajlovic, N., Kajmovic, H., Kapo, A., & Topalovic A. (2015). Body Composition and Balance Measured by Tanita and BBS - The Importance for Competitive Success of Karate Athletes. Technics Technologies Education Management, 10 (1).
25. Kapo, S. (2015). Efikasnost izvođenja tehnika i taktika u karateu na osnovu utjecaja bazično-motoričkih sposobnosti. Fakultet sporta i tjelesnog. Sarajevo.
26. Kapo, S. (2011). Karate- pronađi svoj put. Fakultet sporta i tjelesnog. Sarajevo.
27. Kapo, S., & Cikatić, B. (2010). K-1 - Put do vrha. Fakultet sporta i tjelesnog odgoja. Sarajevo.
28. Kautzner, N. M. J. (2014). Evidências científicas sobre a luta do Karatê Shotokan / Scientific evidence about the fight of the shotokan karate of competition. Revista Brasileira de Prescrição e Fisiologia do Exercício, 8.
29. Koropanovski, N. (2012). Karakteristike neuromišićne funkcije vrhunskih karatista različite specijalizacije. Doktorska disertacija, Univerzitet u Beogradu.
30. Koropanovski, N., Berjan, B., Boţić, P., Pazin, N., Sanader, A., & Jarić, S. (2011). Anthropometric and Physical Performance Profiles of Elite Karate Kumite and Kata Competitors. Journal of Human Kinetics, 30: 107-114.
31. Koropanovski, N., Dopsaj, M., & Jovanović, S. (2008). Characteristics of pointing actions of top male competitors in karate at world and European level. Brazilian Journal of Biomotricity, 2 (4): 241-251.
32. Kuleš, B. (1985). Povezanost nekih antropometrijskih mjera i uspjeha u karate borbi Kineziologija, 17(2).
33. Kuleš, B. (1998). Trening karatista. Zagreb: "Grafikon".

34. Lehmann, G., & Jedliczka, G. (1998). Untersuchungen zur Bestimmung und Entwicklung eines sportartspezifischen konditionellen Anforderungsprofils im Hochleistungstraining der Sportart Karate-Kumite. [Investigations on the determination and development of a sport-event-specific profile of the physical requirements in high-performance training for Karate-Kumite]. Leistungssport, 28(3): 56–61.

35. Malacko, J., & Radjo, I. (2004). Tehnologija sporta I sportskog treninga. Fakultet sporta i tjelesnog odgoja. Sarajevo

36. Parizková, J., & Roth, Z. (1972). The assessment of depot fat in children from skinfold thickness measurements by Holtain (Tanner-Whitehouse) caliper. Hum Biol. 44 (4):613-20.

37. Rutkowski, T., Sobiech, K. A., & Chwałczyńsk, A. (2020). The effect of 10 weeks of karate training on the weight body composition and FFF index of children at the early school age with normal weight and overweight. Archives of Budo 2020, 16.

38. Ratamess, N. A. (2012). ACSM's foundations of strength training and conditioning. American College of Sports Medicine. Philadelphia, Pa.: Wolters Kluwer/Lippincott Williams & Wilkins, cop.

39. Ravier, G., Grappe, F., & Rouillon, J. D. (2003). Comparison between the maximal variables of velocity, force and power from two analysis methods in the functional assessment of karate. Sci Sports, 18: 134-40.

40. Ravier, G., Dugue´ , B., Grappe, F., & Rouillon, J. D. (2006). Maximal accumulated oxygen deficit and blood responses of ammonia, lactate, and pH after anaerobic test: a comparison between international and national elite karate athletes. Int J Sports Med, 27: 810–817.

41. Ravier, G., Dugué, B., Grappe, F., & Rouillon, J. D. (2009). Impressive anaerobic adaptations in elite karate athletes due to few intensive intermittent sessions added to regular karate training. Scandinavian Journal of Medicine & Science in Sports, 19(5), 687-694.

42. Sertić, H., Vidranski, T., & Segedi, I. (2009). Terenski testovi za procjenu specifičnih motoričkih sposobnosti karataša u saq treningu. 8. Godišnja međunarodna konferencija kondicijska priprema sportaša. Zagreb, Hrvatska, 26.-27.02.2010.

43. Swain, P., & Franklin, B. (2006). Comparison of cardioprocective benefits of vigorous versus moderate intensity aerobic exercise. Am J Cardiol, 97: 141-147.

44. Sterkowicz, S. (1992). Sprawność fizyczna karateków. [Physical fitness of karate athletes.](English and in Polish). Physical Education and Sport, (1-2), 59-67.

45. Sterkowicz-Przybycień, K. L., & Żarów, R. (2005). Metody oceny budowy somatycznej a wielkość otłuszczenia młodych mężczyzn uprawiających sporty walki. Annales Universitatis Mariae Curie-Skłodowska Lublin - Polonia; 60, 16 (511): 261- 266.

46. Tabata, I., Nishimura, K., Kouzaki, M., Hirai, Y., Ogita, F., Mijachy, M., & Yamamoto, K. (1996). Effects of moderate-intensity endurance and high-intensity intermittent training on anaerobic capacity and VO2 max. Medicine and Science in Sports and Exercise, 28, 1327-1330.

47. Wojtek, J., Chodzko, Z., Proctor, D. N., Singh, M. A. F., Minson, C. T., Nigg, C. R., George J., Salem, G. J., & Skinner, J. S. (2009). Exercise and physical activity for older adults American College of Sport Medicine Position Stand, Medicine & Science in Sports & Exercise, 41(7):1510-30

48. Škof, B. (2003). Metodika treninga izdržljivosti (aplikacija na trening trčanja na srednje i duge staze) U D. Milanović i I. Jukić (ur.), Kondicijska priprema sportaša, zbornik radova, Zagreb, 2003. Zagreb: Kineziološki fakultet.

EFEKTI PROGRAMSKIH SADRŽAJA NA KOMPOZICIJU TIJELA, FUNKCIONALNE SPOSOBNOSTI I BRZINU IZVOĐENJA TEHNIČKIH ELEMENATA U KARATEU

Cilj ovog istraživanja je utvrditi efekte programskih sadržaja na kompoziciju tijela, funkcionalne sposobnosti i brzinu izvođenja tehničkih elemenata u karateu. Uzorak na kojem je provedeno istraživanje predstavlja 15 ispitanika muškog spola, starosti između 15 i 18 godina sa najmanje tri godine bavljenja karateom. Uzorak varijabli za ovo istraživanje sačinjavale su slijedeće varijable: visina, težina, fleksibilnost, kožni nabor stomaka, kožni nabor bicepsa, kožni nabor tricepsa, kožni nabor leđa-skapula, masna tjelesna masa u %, nemasna tjelesna masa, masna tjelesna masa, kizami tsuki, gyaku tsuki, lijevi mawashi geri, desni mawashi geri, maksimalna frekvencija srca, brzina trčanja pri kojoj se probija anaerobni prag, oporavak srčane frekvencije i TT time - sveukupno vrijeme Conconi testa. Program treninga je trajao 6 sedmica sa ukupno 18 treninga. Pet sedmica radila su se 3 treninga sedmično, a šestu sedmicu četiri treninga. Korištena je kontinuirana, diskontinuirana i intervalna metoda. Program se provodio uz strogu kontrolu opterećenja putem polarove pulsimetrije. Rezultati višestruke analize varijanse su pokazali da je došlo do statistički značajnih efekata pozitivnih transformacija, a uslijed realiziranog programa u trajanju od šest sedmica, na kompoziciju tijela i brzinu izvođenja pojedinačnih pokreta u karateu dok tih promjena nije bilo kod funkcionalnih sposobnosti. Na osnovu rezultata ovog istraživanja, realizirani plan i program je pozitivno djelovao na transformaciju karatista kao i efekte o kojima treba voditi računa u procesu planiranja i programiranja u karate treningu.

Ključne riječi: borilački sport, izvedba, programiranje, transformacija

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DISRUPTION OF SPECIFIC TRAINING CONTINUITY AMONG YOUNG FOOTBALL PLAYERS DUE TO THE COVID-19 PANDEMIC

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ABSTRACT

The global crisis caused by the COVID-19 pandemic has affected the training of football players, disrupting its continuity as one of the basic principles of training. In this regard, the aim of this paper is to determine the fitness level of young football players before and after the lockdown caused by the COVID-19 pandemic, which led us to new findings in specific football training and sports training theory. The subjects in this study were young Serbian football players (15-16 years of age, N = 11). All players were tested for assessment of speed, agility, jumping ability, and endurance before and after the lockdown caused by COVID-19. The results indicate that there is no significant difference in speed at 5, 10, 20, and 30m, in the jumping ability measured by the countermovement jump with and without arm swing, nor in the endurance measured by the YO-YO intermittent recovery test - Level 1. The only statistically significant differences were found in the zig-zag agility test, both with and without dribbling the ball ($p < 0.05$). In conclusion, it can be argued that individual programmes that were the main content of the activities during lockdown could replace systematic football training in terms of developing and sustaining general abilities, such as speed, endurance and power, but it is impossible to compensate for specific team training in terms of specific abilities such as agility.

Keywords: correlations, regression, basketball players

INTRODUCTION

Football is a team sport and is defined by clear rules of competition within which there is a complex action of an individual and a group of players who want to achieve the aims of the football game. Until recently, physical preparation was equated with athletic training in individual sports, while today, it is an inseparable part of football specific training with the ball.

A systematic, integral approach to football fitness training should provide a higher quality of performance, and not just to maximise performance and sustain the highest work rates. Additionally, the aim of fitness training is to keep the players injury free, making them capable of playing competitive games every week (sometimes 2 per week) for most of the season (Walker & Hawkins, 2018).

One of the most important principles of sports training, especially fitness training, is the continuity of the training process. Respect for the principles of continuity in training contributes to the economic exploitation of natural potentials, preservation of the level of training and adaptation, as well as preservation of health and longevity in sport. Sports training is built in such a way to provide positive effects, avoid unjustified interruptions of the training process, and minimise training regression.

One of the basic assumptions of the continuity principle is the optimisation of the effort (load) and rest (recovery) transition. There are periods in the training plan (transition period) when it is desirable for athletes to reduce the level of the training load, rest completely and prepare for the next season (Suarez-Arrones et al., 2019). The athlete should start the new preparatory phase only when fully recovered from the previous competitive season (Bompa & Buzzichelli, 2019). If the athlete initiates a new preparatory phase without full recovery, it is likely that performances will be impaired in future competitive cycles, and the risk of injury will increase (Gabbett & Domrow, 2007; Bisciotti et al., 2020; Woods et al., 2002).

The transition phase, often inappropriately called the off-season, links two annual training plans. This phase facilitates psychological rest, relaxation, and biological regeneration while maintaining an acceptable level of general physical preparation (40-50% of the competitive phase). Training should be low key; all loading factors should be reduced with the main training components centring on general training with minimal, if any, technical or tactical development (Bompa & Buzzichelli, 2019, Reverdito et al., 2020).

The transition phase is the planned period of reduction in training activity and usually lasts 4-5 weeks (Silva et al., 2016). On the other hand, athletes often experience unplanned interruptions in the training process due to illness, injury or other factors, which can lead to a reduction in their usual level of physical activity (Mujika & Padilla, 2000).

The duration of this phase, and especially the load used during it, will greatly influence the changes in cardiorespiratory, muscular and metabolic parameters. In youth athletes, since young people are more active in their daily activities, the same effects are not expected as in adults, but the performance certainly decreases. Surely, changing the type of activity can lead to maintaining the level of physical activity, reducing the negative effects of the transition period.

In this sense, in early 2020, the world faced a global threat, called COVID-19 (coronavirus disease 2019). People were forced to stay at home unless there was a compelling reason. Professional football players found themselves in a non-specific situation in which they had to stop their professional activities and stay in their homes where they had limited training conditions (Eirale et al., 2020; Corsini et al., 2020). Restricted conditions have been exacerbated by the closure of fitness centres and other exercise areas (Cigorvski et al., 2020).

Although this break in training can be identified with the classic transition phase, there are some differences that make it non-specific. All of this affected the players' fitness level when they have returned to specific training

Accordingly, individual programmes are the basis of the transition phase and additional content throughout the competition phase. The goal of these programmes is to solve general preparation tasks and to prevent injuries. There is some research evidence that all components of physical fitness in football players (endurance, speed, agility) have been decreased after transition phase (Helgerud et al., 2001; Casajus, 2001; Caldwell et al., 2009). It is the individual programme that should compensate for the negative effects caused by the lack of team training.
All things considered, the problem of the lack of team training caused by the COVID-19 pandemic and the effects on the level of physical performance arise. In this regard, the aim of this paper is to determine the differences in the fitness level of young football players before and after the lockdown caused by the COVID-19 pandemic, which led us to new findings in specific fitness training of football players and the sports training theory itself.

METHODS

PARTICIPANTS

The sample of the study consisted of 11 (N = 11) young Serbian football players (age group U16, 15-16 years of age). None of the participants reported any medical problem or recent injuries which could affect the test results. They were also instructed to avoid any strenuous activities before testing.

PROCEDURES

Body height was assessed with a standard Martin anthropometer. Body mass, muscle mass and body fat percentage were assessed using a bioelectric impedance method (In Body 720; USA).

The participants performed maximal 30 m sprint with 5 m, 10 m and 20 m split time. Therefore, the results of the 5 m sprint (5m), 10 m spring (10m), 20m sprint (20m), and 30 m sprint (30m) were obtained for further analysis. Participants were instructed to start when they are ready (time recording starts when the first IR beam is cut) and run as fast as possible. Timings were taken using a set of infrared light gates (PAT 02, Uno-Lux NS, Serbia).
Participants were tested on 2 types of vertical jumps, countermovement jump (CMJ) and countermovement jump with arm swing (CMJa). Concerning the CMJ, the subjects were instructed to perform an unconstrained maximum vertical jump from a standing upright position that included the initial counter movement, while keeping their hands akimbo. The countermovement jump with arm swing (CMJa) was performed in the same manner as CMJ, whereas natural arm swing was allowed.

Both jumps were performed on the ergo jump sensor mat (PAT 02, Uno-Lux NS, Serbia), whereas maximal jump height was chosen as a variable of interest.

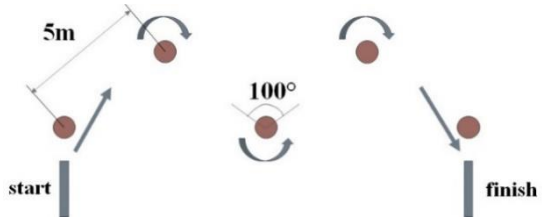

Fig. 1. Illustration of the zig-zag test course

Zig-zag tests were chosen to assess agility, i.e., the speed of change in direction without the ball (ZZ) and with the ball (ZZb), respectively. A zigzag course consisted of a 4 x 5 m section set out at 100° angles (Fig. 1). The selection of this test was based on rapid acceleration, deceleration and balance control required for short running time, which represented the test result. The ability to control the ball while changing direction was assessed through the zig-zag test with the ball (ZZb). The subject was instructed to run with the ball as fast as possible along the same route used in the previous test (Mirkov et al., 2008; Little & Williams, 2005).

The Yo-Yo intermittent recovery test – Level 1 (Krustrup et al., 2003) was used for endurance testing. The Yo-Yo intermittent recovery test (Yo-Yo IRT1) consists of repeated 2 x 20 m runs back and forth between the starting, turning, and finishing line at a progressively increased speed controlled by audio bleeps from a tape recorder. Between each running bout, the subjects have a 10 s active rest period, consisting of 2 x 5 m of walking (Fig. 2). When the subjects have failed to reach the finishing line in time twice, the distance covered is recorded and represents the test result.

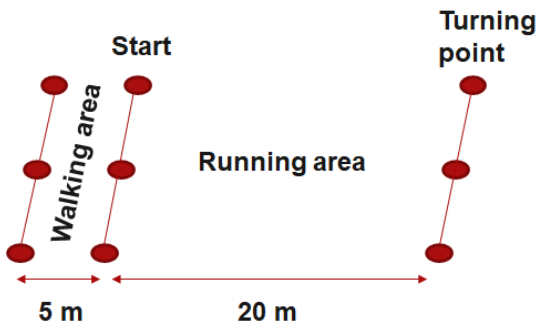

Fig. 2. Illustration of the Yo-Yo intermittent recovery test course

EXPERIMENTAL PROTOCOL

Each participant completed 2 regular testing sessions. The first testing was performed during the winter preparation period (mid-February), two weeks before the start of the competition and one month before lockdown due to the COVID-19 pandemic.

The second testing was performed after the end of the state of emergency (mid-May), three months after the first testing and two months after the beginning of the lockdown.

Both testing sessions included the anthropometric measurements as well as a verbal explanation of the upcoming tests. The second part of testing consisted of several tasks for the assessment of motor abilities: speed, agility, jumping ability (leg muscle power), and endurance. The sessions began with a suitable warm-up procedure for football players (15 min of callisthenic and dynamic stretching). Warm-up was followed by speed tests, then agility tests (ZZ and ZZb, respectively), leg power (CMJ and CMJa, respectively), and finally the endurance test (Yo-Yo IRT1).

All tests (except for the Yo-Yo IRT1) were performed 3 times, where the first trial was a trial attempt. Furthermore, the best out of two trials was taken for further analysis. Due to the size of the test group (11 players) performing the test one after the other, fatigue was never an issue.

STATISTICAL ANALYSIS

Prior to all statistical tests, descriptive statistics were calculated as mean and standard deviation. None of the variables revealed deviations from normality (Kolmogorov-Smirnov test; all $p \geq 0.312$). The first step of analysis was to explore the impact of the break of specific football training on motor abilities in general (speed, agility, leg power) using the Multivariate ANOVA, except for endurance (single variable) which was measured using a paired t-test. When significant F-ratios (in MANOVA) were observed, post hoc comparisons of each separate test were analysed using a Bonferroni multiple-comparison test.

Alpha level was set at $p \leq 0.05$. All statistical tests were performed using Microsoft Office Excel 2007 (Microsoft Corporation, Redmond, WA, USA) and SPSS 20 (IBM, Armonk, NY, USA).

RESULTS

Participants' anthropometric characteristics are depicted in Table 1. No significant differences between participants were observed regarding body height, body mass, and BMI. The only significant difference between the groups was observed in body fat percentage, where participants had a lower body mass percentage after the break caused by the COVID-19 pandemic.

Table 1: Participants' age and anthropometric characteristics presented as mean ± standard deviation.

Variables	Pre-test	Post-test
Body height (cm)	175.1 ± 5.1	175.8 ± 5.3
Body mass (kg)	67.4 ± 6.3	67.9 ± 6.5
BMI (kg/m^2)	22.0 ± 1.1	21.9 ± 1.3
Body fat (%)	11.6 ± 2.7	8.7 ± 2.2*

N = number of participants; BMI = body mass index; * significantly higher from initial testing at $p < 0.05$.

Regarding the speed ability (Fig. 1), the MANOVA performed on a combination of sprint tests did not show a significant main effect ($F = 0.434$; $p = 0.782$; Wilks' Lambda = 0.907; partial eta squared = 0.093).

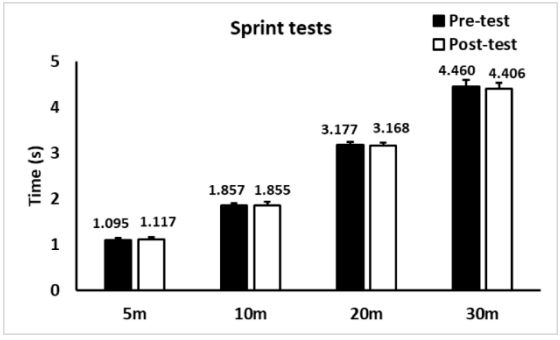

Fig. 1. Results from the pre-test and post-test obtained in sprint tests. Data showed as mean ± standard deviation. * Significant differences at $p < 0.05$.

Regarding the agility (Fig. 2), the MANOVA performed on a combination of agility tests showed a significant main effect ($F = 17.334$; $p < 0.001$; Wilks' Lambda = 0.354; partial eta squared = 0.646). In particular, both dependent variables (ZZ and ZZb) showed significant differences in post-test relative to pre-test (ZZ: $F = 31.404$, $p < 0.001$, partial eta squared = 0.611; ZZb: $F = 9.770$, $p = 0.005$; partial eta squared = 0.328).

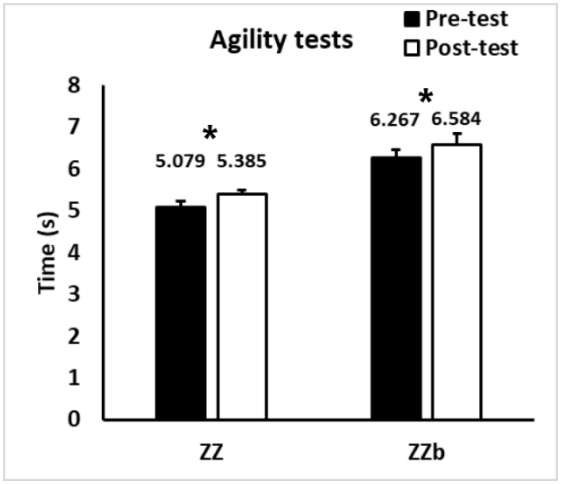

Fig. 2. Results from the pre-test and post-test obtained in agility tests. Data showed as mean ± standard deviation. * Significant differences at $p < 0.05$.

Regarding the leg power (Fig. 3), the MANOVA performed on a combination of jump tests did not show a significant main effect ($F = 1.285$, $p = 0.300$, Wilks' Lambda = 0.881; partial eta squared = 0.119).

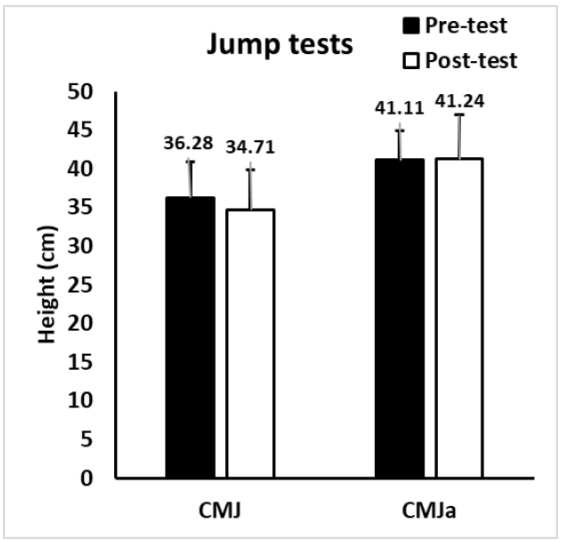

Fig. 3. Results from the pre-test and post-test obtained in jumping tests. Data showed as mean ± standard deviation. * Significant differences at $p < 0.05$.

Regarding the endurance (Fig. 4), the t-test did not show a significant effect ($t = 0.375$, $p = 0.716$, Wilks' Lambda = 0.907; partial eta squared = 0.093).

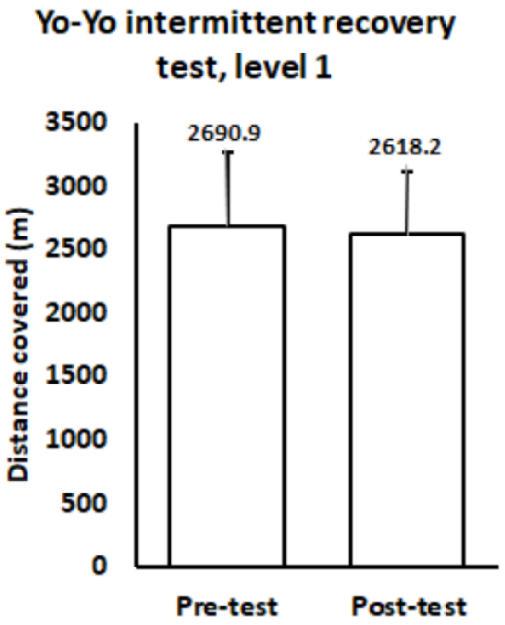

Fig. 4. Results from the pre-test and post-test obtained in Yo-Yo intermittent recovery test. Data showed as mean ± standard deviation. * Significant differences at $p < 0.05$.

DISCUSSION

This study investigated changes in the young football players' fitness level after the lockdown caused by the COVID–19 pandemic. The results show that the break in specific team training caused by lockdown did not affect the level of endurance, speed or power, but did affect the level of agility.

As we said before, there are a few reasons that make this break due to the COVID-19 lockdown specific. First of all, the regular off-season period finished just a few weeks before the start of the lockdown, and most young football teams were near the end of the preparation or beginning of the competition period. Second, the state of emergency lasted for almost two months, which in connection with the first reason, gives a period of almost 3 months without team training in the first third of the calendar year. At the end, there is no off-season period before this one, characterised by lockdown (Eirale et al., 2020). All of this affected the players' fitness level when they have returned to team training.

First of all, we must emphasise that no significant differences in morphological characteristics were observed, which is not in line with previous studies (Jukic et al., 2020; Buchheit et al., 2015; King et al., 2020). From that point, we can conclude that the examined effects are not a consequence of changes in body dimensions. The only significant change in morphological characteristics was observed in body fat, which can be explained by the relatively lower intensity of individual training programmes (Melchiori et al., 2014; Peña et al., 2021; Andreato et al., 2020).

Although a decrease in physical abilities was observed in previous studies after a transitional phase lasting 4 weeks or more (Mujika & Padilla, 2001; Lemmer et al., 2000; Melchiorri et al., 2014), we did not observe significant changes in basic abilities such as speed, power and endurance (Fig. 1, 3 and 4). This can be explained by the content of individual programmes, which mainly consist of basic fitness exercises, such as running and gym exercises (Peña et al., 2021).

Another reason could be the fact that the lockdown occurred at the very beginning of the competition period, which can result in a high level of general abilities at the beginning of a new break, which certainly affects the level of ability after the break (Eirale et al., 2020; Rodríguez-Fernández et al., 2018).

Also, the participants in this study were young football players aged U16, who were generally not endangered by the SARS-CoV-2 virus during the lockdown. For this reason, it can be said that, in this study, we do not have participants who could have the consequences of the disease, but only those who lacked systematic training over a long period of time (Sarto et al., 2020; Chen et al., 2020).

The only ability that is particularly affected by lockdown in our study is agility. Agility can be described as the most specific ability in team sports (Little & Williams, 2005; DiSalvo et al., 2007), which can differentiate players both by the competitive level (Mujika et al., 2009) and by the position in the team (Fiorilli et al., 2017). Also, agility is conditioned by a number of muscular characteristics that cannot be described only by the abilities treated in this study. Different muscular strength qualities, functional movements and specific team training are just some of the factors that affect this ability (Paul et al., 2016).

Precisely, the lack of specific team training is one of the main causes of decreasing agility in our study. The main content of specific training that affects agility are small-sided games (3 vs. 3 to 7 vs. 7). Small-sided games seem to be a very effective tool to improve physical capacities of the soccer players, especially agility (Chaouachi et al., 2014; Rampinini et al., 2007).

As we said above, the individual programmes, which were the only training contents during the lockdown, were focused exclusively on general physical abilities, with little stimulus directed on agility.

In the end, this study has certain limitations. The majority of the recent studies deal with the impact of

COVID-19 on physiological changes more than sport performance directly (Sarto et al., 2020; Bisciotti et al., 2020; Peña et al., 2021). Accordingly, although it turned out that, for example, endurance evaluated by Yo-Yo IRT1 did not change significantly, it would be important to establish the level of different physiological parameters measured by the same or some other testing protocol (e.g., heart rate, anaerobic threshold and aerobic efficiency). Also, our sample consisted of high-level U16 players who received individual programmes from their club, and we cannot determine how the same mode of operation affected players with a lower performance level.

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REFERENCES

1. Andreato, L. V., Coimbra, D. R., & Andrade, A. (2020). Challenges to Athletes During the Home Confinement Caused by the COVID-19 Pandemic. Strength and Conditioning Journal, 42(3), 1-5.
2. Bisciotti, G. N., Eirale, C., Corsini, A., Baudot, C., Saillant, G., & Chalabi, H. (2020). Return to football training and competition after lockdown caused by the COVID-19 pandemic: medical recommendations. Biology of Sport, 37(3), 313–319.
3. Bompa, T. O., & Buzzichelli, C. (2019). Periodization – Theory and methodology of training (6th edition). Champaign, IL: Human Kinetics.
4. Buchheit, M., Morgan, W., Wallace, J., Bode, M., & Poulos, N. (2015). Physiological, psychometric, and performance effects of the Christmas break in Australian football. International journal of sports physiology and performance, 10(1), 120–123.
5. Caldwell, B. P., & Peters, D. M. (2009). Seasonal variation in physiological fitness of a semiprofessional soccer team. Journal of strength and conditioning research, 23(5), 1370–1377.
6. Casajús, J. A. (2001). Seasonal variation in fitness variables in professional soccer players. The Journal of sports medicine and physical fitness, 41(4), 463–469.
7. Chaouachi, A., Chtara, M., Hammami, R., Chtara, H., Turki, O., & Castagna, C. (2014). Multidirectional sprints and small-sided games training effect on agility and change of direction abilities in youth soccer. Journal of strength and conditioning research, 28(11), 3121–3127.
8. Chen, P., Mao, L., Nassis, G. P., Harmer, P., Ainsworth, B. E., & Li, F. (2020). Coronavirus disease (COVID-19): The need to maintain regular physical activity while taking precautions. Journal of sport and health science, 9(2), 103–104.
9. Cigorvski, V., Škovran, M., Fang, H., Rupčić, T., & Knjaz, D. (2020). Differences in the level of physical activity during the lockdown due to the COVID–19 pandemic in young adults. Sport Science, 13(2), 9-15
10. Corsini, A., Bisciotti, G., Eirale, C., & Volpi, P. (2020). Football cannot restart soon during the COVID-19 emergency! A critical perspective from the Italian experience and a call for action. British Journal of Sports Medicine, 54(20), 1186-1187
11. Di Salvo, V., Baron, R., Tschan, H., Calderon Montero, F. J., Bachl, N., & Pigozzi, F. (2007). Performance characteristics according to playing position in elite soccer. International journal of sports medicine, 28(3), 222–227.
12. Eirale, C., Bisciotti, G., Corsini, A., Baudot, C., Saillant, G., & Chalabi, H. (2020). Medical recommendations for home-confined footballers' training during the COVID-19 pandemic: from evidence to practical application. Biology of Sport, 37(2), 203–207.
13. Fiorilli, G., Iuliano, E., Mitrotasios, M., Pistone, E. M., Aquino, G., Calcagno, G., & di Cagno, A. (2017). Are Change of Direction Speed and Reactive Agility Useful for Determining the Optimal Field Position for Young Soccer Players?. Journal of sports science & medicine, 16(2), 247–253.
14. Gabbett, T. J., & Domrow, N. (2007). Relationships between training load, injury, and fitness in sub-elite collision sport athletes. Journal of sports sciences, 25(13), 1507–1519.
15. Helgerud, J., Engen, L. C., Wisloff, U., & Hoff, J. (2001). Aerobic endurance training improves soccer performance. Medicine and science in sports and exercise, 33(11), 1925–1931.
16. Jukic, I., Calleja-González, J., Cos, F., Cuzzolin, F., Olmo, J., Terrados, N., Njaradi, N., Sassi, R., Requena, B., Milanovic, L., Krakan, I., Chatzichristos, K., & Alcaraz, P. E. (2020). Strategies and Solutions for Team Sports Athletes in Isolation due to COVID-19, 8(4), 56.

17. King, A. J., Burke, L. M., Halson, S. L., & Hawley, J. A. (2020). The Challenge of Maintaining Metabolic Health During a Global Pandemic. Sports medicine 50(7), 1233–1241.

18. Krustrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., Pedersen, P. K., & 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.

19. Lemmer, J. T., Hurlbut, D. E., Martel, G. F., Tracy, B. L., Ivey, F. M., Metter, E. J., Fozard, J. L., Fleg, J. L., & Hurley, B. F. (2000). Age and gender responses to strength training and detraining. Medicine and science in sports and exercise, 32(8), 1505–1512.

20. Little, T., & Williams, A. G. (2005). Specifity of acceleration, maximum speed, and agility in professional soccer players. Journal of Strength and Conditioning Research, 19, 76-78

21. Melchiorri ,G., Ronconi, M., Triossi, T., Viero, V., De Sanctis, D., Tancredi, V., Salvati, A., Padua, E., & Alvero Cruz, J. R. (2014). Detraining in young soccer players. Journal of Sports Medicine and Physical Fitness, 54(1), 27-33

22. Mirkov, D., Nedeljkovic, A., Kukolj, M., Ugarkovic, D., & Jaric, S. (2008). Evaluation of the reliability of soccer-specific field tests. Journal of Strength and Conditioning Research, 22(4), 1046-1050

23. Mujika, I., & Padilla, S. (2000). Detraining: Loss of Training-Induced Physiological and Performance Adaptations. Part I. Short Term Insufficient Training Stimulus. Sports Medicine, 30(2), 79-87

24. Mujika, I., & Padilla, S. (2001). Muscular characteristics of detraining in humans. Medicine and science in sports and exercise, 33(8), 1297–1303.

25. Mujika, I., Santisteban, J., Impellizzeri, F. M., & Castagna, C. (2009). Fitness determinants of success in men's and women's football. Journal of sports sciences, 27(2), 107–114

26. Paul, D. J., Gabbett, T. J., & Nassis, G. P. (2016). Agility in Team Sports: Testing, Training and Factors Affecting Performance. Sports medicine, 46(3), 421–442.

27. Peña, J., Altarriba-Bartés, A., Vicens-Bordas, J., Gil-Puga, B., Piniés-Penadés, G., Alba-Jiménez, C., Merino-Tantiñà, J., Baena-Riera, A., Loscos-Fàbregas, E., & Casals, M. (2021). Sports in time of COVID-19: Impact of the lockdown on team activity. Apunts Sports Medicine, 56(209), 100340

28. Rampinini, E., Impellizzeri, F. M., Castagna, C., Abt, G., Chamari, K., Sassi, A., & Marcora, S. M. (2007). Factors influencing physiological responses to small-sided soccer games. Journal of sports sciences, 25(6), 659–666.

29. Reverdito, R. S., Galatti L. R., Strachan, L., Scaglia, A. J., & Paes R. R. (2020). Coaching and continuity make a difference: competence effects in a youth sport program. Journal of Physical Education and Sport, 20(4), 1964-1971.

30. Rodríguez-Fernández, A., Sánchez-Sánchez, J., Ramirez-Campillo, R., Rodríguez-Marroyo, J. A., Villa Vicente, J. G., & Nakamura, F. Y. (2018). Effects of short-term in-season break detraining on repeated-sprint ability and intermittent endurance according to initial performance of soccer player. PloS one, 13(8), e0201111.

31. Sarto, F., Impellizzeri, F. M., Spörri, J., Porcelli, S., Olmo, J., Requena, B., Suarez-Arrones, L., Arundale, A., Bilsborough, J., Buchheit, M., Clubb, J., Coutts, A., Nabhan, D., Torres-Ronda, L., Mendez-Villanueva, A., Mujika, I., Maffiuletti, N. A., & Franchi, M. V. (2020). Impact of Potential Physiological Changes due to COVID-19 Home Confinement on Athlete Health Protection in Elite Sports: a Call for Awareness in Sports Programming. Sports Medicine, 50(8), 1417-1419

32. Silva, J. R., Brito, J., Akenhead, R., & Nassis, G. P. (2016). The Transition Period in Soccer: A Window of Opportunity. Sports Medicine, 46(3), 305–313.

33. Suarez-Arrones, L., Lara-Lopez, P., Maldonado, R., Torreno, N., De Hoyo, M., Nakamura, F. Y., Di Salvo, V., & Mendez-Villanueva, A. (2019). The effects of detraining and retraining periods on fat-mass and fat-free mass in elite male soccer players. PeerJ, 7, e7466.

34. Walker, G. J., & Hawkins, R. (2018). Structuring a Program in Elite Professional Soccer. Strength and Conditioning Journal, 40(3), 72-82

35. Woods, C., Hawkins, R., Hulse, M., & Hodson, A. (2002). The Football Association Medical Research Programme: an audit of injuries in professional football-analysis of preseason injuries. British journal of sports medicine, 36(6), 436–441.

NARUŠAVANJE KONTINUITETA SPECIFIČNOG TRENINGA KOD MLADIH FUDBALERA ZBOG PANDEMIJE COVID-19

Globalna kriza izazvana pandemijom virusa COVID-19 uticala je trening fudbalera narušavajući kontinuitet kao jedan od najvažnijih principa treninga. U skladu sa tim, cilj ove studije je utvrditi nivo fizičke spremnosti mladih fudbalera prije i poslije vanrednog stanja izazvanog pandemijom virusa COVID-19, a što dovodi do novih saznanja u specifičnom fudbalskom treningu, ali i uopšteno u teoriji sportskog treninga. Ispitanici u ovoj studiji su bili mladi fudbaleri iz Srbije (uzrast 15-16 godina, N = 11). Svi igrači su testirani u cilju procjene brzine, agilnosti, skočnosti i izdržljivosti prije i poslije vanrednog stanja izazvanog pandemijom virusa COVID-19. Rezultati ukazuju da ne postoji značajna razlika u brzini na 5, 10, 20 i 30m, u skočnosti procjenjivanoj na osnovu skoka iz čučnja sa pripremom (CMJ) i skoka iz čučnja sa pripremom i zamahom rukama (CMJa), kao ni u izdržljivosti procijenjenoj na osnovu rezultata YO-YO intervalnog testa oporavka – nivo 1. Statistički značajne razlike su uočene samo u Cik-cak testu agilnosti sa i bez lopte ($p < 0,05$). Zaključno se može tvrditi da individualni programi koji su bili dominantna aktivnost tokom vanrednog stanja mogu zamijeniti sistematski fudbalski trening u pogledu razvoja i održavanja općih sposobnosti tipa brzine, izdržljivosti i snage, ali je nemoguće da nadomjeste efekte specifičnog timskog treninga u pogledu specifičnih sposobnosti kao što je agilnost.

Ključne riječi: vanredno stanje, timski trening, diskontinuitet, agilnost, učinak

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THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND SUBJECTIVE WELL-BEING IN UNIVERSITY STUDENTS

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ABSTRACT

Health is a combination of physical and mental well-being. For a person's overall health, it is important to establish a link between individual aspects of mental health and physical activity. Aiming to examine the relationship between physical activity and subjective well-being, as part of mental health, an empirical study was conducted anonymously among 586 students attending different study programmes. In addition to indicating the correlations between the examined variables, the results of the research also indicate the importance of engaging in physical activity in different ways. The obtained results can be an incentive for further research in this area, which is extremely important for preserving a person's physical and mental health, but also an incentive to increase physical activity, thus contributing to the well-being of each individual.

Keywords: physical activity, students, subjective well-being, mental health, levels of physical activity

INTRODUCTION

WHO defines physical activity "as any bodily movement produced by skeletal muscles that requires energy expenditure" (WHO, 2020). In addition to contributing to physical health, physical activity is increasingly being linked with psychological correlates that contribute to the overall life quality. Various positive aspects arising from engaging in physical activity have led to initiatives to include physical activity in one of the fundamental human rights (Kidd & Donnelly, 2000). One such researched benefit is the area of mental health that includes individual well-being. There are two opposing theories of defining well-being – subjective and objective theory. Subjective theory implies an individual's self-reflection on their life, including respecting their own preferences for certain aspects of well-being. On the other hand, objective theory implies a person's "fixed" and proven benefits regardless of their subjective significance to the person's life (Bloodworth, McNamee, & Bailey, 2012). Considering the aim of this research, the authors of this paper will explore the subjective well-being of an individual which is defined as "a good mental state including positive and negative aspects of self-reflection" (OECD Better Life Initiative, 2013). It consists of three self-reflective aspects of the individual: reflection on life, reflection on feelings, and eudaimonia (Panza et al., 2019). Recent studies examining the mentioned correlates differ in their results. Most research has shown the contribution of physical activity to subjective well-being (Wicker et al., 2015; Downward & Dawson, 2015). More in-depth research on this topic has investigated the relationship between different intensities of physical activity and subjective well-being, showing contradictory results. Research on a sample of adolescents showed that the contribution of physical activity to self-reflection on life quality is most prominent in persons who are moderately or vigorously physically active (Loprinzi, 2015; Loprinzi & Davis, 2016). Moderate intensity proved to be crucial for subjective well-being in

a sample of research conducted by Wicker and Ficker (2015), while vigorous activity was negatively correlated with subjective well-being. A study conducted by Downward and Dawson (2015) also contains non-uniform data. Participants with a low physical activity level showed the highest level of subjective well-being on the Subjective Well-Being Scale, and participants with a moderate physical activity level showed the lowest level of subjective well-being. The non-uniform results obtained so far, due to the importance of the topic, call for further research of the above issues in order to obtain consistent answers to the questions on the relationship between physical activity and subjective well-being.

PROBLEM AND AIM

The above studies showing a non-uniform answer to the question of what level of physical activity can establish a positive relationship with subjective well-being require further designing preventive and interventional mental health programmes, but also organising physical activities for young people. Consequently, the goal of the empirical research is to investigate the relationship between students' physical activity and their subjective well-being. This research was conducted anonymously among 586 students attending different study programmes in Croatia and Bosnia and Herzegovina.

METHODS

For the purposes of the research, a three-part questionnaire was used. The first part of the questionnaire included socio-demographic characteristics: gender, faculty, place of study, and grade point average in the previous year. The second part of the questionnaire was The Well Being Questionnaire (Bradley, 1994) with 22 items in which respondents assessed the extent to which individual statements relate to them on a scale of 0 to 3, where 0 meant never, up to 3 which meant always. The third part of the questionnaire was The International Physical Activity Questionnaire – Short Form (IPAQ – SF) (Craig et al., 2003). Respondents assessed their activity in the previous 7 days. Four types of the intensity of physical activity were measured: weak, moderate, energetic/vigorous, and sitting. The minimum duration of the activity was 10 minutes at a time. The empirical research was conducted during October 2021 via Google Forms. The sample consists of 586 students, including 471 (80.4%) female students and 115 (19.6%) male students. The students' study areas include: social sciences (64.7%), kinesiology (22.0%), natural sciences (5.8%), technical sciences (4.9%), humanities (2.0%), and interdisciplinary sciences (0.5%). Kinesiology is separately analysed because the physical activities of kinesiology students, due to the specifics of their study programme, differ from the activities of other students, and therefore it was interesting to examine them. With regard to their GPA from the previous academic year, students were grouped into 4 categories: freshmen (12.1%), less than 3.5 (9.4%), from 3.5 to 4.0 (20.5%), from 4.0 to 4.5 (38.9%), and over 4.5 (19.1%). The respondents include the students coming from the Republic of Croatia and Bosnia and Herzegovina, and the largest number of respondents study in Split (52.5%), Zagreb (27.1%), Mostar (7.5%), Osijek (5.0%), and elsewhere (7.9%). Descriptive analysis was used in the data analysis, which included frequencies, percentages, mean values, and standard deviations. Factor analysis and Spearman's correlation coefficient were also used. The results are presented in the table and are further explained in the text.

RESULTS AND DISCUSSION

Table 1 shows the results on the Subjective Well-Being Scale. The results of the Kaiser-Meyer-Olkin measure of sampling adequacy are 0.956, which represents very high test reliability. It should also be noted that the Bartlett's test is statistically significant ($p < 0.05$). In factor analysis, 3 factors were extracted, which after Varimax rotation with Kaiser normalisation explain a total of 58.275% of the total variance. The factors: F1 – Positive Well-Being, F2 – Depression/Anxiety, and F3 – Good Mood show very high Cronbach's Alpha value indicating the reliability of the questionnaire. The analysis also determined the high consistency of the items within the observed factor and the possibility to form the total score for the mentioned variables.

Table 1: Subjective Well-Being Scale

	F1	F2	F3	$\bar{x}$	SD	Cronbach's Alpha
F1 – Positive Well-Being				**2.17**	**.54**	**.919**
1. I feel that I am useful and needed.	**.550**	-.370		2.18	.66	
3. I find I can think quite clearly.	**.567**			**2.38**	.64	
4. My life is pretty full.	**.726**			2.31	.71	
6. I enjoy the things I do.	**.707**			2.32	.66	
13. I feel energetic, active or vigorous.	**.535**	-.303	.476	**1.91**	.76	
17. I have been happy, satisfied or pleased with my personal life.	**.735**			2.27	.77	
18. I have felt well-adjusted to my life situation.	**.736**			2.16	.76	
19. I have lived the kind of life I wanted to.	**.682**			2.06	.82	
20. I have felt eager to tackle my daily tasks or make new decisions.	**.719**			2.29	.70	
21. I have felt I could easily handle or cope with any serious problem or major change in my life.	**.660**			2.07	.72	
22. My daily life has been full of things that were interesting to me.	**.708**			1.95	.78	
F2 – Depression/Anxiety				**1.05**	**.66**	**.891**
2. I have crying spells or feel like it.		**.683**		1.09	.85	
5. I feel downhearted and blue.	-.363	**.660**		.94	.75	
7. I feel nervous and anxious.		**.710**		1.16	.86	
8. I feel afraid for no reason at all.		**.783**		1.01	.97	
9. I get upset easily or feel panicky.		**.749**		1.18	.97	
10. I feel like I'm falling apart and going to pieces.	-.311	**.700**	-.308	**.80**	.93	
14. I feel dull or sluggish.	-.390	**.528**	-.330	.95	.80	
15. I feel tired, worn out, used up, or exhausted.		**.527**	-.512	**1.27**	.82	
F3 – Good Mood				**1.85**	**.67**	**.688**
11. I feel calm and can sit still easily.	.321		**.530**	1.94	.86	
12. I fall asleep easily and get a good night's rest.			**.773**	**2.02**	.91	
16. I have been waking up feeling fresh and rested.			**.745**	**1.60**	.79	

For F1 – Positive Well-Being, the highest value of the arithmetic means of the respondents' answers is recorded for the item: I find I can think quite clearly $\bar{x}$ = 2.38 (SD = 0.64), followed by I enjoy the things I do $\bar{x}$ = 2.32 (SD = 0.66) and My life is pretty full $\bar{x}$ = 2.31 (SD = 0.71). The lowest value is recorded for the items: I feel energetic, active or vigorous $\bar{x}$ = 1.91 (SD = 0.76) and My daily life has been full of things that were interesting to me $\bar{x}$ = 1.95 (SD = 0.78). This factor shows the participants' self-reflection on their positive well-being. Through participants' insight into their own feelings, life satisfaction, and eudaimonia, we gained insight into key aspects of subjective well-being (Panza et al., 2017).

The highest value of the arithmetic means in F2 – Depression/Anxiety is visible in the items: I feel tired, worn out, used up, or exhausted $\bar{x}$ = 1.27 (SD = 0.82) and I get upset easily or feel panicky $\bar{x}$ = 1.18 (SD = 0.97). For the items: I feel like I'm falling apart and going to pieces $\bar{x}$ = 0.80 (SD = 0.93) and I feel downhearted and blue $\bar{x}$ = 0.94 (SD = 0.75), we notice the lowest values. The responses in this section reveal depressive and anxiety factors. The importance of these factors is manifested in the constant increase in depression and anxiety both in Croatia and in the world. In Croatia, from 2014 to 2015, 5.1% of men and 6.2% of women "suffered" from depression, while even 10.3% of the Croatian population have mild to moderate depressive symptoms (HZJZ, 2017).

For F3 – Good Mood in the item I feel calm and can sit still easily, we record $\bar{x}$ = 1.94 (SD = 0.86), while in the item I fall asleep easily and get a good night's rest $\bar{x}$ = 2.02 (SD = 0.91), and in the item I have been waking up feeling fresh and rested $\bar{x}$ = 1.60 (SD = 0.79). This factor examines the mood of the respondents. Mood, mostly positive, is considered a part of and a significant contribution to an individual's subjective well-being (Otto & Smits, 2011).

Analysing the total values of the factors, we notice that in F1 – Positive well-being $\bar{x}$ = 2.17 (SD = 0.54), in F2 – Depression/Anxiety $\bar{x}$ = 1.05 (SD = 0.66), and in F3 – Good mood $\bar{x}$ = 1.85 (SD = 0.67). These factors give an overall image of the factors that positively or negatively affect the person's subjective well-being. Such results are certainly encouraging because the participants are young people, and it is extremely important that they are positive at this age, as indicated by the results. Knowing that depression and anxiety (Teychenne, 2008), as well as mood (Otto & Smits, 2011), can be influenced, it is important to look at factors that can establish a positive correlation with subjective well-being and contribute to a person's mental health in general.

Table 2 shows the results on The Physical Activity Scale. Vigorous Physical Activity includes: swimming, weight lifting, fast cycling, aerobics, and similar activities, while Moderate Physical Activity includes: lifting certain lighter loads, regular cycling, playing tennis, etc. Walking implies walking for at least 10 minutes in the previous 7 days.

Table 2: The Values of the Intensity of Physical Activity

		N	%
Vigorous Physical Activity	Inactive	340	58.1%
	Minimally Active	183	31.3%
	HEPA Active *	62	10.6%
	Total	585	100.0%
Moderate Physical Activity	Inactive	367	62.7%
	Minimally Active	190	32.5%
	HEPA Active	28	4.8%
	Total	585	100.0%
Walking	Inactive	180	30.8%
	Minimally Active	285	48.7%
	HEPA Active	120	20.5%
	Total	585	100.0%
Total Physical Activity	Inactive	63	10.8%
	Minimally Active	252	43.1%
	HEPA Active	270	46.2%
	Total	585	100.0%

* People who exceed the minimum public health physical activity recommendations and are accumulating enough activity for a healthy lifestyle.

An analysis of the values of Vigorous Physical Activity reveals that 58.1% of the participants are inactive, 31.3% are minimally active, and 10.6% are HEPA active. As for Moderate Physical Activity, inactivity has the highest values in 62.7% of respondents, 32.5% are minimally active, while 4.8% are HEPA active. When it comes to Walking, 30.8% are inactive, 48.7% minimally active, and 20.5% HEPA active. The results of Total Physical Activity indicate that the largest number of respondents are HEPA active, 46.2%, 43.1% are minimally active, and 10.8% are inactive. This shows that the vast majority of respondents try to keep participating in certain physical activities. Surprisingly, there is a high percentage of respondents who engage in high-intensity activities. This is not in accordance with previous research on physical activity in Croatia, which indicate that even 35.8% of people over the age of 18 are physically inactive. The sample of students at the Faculty of Medicine indicates that as many as 54.8% of respondents do not engage in any sport and only 12.8% engage in moderate physical activity (Matković et al., 2010). Furthermore, such results speak in favour of the need to continue researching these phenomena in order to investigate the causes of the results obtained by encouraging physical activity as a significant factor in maintaining physical and mental health.
The correlation between the observed variables was examined using the Spearman's correlation coefficient and is shown in Table 3.

Table 3: Spearman's rho

		Vigorous Physical Activity	Moderate Physical Activity	Walking	Positive well-being	Depression/ Anxiety	Good mood
Vigorous Physical Activity	r	1.000	.504**	.090*	**.138****	**- .142****	.010
	p	.	.000	.030	.001	.001	.807
	N	585	585	585	585	585	585
Moderate Physical Activity	r	.504**	1.000	.152**	.098*	**- .133****	.041
	p	.000	.	.000	.018	.001	.322
	N	585	585	585	585	585	585
Walking	r	.090*	.152**	1.000	.059	-.052	-.007
	p	.030	.000	.	.151	.211	.859
	N	585	585	585	585	585	585
Positive well-being	r	.138**	.098*	.059	1.000	-.646**	.622**
	p	.001	.018	.151	.	.000	.000
	N	585	585	585	586	586	586
Depression/Anxiety	r	-.142**	-.133**	-.052	-.646**	1.000	-.525**
	p	.001	.001	.211	.000	.	.000
	N	585	585	585	586	586	586
Good mood	r	.010	.041	-.007	.622**	-.525**	1.000
	p	.807	.322	.859	.000	.000	.
	N	585	585	585	586	586	586

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 3 shows a positive and a negative correlation between the observed variables. However, these are very weak correlations of r < 0.2 and can therefore only be taken as indicators of a positive or a negative correlation, with Vigorous Physical Activity being weakly positively correlated with positive well-being, while there is a negative correlation with depression/anxiety.

Furthermore, in order to establish the relationship between Total Physical Activity and the observed factors, the Kruskal-Wallis H test was performed. These results are shown in Table 4.

Table 4: Correlation between Total Physical Activity and the observed factors

		N	$\bar{x}$	SD	Arithmetic mean of the ranks	Kruskal -Wallis H	df	p
Positive well-being	Inactive	63	1.96	.58182	228.91			
	Minimally Active	252	2.16	.55060	291.02			
	HEPA Active	270	2.23	.50994	309.80			
	Total	585	2.17	.54102		11.797	2	**.003**
Depression/ Anxiety	Inactive	63	1.36	.75096	362.55			
	Minimally Active	252	1.04	.64472	291.43			
	HEPA Active	270	.98	.62626	278.24			
	Total	585	1.05	.65676		12.803	2	**.002**
Good mood	Inactive	63	1.76	.59026	264.03			
	Minimally Active	252	1.88	.69101	301.76			
	HEPA Active	270	1.85	.67011	291.58			
	Total	585	1.85	.67123		2.606	2	.272

Looking at the significance value for Positive well-being and Depression/Anxiety, it can be noticed that there is a statistically significant difference ($p < 0.05$) with respect to Total Physical Activity. It can be noticed that for Positive well-being, the ranks are higher (the value of the scale is higher) in respondents who engage in moderate and high-intensity activities, while for Depression/Anxiety, the ranks are highest in respondents who are inactive. The obtained results confirm the correlation between physical activity and subjective well-being, precisely in the way that physical activity contributes to a person's health. They also confirm and can be compared with the results of previous research in this area. Thus, research by Downward and Dawson (2015) shows the greatest positive correlation between low-intensity activities and subjective well-being. The concordance of the studies is manifested in the activities of moderate intensity, which, along with the activities of low intensity, recorded a positive correlation with the total score of subjective well-being. The results of research conducted by Wicker and Frick (2015) yield opposite results from our research in the area of the correlation of subjective well-being and high-intensity activities. The data of their sample show a negative correlation between high-intensity activities and subjective well-being, which certainly opens the possibility of further research. The data in this paper, although examined by a different method, are consistent with the results of Loprinzi (2015) and Loprinzi and Davis (2016). Measuring the level of activity intensity with accelerometers, they showed that participants engaging in the activities of high and moderate intensity showed the highest positive correlation with self-reflection on life quality with an emphasis on health.

CONCLUSION

Analysing the obtained results, we can see very interesting data that show the current physical activity of students, which is at a satisfactory level, and we can also see its impact on their subjective well-being. Certainly encouraging is that most students feel positive and the smallest number of them feel depressed/anxious. It is also encouraging that the majority of respondents engage in high-intensity physical activities and only a small part of them engage in low-intensity physical activities. These data certainly have an added value when we look at the latest research result which shows the correlation between total physical activity and positive well-being and depression/anxiety in such a way that respondents who engage in moderate and high-intensity physical activities have the highest ranks of positive well-being, while those that engage in low-intensity physical activities have the highest level of depression/anxiety.

The analysis of the obtained results, as well as the comparison with other studies, indicates the correlation between physical activity and subjective well-being. However, different ways of linking the categories of physical activity with the categories of subjective well-being have been shown. Therefore, this paper can be an incentive for further research in this area and investing scientific efforts to connect and discover the extent to which physical activity and subjective well-being are linked, all with the aim of pointing out the importance of preserving the health of individuals and communities.

REFERENCES

1. World Health Organization. (2020). Physical Activity Retrieved on 28/11/2021 from https://www.who.int/news-room/fact-sheets/detail/physical-activity
2. OECD Better Life Initiative. (2013). OECD Guidelines on Measuring Subjective Well-being. Retrieved on 29/11/2021 from https://www.oecd.org/statistics/oecd-guidelines-on-measuring-subjective-well-being-9789264191655-en.htm
3. Panza, G. A., Taylor, B. A., Thompson, P. D., White, C. M., & Pescatello, L. S. (2017). Physical activity intensity and subjective well-being in healthy adults. Journal of Health Psychology, 24(9), 1257–1267. https://doi.org/10.1177/1359105317691589
4. Kidd, B., & Donnelly, P. (2000). Human rights in sports. International Review for the Sociology of Sport, 35(2), 131-148.
5. Bloodworth, A., McNamee, M., & Bailey R. (2012). Sport, physical activity and well-being: an objectivist account. Sport, Education and Society, 17:4, 497-514, DOI: 10.1080/13573322.2011.608948
6. Wicker, P., Coates, D., & Breuer, C. (2015). The effect of a four-week fitness program on satisfaction with health and life. International Journal of Public Health, 60: 41–47.
7. Downward, P., & Dawson, P. (2015). Is it Pleasure or Health from Leisure that We Benefit from Most? An Analysis of Well-Being Alternatives and Implications for Policy. Social Indicators Research, 126(1), 443–465. https://doi.org/10.1007/s11205-015-0887-8
8. Loprinzi. P. D. (2015). Joint associations of objectively-measured sedentary behavior and physical activity with health-related quality of life. Preventive Medicine Reports, 2: 959–961.
9. Loprinzi, P. D., & Davis, R. E. (2016). Bouted and nonbouted moderate-to-vigorous physical activity with health-related quality of life. Preventive Medicine Reports, 3: 46–48.

10. Wicker, P., & Frick, B. (2015). The relationship between intensity and duration of physical activity and subjective well-being. European Journal of Public Health, 25: 868–872.

11. Bradley, C. (1994). The Well-being Questionnaire. In Handbook of Psychology and Diabetes: A Guide to Psychological Measurement in Diabetes Research and Practice Edited by: Bradley, C. Chur: Harwood Academic Publishers, 89-109.

12. Craig, C. L., Marshall, A. L., Sjostrom, M., Bauman, A., Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J. F., & Oja, P. (2003). International Physical Activity Questionnaire: 12-country reliability and validity. Medicine and Science in Sports and Exercise, 35: 1381-1395. 10.1249/01.MSS.0000078924.61453.FB.

13. Hrvatski zavod za javno zdravstvo. (2017). Depresija. Retrieved on 29/11/2021 from https://www.hzjz.hr/sluzba-promicanje-zdravlja/depresija/

14. Teychenne, M., Ball, K., & Salmon, J. (2008). Physical activity and likelihood of depression in adults: a review. Prev Med, 46(5): 397-411.

15. Otto, S., & Smits, J. (2011). Exercise for Mood and Anxiety: Proven Strategies for Overcoming Depression and Enhancing Well-Being. Oxford.

16. Matković, A., Nedić, A., Meštrov, M., & Ivković J. (2010). Uobičajena tjelesna aktivnost studenata medicinskog fakulteta sveučilišta u Zagrebu. Hrvat Športskomedicinski Vjesnik, 25(2):87-91.

17. Jurakić, D., Pedišić, Ž., & Andrijašević, M. (2009). Physical activity of Croatian population: cross-sectional study using International Physical Activity Questionnaire. Croat Med J, 50(2):165-73.

18. Loprinzi, P. D. (2015). Joint associations of objectively-measured sedentary behavior and physical activity with health-related quality of life. Preventive Medicine Reports, 2: 959-961.

19. Loprinzi, P. D., & Davis, R. E. (2016). Bouted and nonbouted moderate-to-vigorous physical activity with health-related quality of life. Preventive Medicine Reports, 3: 46-48.

POVEZANOST FIZIČKE AKTIVNOSTI I SUBJEKTIVNE DOBROBITI KOD STUDENATA

Zdravlje predstavlja spoj fizičke i mentalne dobrobiti. Kako bi pojedinac bio u potpunosti zdrav važno je uspostaviti vezu između pojedinih aspekata mentalnog zdravlja i tjelesne aktivnosti. S ciljem ispitivanja povezanosti između fizičke aktivnosti i subjektivne dobrobiti, kao dijela mentalnog zdravlja, emprijsko istraživanje je provedeno anonimnim putem između 586 studenata različitih studijskih programa. Osim što ukazuju na međusobnu povezanost ispitivanih varijabli, rezultati istraživanja ukazuju i na važnost bavljenja fizičkom aktivnošću na različite načine. Dobiveni rezultati mogu biti poticaj za daljnja istraživanja ovog područja koje je izuzetno bitno za očuvanje fizičkog i mentalnog zdravlja pojedinaca, ali i poticaj za povećano bavljenje fizičkom aktivnošću, čime se doprinosi dobrobiti svakog pojedinca.

Ključne riječi: fizička aktivnost, studenti, subjektivna dobrobit, mentalno zdravlje, nivoi tjelesne aktivnosti

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DIFFERENCE LEVELS IN THE GOVERNANCE STRUCTURES OF OLYMPIC ORGANISATIONS (FROM BALKAN COUNTRIES)

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ABSTRACT

This article explores the current level of development and differences between Sports Federations in relation to the governance procedures. The paper provided an insight into the governance structures, rules and regulations through a questionnaire addressed to Sports Federations which are members of the National Olympic Committees of Bosnia and Herzegovina, Croatia, Serbia, Montenegro, and Slovenia. The research attempted to investigate the current level of development and differences between the Sports Federations in order to provide recommendations that will serve to improve the current practices of the Sports Federations from Bosnia and Herzegovina.

Keywords: Olympic sports organisations, governance, performance

INTRODUCTION

Governance is defined as a process related to strategy and policy directions, transparency, and accountability of the structures and processes within the management (Camy & Robinson, 2007). Governance in sports organisations can be defined as a process of strategic direction, planning and control of activities with the goal of efficient and effective achievement of positive results presented within the organisation's objectives (Bayle et al., 2007). It is important to understand that governance is exclusively related to strategic and political direction as well as the responsibility for transparent business activities, while the daily operations are the responsibility of the management, i.e., administration of Olympic sports organisations.

It is considered that Henry and Lee (2004) are the pioneers of research in the area of governance structures, defining that governance is not solely related to directing, managing and gaining power within an organisational structure, but it should imply obtaining power within a network of organisations belonging to different levels, especially within Olympic sport.

When observed in terms of structure, a governance structure of Olympic sports organisations is comprised of a General Assembly, Supervisory Committee and Executive Board, while the daily operations are the responsibility of the administration. The General Assembly and the Executive Board have their working parties - committees responsible for certain segments of the work done within an organisation (top sports department, legal department, sports anti-doping department, gender equality strengthening department, etc.).

Based upon this, it follows that, according to their characteristics, Olympic sports organisations belong to the organisations having a corporate governance

structure and characteristics of public commercial organisations (Chappelet, 2016, 2017). Corporate governance actually implies a governance system of an organisation which aims to ensure accountability, probity and openness in the conduct of an organisation, taking into account all stakeholders within the organisation. The governance structure in Olympic sports organisations can be easily recognised through its business practices. The most frequent reasons of poor governance in sports organisations are primarily manifested due to the board members and Secretary General's inexperience, conflict of interest, failure to manage risk, inadequate financial control mechanisms, and poor internal reporting and self-evaluation systems. The analysis of governance structures (SGO analysis) has a growing trend with different methodological approaches for the past two decades (Thibault, et al., 1993; ASOIF, 2017; Australian Sport Commission, 2012; Chappelet & Mrkonjic, 2013; Council of Europe, 2012; Geeraert, 2015, 2017; Mowbray, 2012; One World Trust, 2008; Sport England, 2011; Sport & Recreation Alliance, 2011).

The Australian Sports Commission (a group of authors, ASC, 2003) has specified that governance should encompass three key areas: i) fostering the development of strategic goals; ii) ensuring that the Executive Board oversees the performance of the organisation so as to monitor whether it achieves the establishment of its strategic goals; iii) ensuring that the Executive Board acts in accordance with the members' interests. Such extreme diversity in an organisational structure implies the complexity of the governance structure, limiting the relevance and applicability of generalised good governance principles (Pielke et al., 2020). Most frequently, the problem of establishing a good governance structure lies in the lack of coordination when implementing the principles across a broader landscape of Olympic sports organisations, especially in smaller sports organisations which have fewer staff and therefore fewer people involved in the coordination processes and the establishment of governance structure frameworks. According to Pérez (2003), the complexity of governance structure levels implies: (1) organisational governance, (2) board governance, (3) top structures governance, (4) governance structure management, and (5) metastructure governance.

The aim of this research was to conduct a critical evaluation and determine the differences in the levels of governance structures in the National Olympic Organisations from the Balkan countries. The analysis of governance structures was evaluated through 14 indicators: strategic planning, monitoring and evaluation, statute development, working methods of the Executive Board, Executive Board structure, Executive Board's involvement in the daily activities and management of the federations, successive planning, frequency of consulting with the members, types of development programmes, frequency of conducting a governance evaluation (governance review), risk management, equality and the Executive Board member selection procedure in terms of gender, as well as inclusion and operations of the International Federation. The secondary aim of the research was to compare the governance structure levels of the BiH Olympic organisation with the Olympic organisations of the neighbouring countries of Serbia, Croatia, Slovenia, and Montenegro

METHODS

The research design emerged from the aim of the study which primarily attempted to increase the knowledge about the governance structure in Bosnia and Herzegovina Olympic Sports Federations. UMAP tool (Robinson & Minkin, 2011) was used in the research protocol to collect information and obtain results. Questions from UMAP were meticulously structured and addressed all relevant aspects of the governance structure in the organisations among the Olympic Committees of BiH, Serbia, Croatia, Slovenia, and Montenegro. The governance success assessment included an analysis of 15 basic elements encompassing the foundation of governance activities in a sports organisation related to the level of development in the federations from the domain of strategic planning, the type of monitoring and evaluation conducted by the federations, the structure, operations and educational programmes of the Executive Board, successive planning, governance evaluation, risk management, gender representation in the governance structures, and inclusion in the operations of the parent International Federation. Data analysis was performed using a chi-square method (X^2) with standardised residuals to determine individual differences. Statistical significance was set at $p < 0.05$.

RESULTS

77 National Sports Organisations participated in the research assessing the level of governance structures within 11 evaluation elements. The results obtained for the neighbouring countries of Serbia, Croatia, Slovenia, and Montenegro (a total of 52 Sports Federations) were compared with the results obtained for Bosnia and Herzegovina (25 Sports Federations).

Table 1. How would you describe the strategic planning practice within your federation?

	BiH	Montenegro	Croatia	Slovenia	Serbia	Total
Did not reply	0	17	10	11	12	50
	0.0%	34.0%	20.0%	22.0%	24.0%	100.0%
	-4.4	3.2	.0	.3	.9	
We do not have a plan	0	0	0	1	0	1
	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
	-.5	-.5	-.5	2.0	-.5	
Our activities are planned on an ad hoc basis (depending on the situation when a problem arises)	9	1	3	1	1	15
	60.0%	6.7%	20.0%	6.7%	6.7%	100.0%
	4.3	-1.4	.0	-1.4	-1.4	
Our planning is conducted by external agencies, and it depends on the requirements for obtaining funds from potential sponsors	5	0	0	2	0	7
	71.4%	0.0%	0.0%	28.6%	0.0%	100.0%
	3.6	-1.4	-1.4	.5	-1.4	
Our strategic plan has been developed for the period of four years	11	1	10	7	10	39
	28.2%	2.6%	25.6%	17.9%	25.6%	100.0%
	1.7	**-3.3**	1.1	-.5	1.1	
Our strategic plan is a long-term one, and it has been developed for the period of over 4 years	0	7	3	5	3	18
	0.0%	38.9%	16.7%	27.8%	16.7%	100.0%
	-2.2	**2.2**	-.4	.8	-.4	

$\chi^2 = 66.41$; $p < 0.001$

Observing the issue of strategic planning in the Olympic sports system of the regional countries and BiH, and based on the analysis results for the differences in the observed frequencies related to the question "How would you describe the strategic planning practice within your federation?" (Table 1), it can be noticed that there is a statistically significant difference of the results and responses ($X^2 = 66.41$; $p < 0.001$). The dominating response "Our strategic plan has been developed for the period of four years" with a total of 39 responses differentiates the federations from Montenegro in relation to the federations of the remaining national committees (the smallest number of responses, ASR = -3.3, 2.6%). The response "Our strategic plan is a long-term one, and it has been developed for the period of over 4 years" is significantly different between the members of the Croatian NOC (the largest number of responses, ASR = 2.2, 38.9%) and the remaining federations within the rest of the NOCs. The response "Our planning is conducted by external agencies, and it depends on the requirements for obtaining funds from potential sponsors" significantly differs between the federations belonging to the BiH NOC (the largest number of responses, ASR = 3.6, 71.4%) and the remaining federations of other National Olympic Committees. It is interesting that the response "Our activities are planned on an ad hoc basis (depending on the situation when a problem arises)" is significantly different for the BiH NOC federations (the largest number of responses, ASR = 4.3, 60.0%) in relation to the other federations of the remaining National Olympic Committees, which actually means that a large number of Sports Federations from Bosnia and Herzegovina have not developed a long-term strategic plan, but they plan the activities depending on the situation.

Table 2. What type of monitoring and evaluation do you conduct?

	BiH	Montenegro	Croatia	Slovenia	Serbia	Total
Did not reply	0	18	10	11	12	51
	0.0%	35.3%	19.6%	21.6%	23.5%	100.0%
	-4.5	3.5	-.1	.2	.8	
We do not conduct monitoring and evaluation activities	1	0	1	1	1	4
	25.0%	0.0%	25.0%	25.0%	25.0%	100.0%
	.3	-1.0	.3	.2	.3	
We conduct a subjective evaluation of activities	16	0	0	4	1	21
	76.2%	0.0%	0.0%	19.0%	4.8%	100.0%
	7.2	**-2.5**	**-2.5**	-.2	-1.9	
The monitoring and evaluation activities meet the membership requirements of the International Federation and include the main areas	8	3	11	6	6	34
	23.5%	8.8%	32.4%	17.6%	17.6%	100.0%
	.7	-1.9	**2.1**	-.5	-.4	

We have established key performance indicators concerning the plan, and they are monitored on a regular basis	0 0.0% -1.1	1 20.0% .0	1 20.0% .0	3 60.0% 2.2	0 0.0% -1.1	5 100.0%
We have developed a strategic framework for monitoring and evaluation which monitors the plan and all the activities within the federation	0 0.0% -2.0	4 26.7% .7	3 20.0% .0	2 13.3% -.8	6 40.0% **2.1**	15 100.0%
$\chi^2 = 80.99$; $p < 0.001$						

The analysis results for the differences in the observed frequencies related to the question "What type of monitoring and evaluation do you conduct?" (Table 2) indicated that there is a statistically significant difference of the results and responses ($X^2 = 80.99$; $p < 0.001$). The dominating response "The monitoring and evaluation activities meet the membership requirements of the International Federation and include the main areas" with a total of 34 responses differentiates the federations from Croatia in relation to the federations of the remaining national committees (the largest number of responses, ASR = 2.1, 32.4%). The response "We have developed a strategic framework for monitoring and evaluation which monitors the plan and all the activities within the federation" is significantly different between the members of the Serbian NOC (the largest number of responses, ASR = 2.1, 40.0%) and the remaining federations within the rest of the NOCs. The response "We conduct a subjective evaluation of activities" significantly differs between the federations belonging to the BiH NOC (the largest number of responses, ASR = 7.2, 76.2%) and the remaining federations of other national committees, which clearly points out that the BiH sports organisations do not dedicate enough time for monitoring and evaluation activities of their own programmes.

The analysis results for the differences in the observed frequencies related to the question "To what extent has your statute been developed?" show that there is a statistically significant difference of the results and responses ($X^2= 47.16$; $p < 0.001$). The dominating response "The statute establishes all operations within the federation, the rules and procedures" with a total of 52 responses differentiates the federations from BiH in relation to the federations of the remaining national committees (the largest number of responses, ASR = 5.0, 40.4%). The response "The statute states the internal rulebooks of the organisation" is significantly different between the members of the Croatian NOC (the largest number of responses, ASR = 2.3, 60%) and the remaining federations within the rest of the NOCs. The response "We have a statute" significantly differs between the federations belonging to the Slovenian NOC (the largest number of responses, ASR = 2.7, 75.0%) and the remaining federations of other national committees.

The analysis results for the differences in the observed frequencies related to the question "How would you describe the operations of your Executive Board?" determine that there is a statistically significant difference of the results and responses ($X^2 = 30.42$; $p = 0.016$). The dominating response "We have a formally established structure and boards which clearly prescribe the rules of procedure and scope of operations" with a total of 55 responses differentiates the federations from BiH in relation to the federations of the remaining national committees (the largest number of responses, ASR = 2.9, 30.9%). The response "We have a certain number of boards which monitor the guidelines issued by the Executive Board" is the second most represented response.

The analysis results for the differences in the observed frequencies related to the question "What is the structure of your Executive Board?" indicated that there is a statistically significant difference of the results and responses ($X^2= 69.73$; $p < 0.001$) among the regional Sports Federations. The dominating response "The Executive Board comprises the selected persons who have no clearly defined roles" with a total of 33 responses differentiates the federations from BiH in relation to the federations of the remaining national committees (the largest number of responses, ASR = 7.0, 60.6%). The response "All members of the Executive Board have clearly defined responsibilities and roles (portfolio)" is significantly different between the members of the Serbian NOC (the largest number of responses, ASR = 2.5, 35.5%) and the remaining federations of other countries. Through insight into the analysis results for the differences in the observed frequencies related to the question "To what extent has your Executive Board been involved in daily activities and governance of the federation (governance/ management distinction)?", we can observe that there is a statistically significant difference of the results and responses ($X^2 = 64.75$; $p < 0.001$). The dominating response "The Executive Board delegates managerial responsibilities to the employees (administration)" with a total of 29 responses differentiates the federations from Croatia in relation to the federations of the remaining national committees (the largest number of responses, ASR = 2.2, 34.5%). The response "A few key people from the Executive Board govern the federation and all daily activities" is significantly different between the members of the BiH NOC (the largest number of responses, ASR = 3.9, 63.6%) and the remaining federations within the rest of

the NOCs. The response "The Executive Board completely governs the federation and all daily activities" is the dominating response in federations from the Serbian sports system.

The analysis results for the differences in the observed frequencies related to the question "What type of successive planning is in effect in your Executive Board?" indicated that there is a statistically significant difference of the results and responses ($X^2 = 65.19$; $p < 0.001$). The dominating response "The number of mandates in the Executive Board is not limited, the Executive Board members are usually re-elected for another mandate" with a total of 28 responses differentiates the national committee federations and dominates within the BiH sports system (ASR = 3.3, 39.3%). The response "The duration of a mandate in the Executive Board is limited, signifying that the Executive Board members should be replaced" is significantly different between the members of the BiH NOC (the largest number of responses, ASR = 4.2, 52.4%) and the remaining federations within the rest of the NOCs. This data points to the fact that a large number of Sports Federations in BiH are not aware of the significance of successive planning. The response "We conduct successive planning for the Executive Board aiming at identifying new people with appropriate skills" significantly differs between the number of frequencies for the federations belonging to the Serbian National Committee (the largest number of responses, ASR = 3.9, 56.3%) and the federations of the remaining national committees. The response "There is a "fluctuation" of new people in the Executive Board, and through regular education, we ensure continuity of operations in our federation" is significantly different between the number of responses from federations belonging to the Serbian NOC (the largest number of responses, ASR = 2.0, 66.7%) and the federations of the remaining national committees.

Analysing the differences in the observed frequencies related to the question "How often do you consult your members (clubs) regarding issues of organisational governance?", it is evident that there is a statistically significant difference of the results and responses. The dominating response "Consultations are conducted occasionally and concerning certain issues" with a total of 35 responses differentiates the federations from the National Committee of Montenegro (the smallest number of responses, ASR = 2.5, 42.2%) in relation to the federations of the remaining national committees. The response "We lead occasional and informal discussions" significantly favours the federations within the BiH sports system (ASR = 4.2, 70%).

Through insight into the analysis results for the differences in the observed frequencies related to the question "What type of developmental or educational programme do you implement for your Executive Board members?", we can observe that there is a statistically significant difference of the results and responses ($X^2 = 101$; $p < 0.001$). The dominating response "We put documents at their disposal so that they would be familiarised with the operations in the organisation (statute, rulebooks, etc.)" with a total of 50 responses differentiates the federations from the National Committee of BiH (the largest number of responses, ASR = 5.9, 50%) and Serbia (the smallest number of responses, ASR = -3.8, 0.0%) in relation to the federations of the remaining national committees. The response "None" significantly differentiates the members of the Croatian NOC (the largest number of responses, ASR = 2.2, 45.5%) and the remaining federations within the rest of the NOCs. The response "Apart from familiarising the members with the operations conducted in the organisation and training, we conduct a work assessment for the Executive Board members" is significantly different between the members of the Serbian NOC (the largest number of responses, ASR = 4.5, 77.8%) and the remaining federations of other national committees.

The analysis results for the differences in the observed frequencies related to the question "How often do you conduct a governance review (governance evaluation)?" indicated that there is a statistically significant difference of the results and responses provided by the Sports Federations from the observed countries ($X^2 = 76.97$; $p < 0.001$). The dominating response "We react when issues arise" with a total of 25 responses significantly differentiates the federations from the BiH National Committee (the largest number of responses, ASR = 4.6, 52.0%) in relation to the federations of the remaining national committees. The response "The governance evaluation is a part of our strategic plan, and it is continuously implemented" is significantly different between the members of the Slovenian NOC (the largest number of responses, ASR = 3.1, 53.8%) and the remaining federations within the rest of the NOCs. The response "We do not conduct such evaluations" is the dominant response in the BiH sports system in relation to the other sports systems (ASR = 4.1, 61.5%).

Risk management is an important business segment in the Olympic sports organisations and it concerns the establishment of clear regulations and plans which should serve as guidelines in case of unforeseen circumstances. If we analyse the differences in the observed frequencies related to the question "How do you handle risk management within your federation?", we can observe that there is a statistically significant difference of the results and responses ($X^2 = 62.73$; $p < 0.001$) between the Sports Federations of the 5 countries considered in this research. The dominating response "We identify potential risks which we might face prior to implementing each activity" with a total of 36 responses significantly differentiates the federations from the BiH National Committee (the

largest number of responses, ASR = 5.4, 58.3%) in relation to the federations of the remaining national committees. The response "We informally consider the risks before the activity" significantly differentiates the members of the BiH NOC (the largest number of responses, ASR = 2.2, 40.0%) and the remaining federations within the rest of the NOCs.

The analysis results for the differences in the observed frequencies related to the question "What is the attitude towards gender equality in the federation, and what is the percentage of females in your Executive Board?" indicated that there is a statistically significant difference of the results and responses ($X^2 = 44.68$; $p < 0.001$). The dominating response "We do not have any female members in the Executive Board, but it is clear that we must include more women" with a total of 22 responses significantly differentiates the federations from the BiH National Committee (the largest number of responses, ASR = 2.8, 40.9%) in relation to the federations of the remaining national committees. The response "Women make up less than 10% of the total number of our Executive Board members" significantly differs between the number of frequencies for the federations belonging to the Serbian National Committee (the largest number of responses, ASR = 2.2, 38.9%) and the remaining federations of other National Olympic Committees. If we consider the analysis results for the differences in the observed frequencies related to the question "What is the procedure of selecting females as members in your Executive Board?" in the sports systems of BiH and regional countries, we can notice that there is a statistically significant difference of the results and responses ($X^2 = 56.54$; $p < 0.001$). The dominating response "We advise all members to be committed and run for positions" with a total of 31 responses significantly differentiates the federations from the National Committee of Montenegro (the smallest number of responses, ASR = -2.2, 6.5%) in relation to the federations of the remaining national committees. The response "We have developed specific roles/ positions within the Executive Board which can be filled solely be females" is significantly different between the members of the Serbian NOC (the largest number of responses, ASR = 2.8, 75%) and the remaining federations within the rest of the NOCs.

Through insight into the analysis results for the differences in the observed frequencies related to the question "How involved are you in the operations of your International Federation?", it can be noticed that there is a statistically significant difference of the results and responses ($X^2 = 46.13$; $p < 0.000$) The dominating response "the representatives of our federation are delegated to committees and working parties of the International/European Federation" with a total of 36 responses significantly differentiates the federations from the Croatian National Committee (the largest number of responses, ASR = 2.8, 36.1%). This data is very interesting and confirms that these countries are highly involved in the operations of International Federations. The response "We occasionally attend meetings of the International Federation" significantly differentiates the members of the Serbian NOC (the largest number of responses, ASR = 4.6, 72.7%) and the remaining federations within the rest of the countries. The response "We regularly participate in meetings of the International Federation (General Assembly, forums, etc.)" significantly differs the federations from the BiH NOC (the largest number of responses, ASR = 4.5, 50%).

DISCUSSION

The aim of the research was to determine the governance structure and levels in Olympic sports organisations from BiH and the neighbouring countries as well as to compare the governance structure of BiH Olympic institutions with those from Serbia, Croatia, Slovenia, and Montenegro.

Through insight into the results, it is concluded that there is a significant difference in the description of work methods used in the Executive Boards within the NOC federations from the region. In relation to the federations from the region, the federations from Bosnia and Herzegovina have the largest number of federations with the Executive Boards lacking the established working parties.

There is a significant difference in the federations' inclusion in the operations of the International Federations. The data that only two federations from Slovenia and one from Serbia have representatives in the Executive Board of the parent International or European Federation is also interesting, and anyway, it is necessary to change this practice so that the federations from the region can have a higher impact on the operations of International Federations. This results in an improvement of professionalism in a sports organisation (Shilbury et al., 2011).

Most BiH federations are at a higher scale of development when it comes to this issue, since they have statutes establishing all operations within the federations, and the reason for the high level of development lies in the fact that the BiH federations must have a statute establishing all operations, rules and procedures within the federation when entering into the register. The research results indicate that, together with the President, the Executive Board of Olympic sports organisations has the highest level of responsibility for governing the organisation. In most Olympic sports organisations, the Executive Board comprises 5 to 20 members selected from the organisation's members at the highest session - the organisation's General Assembly. Compared to the countries from the region, the structure of

BiH federations demonstrates the most significant deviation in defining the responsibilities and roles of the Executive Board members. It is interesting that a very small number of federations (Slovenia 1 and Serbia 2) are at the highest scale of development when it comes to successive planning, implying that they have a permanent "fluctuation" of new people in the Executive Board, and through regular education, they ensure the work continuity in the federations, which should be one of the functions of a good organisation (Kikulis, 2000).
It is visible that the Sports Federations from the regional countries are at a higher level of development than the BiH federations when it comes to the subjective evaluation and self-evaluation. 64% of BiH federations conduct a subjective evaluation of activities, and not one federation from BiH is at the highest scale of development as they have not established a strategic framework for monitoring and evaluation which monitors the plan and all the activities in the federation.
There is a significant difference in the type of developmental or educational programmes which the federations have at disposal for the Executive Board members. Unlike the federations from the other countries, especially Slovenia and Serbia which, apart from education, conduct performance evaluations of individual Executive Board members, the largest number of federations from BiH are at a low level of development, having no educational programmes for their Executive Board members, but they put documents at their disposal so that they would familiarise themselves with the operations conducted in the organisation.
In contrast to the regional countries, a large number of BiH federations do not conduct governance evaluations which would significantly facilitate the Sports Federations in assessing what has already been achieved within the plan so as to accordingly monitor the plan implementation success. Only one federation from BiH conducts a governance evaluation as part of its strategic plan, and it is continuously conducted, while in Slovenia, for example, 7 federations evaluate the governance as an integral part of the strategic plan. Strategic planning should be one of the fundamental prerequisites of a good organisation (Minikin, 1996).
The research conducted in 2013 has confirmed that a large number of Olympic Committees follow the practice recommending that 20% of the Executive Board members are female; however, in this research, it was also determined that there is an insufficient number of women in leadership positions within the Olympic Movement. Out of 204 National Olympic Committees that were established worldwide, only 11 NOCs had a female President, while 23 women occupied the position of Secretary General (Sport Administration Manual, 2014). Therefore, the International Olympic Committee's action plan concerning this issue implied an organisation of a World Conference on Women and Sport so as to monitor the progress made in this area, in addition to implementing a "Women Leadership Empowerment" seminar at a continental level to encourage women who hold a position within the Olympic Committee to undertake steps and run for leadership positions. Such examples would definitely serve as a good recommendation for the Sports Federations from the region and BiH considering the research results concerning gender equality and the fact that an exceptionally small percentage of federations have the recommended 20% of females in their governance structures. Unlike the federations from the region, the largest number of BiH federations have no female Executive Board members, but they stated that they are aware of the need to include more female members. Having in mind that the International Olympic Committee recommends that the inclusion percentage of females should be 20% or higher, it is clear that this issue should have a more serious approach so that the Olympic sports system in BiH would satisfy the IOC's recommendations regarding gender equality.
Not one BiH Sports Federation has incorporated a rulebook on risk management in its strategic plan or a detailed approach to risk factors and a method to successfully overcome them, and risk control is one of the essential factors of effectiveness in a sports organisation (Papadimitriou, 2007). It is certainly important to emphasise that risk management should be a part of the general procedures operating within the Olympic sports organisations and an integral part of sport organisation governance, which is why it is absolutely necessary that the Executive Boards of the BiH Olympic sports organisations apply a serious approach to this type of planning in BiH.

CONCLUSION

Based upon the research results, several conclusions arise, which are important for the capacity development of sports organisations and in accordance with the research conducted by Robinson et al. (2011):

- In most Sports Federations from Bosnia and Herzegovina, the Executive Board members do not have clearly defined responsibilities and roles, which is not the case with the regional countries where a large number of federations have introduced a so-called "portfolio board" (clearly defined responsibilities and roles for each individual Executive Board member) so as to ensure greater involvement and maximise the effectiveness of each individual Executive Board member.

- There is a significant difference in the structure and strategic planning practice of the observed federations. It can be noticed that the Olympic sports organisations from Bosnia and Herzegovina significantly deviate from the regional federations considering that the strategic planning practice is not applied in a large number

of federations. Not one federation from BiH has developed a long-term strategic plan for the period of over 4 years, which is the practice of a large number of federations from other countries investigated in this research. The stated data clearly point out the fact that it is necessary to implement strategic planning practices so that the BiH federations could effectively reach their long-term goals and therefore become more competitive.

- There is a significant difference in the structure and manner of the Executive Board's involvement in daily activities and governance of the federation (governance/management distinction) in the BiH sports structure.

- The area of educational programme development is one of the areas where it is necessary to accomplish significant progress in the Olympic sports system of BiH.

- The results inevitably lead to the conclusion that the federations from Bosnia and Herzegovina significantly deviate from the federations of other countries investigated in this research concerning the governance evaluation, and it is necessary to conduct further in-depth evaluations of higher quality.

- Quality risk management should, in the development of an organisation, represent one of the priorities implying that all parties within the organisation are obligated and responsible for undertaking well-thought-out activities aiming to decrease the impact of possible unforeseen activities on all the plans and activities of the federation.

REFERENCES

1. ASOIF. (2017). First review of IF governance. Lausanne: ASOIF.
2. Australian Sport Commission. (2012). Sport governance principles. Canberra: Australian Sport Commission.
3. Bayle, E., & Robinson, L. (2007). A Framework for Understanding Performance of National Governing Bodies of Sport. European Sport Management Quarterly, 7(3), pp. 249 – 268.
4. Camy, J., Robinson, L. (2007). Managing Olympic Sport Organization. International Olympic Committee, Olympic Solidarity. Human Kinetics Publishers.
5. Chappelet, J. (2017). Beyond governance: the need to improve the regulation of international sport. Sport in Society. doi:10.1080/17430437.2018.1401355
6. Chappelet, J.-L. (2016). From Olympic administration to Olympic governance. Sport in Society, 19 (6), 739–751.
7. Council of Europe. (2012). Good governance and ethics in sport. Parliamentary assembly committee on culture, science education and media. Strasbourg: Council of Europe.
8. Geeraert, A. (2015). Sports governance observer 2015: The legitimacy crisis in international sports governance. Copenhagen: Play the Game.
9. Geeraert, A. (2017). National sports governance observer. Indicators for good governance in national federations (Preliminary report). Aarhus, Denmark: Play the Game/Danish Institute for Sports Studies.
10. Henry, I., & Lee, P. C. (2004). Governance and ethics in sport. In S. Chadwick & J. Beech (Eds.), The business of sport management (pp. 25–42). Harlow: Pearson Education.
11. Jackson, R. (2014). Sport administration manual.
12. Kikulis, L. M. (2000). Continuity and change in governance and decision making in national sport organizations: Institutional explanations. Journal of Sport Management, 14, 293–320.
13. Minikin, B. (1996). Guidelines for Strategic Planning in Sport. Unpublished Paper, ASP 2000 Sports Programme, International Section, Australian Sports Commission, Canberra, ACT.
14. Mowbray, D. (2012). The contingent and standards governance framework for national governing bodies. In L. Robinson, P. Chelladurai, G. Bodet, & P. Downward (Eds.), Routledge handbook of sport management (pp. 26–41). Oxon: Routledge.
15. One World Trust. (2008). Global accountability report. London: One World Trust.
16. Papadimitriou, D. (2007). Conceptualizing effectiveness in a non-profit organizational environment. Int. Jnl. of Public Sector Management, 20(7) pp. 571 – 587.
17. Pérez, R. (2003). La gouvernance de l'entreprise [Corporate governance]. Paris: la découverte.

18. Pielke Jr, R., Harris, S., Adler, J., Sutherland, S., Houser, R., & McCabe, J. (2020). An evaluation of good governance in US Olympic sport National Governing Bodies. European Sport Management Quarterly, 20(4), 480-499.

19. Robinson, L., Minkin, B. (2011). Developing the capacity of National Sport Associations – A programme of capacity building of National Sport Organisations. Sport, Business and Management: An International Journal. October 2011.

20. Robinson, L., Minkin, B. (2011). Developing the capacity of National Sport Associations – A programme of capacity building of National Sport Organisations. Sport, Business and Management: An International Journal. October 2011.

21. Shilbury, D., Ferkins, L. (2011). Professionalisation, sport governance and strategic capability. Managing Leisure, 16, 108–127.

22. Sport & Recreation Alliance. (2011). A voluntary code for good governance for the sport & recreation sector. London: Sport & Recreation Alliance.

23. Sport England. (2011). A charter for sport governance. London: Sport England.

24. Thibault, L., Slack T., & Hinings, B. (1993). A framework for the analysis of strategy in non-profit sport organizations. Journal of Sport Management, Vol. 7, pp. 25-43.

NIVO RAZLIKA U UPRAVLJAČKIM STRUKTURAMA OLIMPIJSKIH ORGANIZACIJA (BALKANSKIH ZEMALJA)

Ovaj rad istražuje trenutni nivo razvoja i razlike između sportskih saveza u odnosu na procedure upravljanja. Rad je dao uvid u upravljačke strukture, pravila i propise putem upitnika koji je upućen sportskim savezima koji su članovi nacionalnih olimpijskih komiteta Bosne i Hercegovine, Hrvatske, Srbije, Crne Gore i Slovenije. Istraživanje je pokušalo ispitati trenutni nivo razvoja i razlike između sportskih saveza kako bi se dale preporuke koje bi služile za poboljšanje trenutnih praksi sportskih saveza Bosne i Hercegovine.

Ključne riječi: olimpijske sportske organizacije, upravljanje, izvedba

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ACHIEVEMENT DIFFERENCES OF BASIC CARVING OVER ANTHROPOMETRIC CHARACTERISTICS

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ABSTRACT

This research analyses the techniques involved in basic carving in relation to anthropometric characteristics of subjects. The first aim of this study was to determine whether there is a statistically significant difference between the subjects in the technique of performing basic carving in relation to their anthropometric characteristics. The second aim of this study was to determine the difference in the technique of basic carving in relation to anthropometric characteristics of subjects. A sample of 30 students, average age 22 years, male, was measured by 12 anthropometric measures and a situational-motor test. Alpine skiing technique was assessed through basic carving, the technical element of skiing which is present in the main form of skiing. Based on the performance of the basic carving and the obtained results, three subsamples of respondents were defined as "weak", "moderate" and "good". Between the treated subsamples, differences in anthropometric characteristics were established, and the limits in the degree of adoption of the basic carving technique were clearly defined. The subsample defined as "weak" has less pronounced measures of longitudinal and transversal dimensionality, volume and body weight, and has moderately pronounced skinfolds of the upper arm and back with a more pronounced length of the lower leg. The subsample defined as "moderate" has less pronounced skinfolds and moderately expressed length of the lower leg, the circumference of the upper leg, and the diameter of the knee. Body height, shoulder width, abdominal skinfold, body weight, arm length, medium chest circumference, and pelvic width are more pronounced. The subsample defined as "good" has a less pronounced knee length and medium chest circumference, and has a moderately pronounced body height, shoulder width, abdominal skinfold, body weight, arm length, and pelvic width. It has more pronounced skinfolds of the upper arm and back, as well as the circumference of the upper leg and the diameter of the knee. Based on these results, we can conclude that the differences are established and boundaries are clearly defined in the level of adoption of the basic carving techniques between subsamples in relation to anthropometric characteristics.

Keywords: alpine skiing, basic carving, anthropometric characteristics

INTRODUCTION

The development and improvement of ski equipment, primarily skis, entailed the emergence and production of the first carving skis that allow the development of a new carving skiing technique (Hirano & Tada, 2005; Hörterer, 2005). Alpine skiing is the specific and complex sport activity that takes place on a different configuration of the terrain and requires the skiers to have high quality skiing technique that can be applied in the given circumstances (Hadžić et al., 2012). Carving skiing technique enables continuous riding on the edges when turning, and turning without skidding Hörterer (2005). Also, the appearance of carving skiing caused an innovation in the learning process

of the carving ski technique. In the process of learning the ski technique, as a transitional phase between the elements of the plow and parallel ski technique, today, we often use is the so-called wedge (V) position of skis, in which the back parts of the skis are less spread, compared to the plow position (Lešnik et al., 2002). Using the V-position of skis in the learning process, either as a methodological exercise or as an element of ski technique, gradually prepares the skier for performing the turn in its entirety by way of the parallel ski technique (Cigrovski et al., 2010). This learning approach completely omits elements of the plow ski technique (Murovec, 2006). Therefore, it is important to identify factors that play a significant role in the adoption of skiing technique, and that each skier, beginner, through the alpine ski schools adopts the elements of alpine skiing at a high level (Joksimović et al., 2009). The ski carving technique represents the basic element in which a skier continuously connects multiple turns that are a combination of wedge turns and the parallel skiing technique (Hadžić, 2008). Because of the new learning approach to alpine skiing, the goal of this work is to determine the difference in the technique of basic carving in relation to anthropometric characteristics of the subjects, and to determine which anthropometric characteristics contribute to the adoption of the basic carving techniques in ski beginners. Research focused on the valorisation and evaluation of skiing techniques, (Andersen et al., 1990; Dopsaj, 2004; Cigrovski, 2007; Blakeslee, 2009; Mladenović, 2016 indicate a different approach in defining the way in which the degree of adopting ski knowledge is assessed, i.e., determined.). By determining and analysing various parameters of the adoption of alpine skiing techniques, it is possible to systematically monitor the relevant performance variables of the rational technique and discover reserves for better sports results at each level and degree of training in skiing technique.

METHODS

The key issue, and the whole problem orientation of this research is related to the analysis of the performance of basic carving in alpine skiing in relation to anthropometric characteristics of subjects. Measurement of anthropometric characteristics was carried out at the Faculty of Sports and Physical Education, before the students' departure to the compulsory practical skiing course. The assessment of the skiing technique was performed on the slopes of Kopaonik after the seven-day programme was implemented. Ski teaching lasted for seven days, a total of 42 hours, and was performed by three teachers at the identical programme. During the day, the class was implemented for a total of 6 hours where the first three hours were reserved for applied learning of ski technique elements, and the three remaining afternoon hours were intended for training. The evaluators were teachers who have vast experience in this business. Each subject was assessed by all three evaluators from different positions. Three independent evaluators gave the ratings to each respondent for the demonstration of the selected elements of ski technique - basic carving, and the final score was the average of the three ratings. The adoption levels of skiing knowledge in participants were evaluated with the score of 5 to 10 considering the ski bending to the arc shape, speed control based on the completion of the turn, the appropriate posture that ensures the centre of gravity lies in the middle of the foot, as well as demonstration ease and smoothness. During the data processing, based on the final (formed) scores in the performance of basic carving, the sample is divided into three subsamples, which were called "weak", "moderate" and "good" (Hadžić et al., 2013).

SUBJECT SAMPLE

In this study, the sample consisted of 30 students of the Faculty of Sports and Physical Education, male ski novices, average age 22 years, divided into three subsamples compared to the techniques involved in basic carving as follows: the first subsample consists of 9 subjects classified as ("weak"), the second consists of 10 respondents classified as ("moderate") and the third sub-sample consists of 11 respondents classified as ("good").

THE SAMPLE OF MEASURING INSTRUMENTS

Anthropometric characteristics followed in this study were measured according to the instructions and regulations of the International Biological Program (IBP). The program consists of 39 measures (Mišigoj-Duraković, 2008), some of which were used in this study.

DATA PROCESSING METHODS INSTRUMENTS

In line with the aim of this research, appropriate statistical data processing methods were chosen. To avoid the loss of information, data scaling was performed on contingency tables by finding the finest links and information on nonparametric sizes. Based on the above, it is evident that the application of discriminant analysis (DISCKRA) on the scaled data is possible. By calculating the coefficient of discrimination, the features that determine the specificity and characteristics of the subsamples are removed from further processing, i.e., reduction of the observed space is applied.

RESULTS

In accordance with the defined purpose of the research, the thematic unit anthropometric characteristics of the respondents will be analysed in relation to the techniques involved in basic carving in alpine skiing. The central and dispersion parameters, measures of skewness and kurtosis of the mentioned anthropometric characteristics represent the basic carving technique and direct us to the possibility of using parametric procedures.

Table 1: The central and dispersion parameters and measures of skewness and kurtosis of the anthropometric characteristics for the subsample – "weak" (9)

	M	SD	Min	Max	CV	Range		Sk.	Ku.
AMAST	75.56	15.77	61.0	114.0	20.86	63.43	87.68	1.76	2.13
AOGK	96.67	9.42	88.0	117.0	9.75	89.42	103.91	1.21	.34
AONDK	53.33	5.96	44.0	64.0	11.17	48.75	57.91	.25	-.49
AVIST	176.78	7.93	167.0	191.0	4.49	170.68	182.88	.50	-.73
ADUPK	55.33	16.71	51.0	59.0	30.20	52.49	78.18	.64	-1.49
ADRUK	76.33	3.78	71.0	81.0	4.95	73.43	79.24	-.44	-1.36
AKNNL	10.86	6.01	5.0	22.0	55.38	6.23	15.48	.79	-.84
AKNTR	16.50	10.62	6.0	39.0	64.35	8.34	24.66	1.11	.23
AKNL	13.77	10.79	7.0	41.0	78.39	5.47	22.06	2.03	2.77
ADKL	8.99	1.18	7.5	10.9	13.10	8.08	9.89	-.02	-1.11
AŠIKA	29.72	2.28	27.0	33.0	7.67	27.97	31.48	.22	-1.60
AŠIRA	40.22	3.05	33.5	44.0	7.59	37.88	42.57	-1.10	.78

Legend: M (mean), SD (standard deviation), Min (minimum value), max (maximum value), CV (coefficient of variation), Range (Range), Sk. (standardised coefficient of asymmetry, curvature), Ku. (standardised coefficient of elongation or flatness).

Minimum (min) and maximum (max) values of the anthropometric characteristics of the "weak" subgroup indicate that the values are in the expected range. Greater heterogeneity of the coefficient of variation (CV) indicates that the subsample is "weak" by the following characteristics: length of the lower leg (ADUPK), forearm skinfold (AKNNL), abdominal skinfold (AKNTR), skinfold (AKNL), and knee diameter (ADKL). The coefficient of variation (CV) indicates the homogeneity characteristics: body mass (AMAST), chest circumference (AOGK), thigh circumference (AONDK), body height (AVIST), arm length (ADRUK), pelvic width (ASIKA), and shoulder width (ASIRA). Increased values of skewness (Sk.) indicate that the distribution is highly asymmetric with negative pelvic width (ASIKA). Increased values of skewness (Sk) indicate extremely positive asymmetric distribution with the following characteristics: body mass (AMAST), chest circumference (AOGK), abdominal skinfold (AKNTR), and skinfold (AKNL). Normal (tolerant) asymmetry values of skewness (Sk) are determined by the following characteristics: the volume of the thigh (AONDK), body height (AVIST), length of the lower leg (ADUPK), arm length (ADRUK), forearm skinfold (AKNNL), knee diameter (ADKL), and pelvic width (ASIKA). Higher values of kurtosis (Ku) indicate the elongated curve with the following characteristics: body mass (AMAST), chest circumference (AOGK), abdominal skinfold (AKNTR), skinfold (AKNL), and shoulder width (ASIR). Negative values of kurtosis (Ku) indicate the flattened curve with the following characteristics: the volume of the thigh (AONDK), body height (AVIST), length of the lower leg (ADUPK), arm length (ADRUK), forearm skinfold (AKNNL), knee diameter (ADKL), and pelvic width (ASIKA).

Table 2: The central and dispersion parameters and measures of skewness and kurtosis of the anthropometric characteristics for the subsample – "moderate" (10)

	M	SD	Min	Max	CV	Range		Sk	Ku
AMAST	81.90	13.75	68.0	105.0	16.78	72.06	91.74	.83	-.90
AOGK	100.70	8.87	89.0	116.0	8.81	94.35	107.05	.39	-1.02
AONDK	55.60	4.79	50.0	64.0	8.61	52.17	59.03	.54	-.92
AVIST	180.50	6.93	170.0	190.0	3.84	175.54	185.46	-.10	-1.32
ADUPK	56.00	10.50	54.0	61.0	18.75	52.49	67.51	2.39	4.23
ADRUK	77.60	3.92	72.0	83.0	5.05	74.79	80.41	-.03	-1.50
AKNNL	10.18	3.85	5.6	17.0	37.83	7.42	12.94	.67	-.69
AKNTR	19.66	8.91	11.0	35.0	45.32	13.28	26.03	.64	-1.16
AKNL	13.15	5.05	8.0	25.0	38.43	9.53	16.77	1.39	1.07
ADKL	9.94	.89	8.0	11.4	8.99	9.30	10.58	-.56	.75
AŠIKA	30.05	1.34	28.0	32.0	4.47	29.09	31.01	.18	-1.06
AŠIRA	41.55	2.60	36.0	46.0	6.25	39.69	43.41	-.45	.75

Legend: M (mean), SD (standard deviation), Min (minimum value), max (maximum value), CV (coefficient of variation), Range (Range), Sk. (standardised coefficient of asymmetry, curvature), Ku. (standardised coefficient of elongation or flatness).

Minimum (min) and maximum (max) values of the anthropometric characteristics of the "moderate" subgroup indicate that the values are in the expected range. Greater heterogeneity of the coefficient of variation (CV) indicates that the subsample is "moderate" by the following characteristics: forearm skinfold (AKNNL), abdominal skinfold (AKNTR), skinfold (AKNL), and knee diameter (ADKL). The coefficient of variation (CV) indicates the homogeneity characteristics: body mass (AMAST), chest circumference (AOGK), thigh circumference (AONDK), body height (AVIST), length of the lower leg (ADUPK), arm length (ADRUK), pelvic width (ASIKA), and shoulder width (ASIRA). Increased values of skewness (Sk) indicate that the distribution is highly negatively asymmetric, and it is not notified. Increased values of skewness (Sk) indicate extremely positive asymmetric distribution with the following characteristics: length of the lower leg (ADUPK) and skinfold (AKNL). Normal (tolerant) asymmetry values of skewness (Sk) are determined by the following characteristics: body mass (AMAST), chest circumference (AOGK), thigh circumference (AONDK), body height (AVIST), arm length (ADRUK), forearm skinfold (AKNNL), abdominal skinfold (AKNTR), knee diameter (ADKL), pelvic width (ASIKA), and shoulder width (ASIRA). Higher values of kurtosis (Ku) indicate the elongated curve with the following characteristics: length of the lower leg (ADUPK), skinfold (AKNL), knee diameter (ADKL), and shoulder width (ASIRA). Negative values of kurtosis (Ku) indicate the flattened curve with the following characteristics: body mass (AMAST), chest circumference (AOGK), thigh circumference (AONDK), body height (AVIST), arm length (ADRUK), forearm skin fold (AKNNL), abdominal skinfold (AKNTR), and pelvic width (ASIKA).

Table 3: The central and dispersion parameters and measures of skewness and kurtosis of the anthropometric characteristics for the sub-sample – "good" (11)

	M	SD	Min	Max	CV	Range		Sk	Ku
AMAST	77.46	8.12	65.0	87.0	10.48	72.00	82.91	-.63	-1.18
AOGK	96.46	13.07	61.0	110.0	13.55	87.67	105.24	-1.91	3.13
AONDK	55.91	3.78	48.0	61.0	6.76	53.37	58.45	-.64	-.18
AVIST	179.18	4.92	172.0	187.0	2.74	175.88	182.49	.01	-1.22
ADUPK	54.64	9.10	51.0	59.0	16.65	52.52	64.75	2.44	4.82
ADRUK	76.73	3.35	72.0	82.0	4.36	74.48	78.98	-.12	-1.08
AKNNL	12.30	3.90	7.0	21.0	31.68	9.68	14.92	.93	.31
AKNTR	18.18	6.25	9.0	27.6	34.36	13.98	22.38	.02	-1.26
AKNL	13.78	3.11	9.0	17.9	22.55	11.69	15.87	-.16	-1.40
ADKL	10.13	.77	9.0	11.6	7.56	9.61	10.64	.37	-.56
AŠIKA	29.73	1.38	26.5	32.0	4.66	28.80	30.66	-.79	1.15
AŠIRA	41.32	3.04	37.0	48.0	7.37	39.27	43.36	.76	.21

Legend: M (mean), SD (standard deviation), Min (minimum value), max (maximum value), CV (coefficient of variation), Range (Range), Sk (standardised coefficient of asymmetry, curvature), Ku (standardised coefficient of elongation or flatness).

Minimum (min) and maximum (max) values of the anthropometric characteristics of the "good" subgroup indicate that the values are in the expected range. Greater heterogeneity of the coefficient of variation (CV) indicates that the subsample is "good" by the following characteristics: forearm skinfold (AKNNL), abdominal skinfold (AKNTR), skinfold (AKNL), and knee diameter (ADKL). The coefficient of variation (CV) indicates the homogeneity characteristics: body mass (AMAST), chest circumference (AOGK), thigh circumference (AONDK), body height (AVIST), length of the lower leg (ADUPK), arm length (ADRUK), pelvic width (ASIKA), and shoulder width (ASIRA). Increased values of skewness (Sk) indicate that the distribution is highly negatively asymmetric at chest circumference (AOGK). Increased values of skewness (Sk) indicate extremely positive asymmetric distribution with the following characteristics: length of the lower leg (ADUPK). Normal (tolerant) asymmetry values of skewness (Sk) are determined by the following characteristics: body mass (AMAST), thigh circumference (AONDK), body height (AVIST), arm length (ADRUK), forearm skinfold (AKNNL), abdominal skinfold (AKNTR), skinfold (AKNL), knee diameter (ADKL), pelvic width (ASIKA), and shoulder width (ASIRA). Higher values of kurtosis (Ku) indicate the elongated curve with the following characteristics: chest circumference (AOGK), length of the lower leg (ADUPK), forearm skinfold (AKNNL), pelvic width (ASIKA), and shoulder width (ASIRA). Negative values of kurtosis (Ku) indicate the flattened curve with the following characteristics: body mass (AMAST), thigh circumference (AONDK), body height (AVIST), arm length (ADRUK), abdominal skinfold (AKNTR), skinfold (AKNL), and knee diameter (ADKL).

This subsection will prove or reject the claim that there is a significant difference in the technique of basic carving in relation to anthropometric characteristics of subjects.

Table 4: The significance of differences in the technique of basic carving in relation to anthropometric characteristics of subjects

Analysis	n	F	p
DISKRA	12	39.211	.000

Table 4 presents the results of discriminant analysis (DISKRA) to determine the significance of differences in the technique of basic carving in relation to anthropometric characteristics of subjects. When looking at the anthropometric characteristics as a system using the discriminant analysis (DISKRA), it clearly shows, based on the value of p = .000, that there is a difference and clearly defined boundary in the technique of basic carving between the respondents, which is manifested latently. This fact suggests that there are probably latent characteristics that, in conjunction with other features (synthesised), contribute to discrimination against respondents in the technique of basic carving.

Table 5: The significance of differences in the technique of basic carving in relation to anthropometric characteristics of subjects

	F	k.dsk
AMAST	.637	.130
AOGK	.497	.051
AONDK	.803	.080
AVIST	.768	.189
ADUPK	.800	.093
ADRUK	.301	.090
AKNNL	.581	.147
AKNTR	.318	.152
AKNL	.028	.098
ADKL	3.982	.077
AŠIKA	.124	.031
AŠIRA	.560	.183

Legend: k.dsk is the coefficient of discrimination.

A review of Table 5, when considering the anthropometric characteristics of the subjects individually using the discriminant analysis (DISKRA), provides the discrimination coefficient (k.dsk) that points to the claim that there is a difference in the technique of basic carving between the respondents and that the greatest contribution to discrimination, that is the biggest difference, is with the following variables: body height (.189), shoulder width (.183), abdominal skinfold (.152), forearm skin fold (.147), body mass (. 130), skinfold (. 98), lower leg length (.093), arm length (.090), the volume of the thigh (.080), knee diameter (.077), chest circumference (.051), and pelvic width (.031).

DISCUSSION

Based on the previous discussion and analysis of samples from 30 subjects, in accordance with the applied methodology, the logical sequence of study was to determine the characteristics and homogeneity of each subsample based on the performance technique of basic carving and the distance between them. The fact that p = .000 in the discriminant analysis (DISKARA) means that there are no clearly defined boundaries between the subsamples on the basis of performing the technique of basic carving, i.e., it is possible to determine the feature of each subsample based on the technique of basic carving in relation to anthropometric characteristics.

Table 6: Characteristics and homogeneity of the subsamples based on the performance techniques of basic carving in relation to anthropometric characteristics

	Weak	Moderate	Good	dpr %
AVIST	less	greater	moderate	14.307
AŠIRA	less	greater	moderate	13.853
AKNTR	less	greater	moderate	11.506
AKNNL	moderate	less	greater	11.128
AMAST	less	greater	moderate	9.841
AKNL	moderate	less	greater	7.419
ADUPK	greater	moderate	less	7.040
ADRUK	less	greater	moderate	6.813
AONDK	less	moderate	greater	6.056
ADKL	less	moderate* [1]	greater* [1]	5.829
AOGK	moderate	greater	less	3.861
AŠIKA	less	greater	moderate	2.347
n/m	**7/9**	**6/10**	**8/11**	
%	**77.78**	**60.00**	**72.73**	

Legend: hmg - homogeneity; dpr% - contributing feature characteristics.

The status of each subsample performance of the basic carving techniques is mostly defined by body height because the contribution feature characteristics are 14.31% followed by: shoulder width (13.85%), abdominal skinfold (11.51%), upper arm skinfold (11.3%), body weight (9.84%), skinfold (7.42%), lower leg length (7.04%), arm length (6.81%), the volume of the thigh (6.06%), knee diameter (5.83%), chest circumference (3.86%), and pelvic width (2.35%). Homogeneity of the "weak" subsamples is 77.78%; for the "moderate" subsample, it is 60.00%, and for the "good" subsamples, it is 72.73%. Based on the above, it can be said that the characteristics of the subsample with "weak" features are present in 7 out of 9 subjects, which means that two subjects have other features rather than the characteristics of their group and the homogeneity of the subsamples is as great as 77.78%. The characteristics of "moderate" subgroups are present in 6 out of the 10 subjects; homogeneity is 60.0% for 4 of the respondents who have other features. Additionally, the characteristics of the subsample with "good" features are present in 8 out of 11 subjects; homogeneity is high at 72.7% for 3 subjects who had other characteristics. This means that one can expect that subjects whose characteristics are similar to that of the "weak" subsample, but their belonging based on the basic carving technique is unknown, have a reliability of 77.8% of belonging only to the subsample characterised as "weak", i.e., it is possible to forecast with certainty that a particular respondent with such features can be classified in the "weak" subsample. Based on the anthropometric characteristics of the respondents, it can be said that the subsamples have the following features: The "weak" subsample has less pronounced following characteristics: body height, arm length, body mass, the volume of the thigh, shoulder width, pelvic width, knee diameter, and

abdominal skinfold. The following characteristics are moderately expressed: skinfold, upper arm skinfold and chest circumference. The following characteristics are more pronounced: length of the lower leg. The "moderate" subsample has less pronounced following characteristics: skinfold, upper arm skinfold. The following characteristics are moderately expressed: length of the lower leg, thigh circumference and knee diameter. The following characteristics are more pronounced: body height, shoulder width, abdominal skinfold, body mass, arm length, chest circumference, and pelvic width. The "good" subsample has less pronounced following characteristics: lower leg length and chest circumference. The following characteristics are moderately expressed: body height, shoulder width, abdominal skinfold, body mass, arm length, and pelvic width. The following characteristics are more pronounced: skinfold, upper arm skinfold, thigh circumference, and knee diameter.

Similar conclusions were reached by applying anthropometric measures in predicting the achievement of the basic carving technique in alpine skiing (Hadžić et al., 2014).

Table 7: Distance (Mahalanobis) between the subsamples in the technique of basic carving in relation to anthropometric characteristics of the respondents

	Weak	Moderate	Good
Weak	.00	1.80	2.32
Moderate	1.80	.00	1.39
Good	2.32	1.39	.00

By calculating the Mahalanobis distance between the subsamples in the technique of basic carving performance, another indication of similarity or difference can be obtained. Distances from Table (7) indicate that the least distance is present between the "good" and "moderate" subsamples (1.39), and the outermost one is seen between the "good" and "poor" subsamples (2.32).

Table 8: Grouping of subsamples in the performance technique of basic carving in relation to the anthropometric characteristics of the respondents

Level	Closeness
Moderate, Good	1.39
Weak, Moderate	2.16

Based on the displayed dendrogram, it can be seen that the closest subsamples are the "moderate" and "good" ones with the distance of 1.39, and the biggest difference is seen between the "weak" and "moderate" subsamples with the distance of 2.16.

CONCLUSION

A sample of 30 subjects was analysed and divided into three subgroups based on the score obtained by the performance techniques of basic carving in alpine skiing. In accordance with the predetermined objectives of the research, the methodological approach of this study analysed the difference in the technique of basic carving between the respondents in relation to their anthropometric characteristics. Based on the results, their interpretation can give us the following conclusions: For anthropometric characteristics of respondents, by using the discriminant analysis (DISKRA . 000), the results indicate that the technique of basic carving shows no difference between the three subsamples with a coefficient of discrimination: body height (.189), shoulder width (.183), abdominal skinfold (.152), forearm skinfold (.147), body mass (.130), skinfold (.098), lower leg length (.093), arm length (.090), the volume of the thigh (.080), knee diameter (.077), chest circumference (.051), and pelvic width (.031). As the differences are established and boundaries clearly defined, the characteristics and homogeneity of each subsample are determined. Based on the anthropometric characteristics of the respondents, it can be concluded that: The subsample defined as "poor" has a less pronounced body height, arm length, body weight, thigh circumference, shoulder width, pelvis, knee diameter, and abdominal skinfold with the moderately expressed skinfold and upper arms, back and chest circumference. The length of the lower leg is more pronounced. Homogeneity of the "weak" subsample is 77.78%. The subsample defined as "moderate" has less pronounced skinfolds of the upper arms and back with the moderately pronounced shin length, thigh girth and knee diameter. Body height, shoulder width, abdominal skinfold, body mass, arm length, chest circumference, and pelvic width are more expressed. Homogeneity of the "moderate" subsample is 60.00%. The subsample defined as "good" has less pronounced shin length and chest

circumference, and has expressed a moderate body height, shoulder width, abdominal skinfold, body mass, arm length, and pelvic width. Forearm and back skinfold, as well as the volume of the thigh and knee diameter are more expressed. Homogeneity of the "good" subsample is 72.73%.

The significance of this research is manifold, both for theory and for practice. Observed from a theoretical point of view, there is no doubt that it has given new results that enable comparison with previous and future research in this field, and comparison of other skiers of the same age and gender. The contribution and practical significance of this paper lies in a closer familiarisation with the causal relationships between anthropometric characteristics on the one hand and the success of the adoption of basic skiing techniques in the student population, on the other hand.

REFERENCES

1. Andersen, R. E., Montgomery, D. L., Turcotte, R. A. (1990). An on-site test battery to evaluate giant slalom skiing performance. Sports Med Phys Fitness, 30, 3: 276-82. PMID: 2266759.
2. Blakeslee, M. (2009). Prepare for Superficial Inconsistencies. The Official Publication of the Professional Ski Instructors of America - Eastern / Education Foundation. Downloaded from the network on 12.10.2009. s: www.psia-e.org
3. Castanier, C., Le Scanff, C., Woodman, T. (2010). Who takes risks in high-risk sports? A typological personality approach. Res Q Exerc Sport, 81, 4: 478-84. doi: 10.1080/02701367.2010.10599709
4. Cigrovski, V., Matković, B., Matković, B. (2010). Is the way of teaching alpine skiing without the use of pulmonary ski technique more effective? Sportlogija, 2: 41-48.
5. Cigrovski, V. (2007). The effectiveness of different methods in the process of learning ski knowledge. Doctoral thesis. Zagreb, Croatia: Faculty of Kinesiology.
6. Dopsaj, M., Jocić, D., Blagojević, M., Vučković, G. (2004). Validation of various expert methods for the assessment of basic skiing knowledge among students of the Police Academy. Safety, 46, 2: 289-300.
7. Hadžić, R., Petković, J., Nikšić, E. (2019). Analysis of acquisition level of wedge turn technique in alpine skiing in comparison to anthropometric characteristics of examinees. Journal of the Anthropological Society of Serbia, 54: 15-25, doi: 10.5937/gads54-15550
8. Hadžić, R., Bjelica, D., Georgijev, G., Vujović, D., Popović, S. (2014). Anthropometrical Characteristics of Subjects in Predicting Technique Achievements of Basic Turn In Alpine Skiing. International Journal of Morphology, 32, 1: 232-240. doi.org/10.4067/S0717-95022014000100039
9. Hadžić, R. (2008). Technique and methodology of skiing (In Montenegrin). Rožaje: Copyright.
10. Hirano, Y., Tada, N. (2005). Numerical simulation of a turning alpine ski during recreational skiing. Med Sci Sports Exerc, 28, 9: 1209-1213. doi:10.1097/00005768-199609000-00020
11. Hraski, M., Hraski, Ž. (2010). Osnovne antropometrijske karakteristike alpskih skijašica u periodu 2006 – 2010. [Basic anthropometric characteristics of female alpine skiers in period 2006 – 2010]. Hrvatski športskomedicinski vjesnik, 25, 2: 81-86. https://hrcak.srce.hr/64525
12. Joksimović, S., Joksimović, A, Hadžić, R. (2009). The load of musculature in ski carving and relaxation technique. Physical Culture, 276-278. UDK 796. 926. 012. 1
13. Kuna, D., Franjko Maleš, B. (2008). The effect of some motor skills in the implementation of the veleslalom of ski instructor. Contemporary Kinesiologijy, 147 -152. CROSBI ID: 384049
14. Lesnik, B., Murovec, S., Gašperšić, B. (2002). Opredelitev oblik drsenja in smučanja. In: A. Guček, D. Videmšek, et al. Skiing nowadays. Ljubljana: ZUTS, 28-90.
15. Puhalj, S., Lešnik, B. (2018). Influence of morphological characteristics, physical fitness and ski technique on ski racing performance in girls aged 12 to 14. Facta universitatis, 15, 2: 271–276. ID: 55379118
16. Makowski, K., Aschenbrenner, P., Krawczynski, B. (2014). The role of selected intrapsychic factors in alpine skiing instruction. Baltic J. Health Phys. Act, 6, 2: 135–141. doi:10.2478/bjha-2014-0013
17. Mišigoj-Duraković, M. (2008). Kinantropological-biological aspects of physical exercise. Zagreb: Faculty of Kinesiology, University of Zagreb.
18. Mladenović, D. (2016). Methodological problem of valorization of alpine skiing technique. Current in practice, 26, 1: 15-21.
19. Senner, V., Lehner, S., Bohm, H. (2009). Equipment development and research for more performance and safety. In Science

and Skiing IV; M ˝uller, E., Lindinger, S., Stoggl, T., Fastenbauer, V., Eds.; Meyer & Meyer Verlag: Salzburg, Austria, pp. 110–133.

20. Thiel, C., Rosenhagen, A., Roos, L., Huebscher, M., Vogt, L., Banzer, W. (2009). Physiologic characteristics of leisure alpine skiing and snowboarding. In Science and Skiing IV; M ˝uller E., Lindinger S., Stoggl T., Fastenbauer V., Eds.; Meyer and Meyer Sport: Salzburg, Austria, pp. 516–522.

RAZLIKE U IZVOĐENJU OSNOVNOG ZAOKRETA U ODNOSU NA ANTROPOMETRIJSKE KARAKTERISTIKE

Ovo istraživanje analizira tehnike obuhvaćene osnovnim zaokretom u odnosu na antropometrijske karakteristike ispitanika. Prvi cilj ovog istraživanja je bio utvrditi postojanje statistički značajne razlike između ispitanika u tehnici izvođenja osnovnih zaokreta, a u odnosu na njihove antropometrijske karakteristike. Drugi cilj ovog istraživanja je bio utvrditi razliku u tehnici osnovnog zaokreta u odnosu na antropometrijske karakteristike ispitanika. Uzorak od 30 studenata, prosječne dobi od 22 godine, muškog spola, je testiran mjerenjem 12 antropometrijskih mjera i korištenjem testova za procjenu situaciono-motoričkih sposobnosti. Tehnika alpskog skijanja je procijenjena putem osnovnog zaokreta, tehničkog elementa skijanja koji je prisutan u osnovnom obliku skijanja. Na osnovu izvedbe osnovnog zaokreta i dobivenih rezultata definisana su tri poduzorka ispitanika, i to: "loši", "umjereni" i "dobri". Razlike u antropometrijskim karakteristikama tretiranih poduzoraka su ustanovljene te su jasno definisane granice u stepenu usvajanja tehnike osnovnog zaokreta. Poduzorak definisan kao "lošˮ je imao manje izražene mjere longitudinalne i transverzalne dimenzionalnosti, obima i težine tijela, te je imao umjereno izražene kožne nabore nadlaktice i leđa sa više izraženom dužinom potkoljenice. Poduzorak definisan kao "umjerenˮ je imao manje izražene kožne nabore te umjereno izraženu dužinu potkoljenice, obim natkoljenice i promjer koljena. Tjelesna visina, širina ramena, kožni nabor stomaka, tjelesna težina, dužina ruku, srednji obim grudnog koša i širina karlice su više izražene. Poduzorak definisan kao "dobarˮ je imao manje izraženu dužinu koljena i srednji obim grudnog koša sa umjereno izraženom tjelesnom visinom, širinom ramena, kožnim naborom stomaka, tjelesnom težinom, dužinom ruku i širinom karlice. On ima više izražene kožne nabore nadlaktice i leđa, kao i obim natkoljenice i promjer koljena. Na osnovu ovih rezultata možemo zaključiti da su razlike ustanovljene te su jasno definisane granice u stepenu usvajanja tehnike osnovnog zaokreta između poduzoraka u odnosu na antropometrijske karakteristike.

Ključne riječi: alpsko skijanje, osnovni zaokret, antropometrijske karakteristike

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DIFFERENCES IN THE EFFICIENCY OF SKI TRAINING ON SNOW AND ON A SKI SIMULATOR

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ABSTRACT

A ski training programme is a learning programme that forms a constituent part of every ski school. It aims to teach its students the most basic elements of skiing techniques. This research will compare the efficiency of the typical skiing lessons conducted on snow with a new approach to skiing lessons using a ski simulator which may be used before, during and after the skiing season. The research sample consisted of the students from the Bjelogrivac ski school and the school for skiing instructors, MASI team. The research used the common elements of ski training that form the basis for learning skiing techniques such as: snowplough glide, snowplough turn, snowplough turn with side slipping and basic carving. We researched the success rate of skiing both on snow and on the artificial surface using a ski simulator, which bares most resemblance to skiing techniques used on snow, after which we compared the variables of both groups. In the case of the Bjelogrivac ski school, their beginners largely completed the basic skiing course with success, but a certain number failed to adopt all the elements and remained at the same level during the following ski season. However, the best results were shown by combining these two methods. One of the advantages of a ski simulator is that it can be used for training purposes all year round. This may, in turn, significantly improve the efficiency with which skiing techniques are performed on snow.

Keywords: skiing, ski simulators, students, technique, training, assessment

INTRODUCTION

As one of the oldest sports that originated as a need for people to move as fast and easy as possible in winter conditions, today, skiing is almost an indispensable part of winter recreation for everyone who wants to enjoy this sport or do it professionally.

Rarely does a sport have such a long and comprehensive history as alpine skiing. As the development of skis, ski boots, ski bindings, and technical equipment on the slopes progressed throughout history, alpine skiing and skiing techniques developed at the same time.

Skiing plays a very important role at an early age, given that this type of sport has a positive effect on the development of motor skills, socialisation, self-esteem, and the like. It is known that the period up to the seventh year of age is crucial in all segments of personality development. Therefore the role of sports is of utmost importance. During this period, a child acquires different habits that affect his intelligence and, at the same time, develops speed and coordination (Hadžić, Bjelica, 2005). Skiing also has a positive effect on adults. In addition to its recreational characteristics, it is also the sport that anyone can do, regardless of how old they are. Furthermore, this type of sport has no negative

consequences on the body. All this holds true only if it is performed properly, i.e., if the person has been trained by an instructor.

However, this sport carries with it certain risks, and as such is considered one of the high-risk sports, primarily due to the speed of movement, i.e., internal characteristics, such as altitude, equipment, snow surface, and other skiers, as well as external characteristics, i.e., individual factors, such as gender, age, motor skills, psychological state, and the like (Ropret, Janačković-Ćupić, 2014).
The programmes of alpine skiing schools may also be useful as an additional sports activity for children and young people. Alpine skiing activities can have an impact on the development of the most important motor skills in certain sports, but also on the multifaceted development of children athletes (Saks, Cigrovski, Maravić, & Matković, 2015).

The most widespread and the most popular approach in the training of alpine skiers is the one in which elements of different skiing techniques are used. Transferring skiing knowledge this way is known as a combined knowledge transfer. Therefore, there are several ways to learn alpine skiing: adaptation to ski equipment and basic forms of skiing, initial forms of skiing, advanced forms of skiing, top forms of skiing - field and competition (Lešnik, Žvan, 2010).

The appearance of carving skis in the training of alpine skiers influenced the development of a direct training method, where beginners are only trained to learn the elements of parallel skiing (Murovec, 2006). In addition to fitness training, it is recommended to use similar movements as in alpine skiing a few months before the skiing season (Roman, Miranda, Martinez, & Jesus, 2009). Skier training also includes alternative sports that are similar to skiing itself (Wu, Nozawa, Perteneder, & Koike, 2020).

As one of the most famous winter sports, alpine skiing attracts people who go back to it every year. Since skiing is limited to the winter period, ski equipment and mountain slopes, today, a large number of instructors use indoor spaces with ski simulators that solve this as well as the problem of ski training.

In addition to education and technique, ski training methodology encompasses the health of individuals and groups. Healthy lifestyles should be an indispensable part of ski training methodology. This is of special importance for the youngest. Although their bodies are healthy and young, it is essential to instil such way of life in them and teach them to live it accordingly. The instructor has a very important role here. First and foremost, he should be a role model. In other words, he must show them what it means to be an athlete. He ought to give examples of the things that have positive and harmful influences on our body and health.

Due to the specific mountain environment in which snow sports and alpine skiing are taught, it is recommended to describe motor-skills-related tasks as briefly as possible. Proper demonstration is what needs to be focused on, regardless of whether a preschool child or a student is being taught (Neljak, 2013). All ski school students can adopt and improve the elements of skiing techniques with a synthetic and analytical method of training. The synthetic method is characterised by performing motor tasks as a whole, while the analytical method means training according to skiing technique levels. The analytical method is intended for the training of beginners, while the synthetic method is very often used by skiers who have reached an advanced level (Cigrovski et al., 2019). Training beginners using exclusively parallel ski techniques is a direct way to learn alpine skiing. The second category of ski training programmes consists of ski techniques or elements, which include: snowplough glide, snowplough turn, snowplough turn with side slipping and basic carving. All the listed skiing techniques have the elements of parallel and snowplough skiing techniques. The exception is the basic carving which is mainly used as an element of the parallel skiing technique (Murovec, 2006).

At the end of each course that lasts 15 days (or 2x7 days), diplomas are awarded to all candidates. In addition, students are also assessed on how well they adopted different skiing elements and techniques. Depending on the number of candidates who are largely beginners, one instructor is usually assigned to lead a group of 10 beginners. Tests aimed at assessing the acquisition of skiing techniques (Table 1) are conducted in a quite simple way, i.e., by performing several basic skiing elements, which are valued with (+) and (-). Skiing technique acquisition results show that, out of 10 candidates, 7 have fully mastered all the basic skiing elements (+ + +), while 3 candidates have failed to meet the designated criteria (+ - -). Ski instructors noticed several problems: that one third of the candidates had not completed their ski training during the season, and consequently remained at the same level the following season. This may result in a lack of motivation in some individuals.

A – Beginner's level	B – Basic level	C – Advanced level
Familiarisation with the skiing equipment	Basic warm-up games	Side slipping without plough
Basic ski stance	Snowplough glide	Parallel turns
How to fall properly	Snowplough turn	Carving technique
Uphill skiing	Side slipping	
Snowplough technique	Parallel turns with side slipping	

Table 1: Bjelogrivac ski school programme

APPLICATION OF NEW METHODS IN SKI TRAINING – A SKI SIMULATOR

Skiing is an activity that requires coordination of the upper and lower body. Due to the higher speed, the skier has to engage the muscles responsible for rotation when going down the slope. Adequate training is required to train skiing techniques and perform these movements. In order for all of the above to be automated in terms of skiers' motor skills, using skiing techniques as early as possible, it is necessary to provide training conditions throughout the year. This can be achieved by practicing skiing techniques on ski simulators. One of the ways to train skiers is to use a ski simulator (Moon, Koo, Kim, Shin, 2015). Today, they are considered very important in the training programme for skiers, mostly because they improve the strength and technique of alpine skiing (Fausto, Panizzolo, Marcolin, & Petrone, 2013). Skiing is a sport that is associated with the winter period, which is limited to one season. So, the ski training itself is programmed for that period of time, which means that it is limited compared to other sports. Currently, the best solution for these problems, for competitors and recreational skiers alike, are ski simulators as a way to have ski training throughout the year (Nozawa, Wu, & Koike, 2019).

As skiing is a winter sport and depends on many factors (time, distance from the ski centre and finances), it happens that beginners easily give up (dissatisfaction with the training programme and their own performance, fear of injuries, having to wait a long time before the next season, etc.).

Therefore, the possibility of practical use of modern ski training methods has enabled beginners as well as competitors to practice skiing throughout the year through the simulation of alpine skiing techniques.

The Olymp ski club from Banja Luka made its first ski simulator and, by doing so, enabled a one-year workout programme. Due to unfavourable weather conditions that affect the continuity of ski trainings along with the outbreak of the corona virus pandemic, they found a way to train their new and regular members outside the ski season. The club's ski instructors discovered a much easier way to teach skiing techniques, primarily because they can organise classes individually or in small groups. Detection and elimination of errors is much more efficient when compared to real working conditions, mostly because they can stop at any moment and return to the starting position. The simulator is programmed in such a way that its surface is most similar to a sunny day on a ski slope. In other words, the surface closely resembles a melting slope. Skiing on such a slope is a lot harder, but there are fewer possibilities to make mistakes. The speed is also adjustable and gives an advantage in communication and demonstration of skiing techniques. The research encompassing a group of candidates attending this ski school was aimed at finding out how much time it takes to master the basic ski elements from the basic positions to the snowplough turn.

According to this research, 45 minutes of skiing on a ski simulator, i.e., 1 hour for each beginner in the group is enough to master the basic elements of skiing technique. Basic ski stances, snowplough position and turn can be mastered in 1 hour of active ski learning. It was confirmed that the exercises on the simulator are directly applicable on a natural surface. Using the transfer of motor knowledge from one surface to another, we noticed nearly identical preparatory stances required to perform every basic element of skiing technique.

Scientists from Italy conducted a study in which 5 professional skiers and ski instructors demonstrated skiing techniques directly on a natural surface during the season and on a ski simulator. The aim of the research was to compare the positions of the body directly related to the position of the knee joint and muscle contraction during the parallel ski technique or "carving" skiing technique. Furthermore, their motivation was to find an alternative solution for competitors and

recreational skiers in the off-season. The conclusion of their research is that on the Skimagic simulator, the position of muscles and joints has a fairly similar pattern as skiing on a natural surface.

In addition, the angle made on this simulator when performing the parallel skiing technique can, by adequately adjusting the speed on the simulator, enable the same position of the skis as on the real surface (Fausto, Panizzolo, Marcolin, & Petrone, 2013).

THE PROBLEM, SUBJECT AND AIM OF THE RESEARCH

The problem of the research was to find out about the differences in the acquisition of skiing technique in the ski schools that train only during the skiing season and in the ski schools that train during the season and off-season with the help of modern ski simulators.

The subject of this research is the analysis of how successful training programmes of the two ski schools are, given that one has a programme limited only to the winter season, while the other provides skiing lessons throughout the year.

The main aim of the research is to examine which training method yields better results.

METHOD

This research belongs to the group of theoretical and empirical research, and in relation to time, it is of a transversal character. The NSPC test (National Ski Patrol in a Central Division test 2009) was used to assess the adoption of ski techniques on snow and on a ski simulator. This test assesses ski knowledge with a simple assessment criteria, i.e., (+) which indicates that the task has been adopted or that the candidate excels at the task, (+ -) that the task has been performed in a satisfactory way and (-) signifying that the candidate has failed to complete the task.

SAMPLING

The sample of respondents consisted of 50 students of the Bjelogrivac ski school aged 6-8, as well as 52 students of the "MASI" programme ski school of the same age. The gender of the participants is not included.

DATA PROCESSING METHOD

The following elements of the ski training programme can be selected to assess the knowledge of the candidates who do not have previous skiing experience after a seven-day programme: side slipping, parallel turns, basic turns, basic carving (Cigrovski, 2007).

The NSPC (National Ski Patrol in a Central Division test) was used to calculate the acquisition of skiing knowledge, which is very simple to perform but also quite relevant, and we obtained the following statistics which indicate:

1. (+) That the candidate efficiently performs a skiing element with very small oscillations and errors that are acceptable for the first 3 basic elements (snowplough glide, snowplough turn and snowplough turn with side slipping). (+) in the case of the basic carving is accepted only if the candidate is able to fully perform the given ski element.

2. (+) / (-) That the candidate satisfactorily adopts the given ski element, that he makes mistakes, but that the demonstration of the ski element does not deserve the lowest grade.

3. (-) That the candidate fails to perform the given ski element at a satisfactory level; that the position of the body while moving and performing turns is not harmonised with the technique of the skiing element, and that he makes more mistakes than allowed when performing a task.
Non-parametric statistics were used to compare variables between groups.

RESULTS AND DISCUSSION

RESULTS OF THE ADOPTION OF SKI ELEMENTS

-Ski elements-	Fully acquired (+)	Satisfactorily acquired (+) / (-)	Failed to acquire (-)
Snowplough glide	41 candidates	7 candidates	2 candidates
Snowplough turn	38 candidates	7 candidates	5 candidates
Snowplough turn with side slipping	29 candidates	10 candidates	11 candidates
Basic carving	22 candidates	12 candidates	16 candidates

Table 2: Results of the acquisition of skiing elements by the candidates of the Bjelogrivac ski school

Table 2 results show that the acquisition of skiing elements or skills varies depending on the difficulty of the task. The number of candidates who fully or partially master a skill is significantly more positive than the number of candidates who do not. Since the programme of this ski school is limited to one season, similar or the same results may be expected the following season.

-Ski elements-	Fully acquired (+)	Satisfactorily acquired (+) / (-)	Failed to acquire (-)
Snowplough glide	42 candidates	7 candidates	3 candidates
Snowplough turn	38 candidates	8 candidates	6 candidates
Snowplough turn with side slipping	30 candidates	10 candidates	12 candidates
Basic carving	22 candidates	12 candidates	18 candidates

Table 3: Results of the acquisition of skiing elements by the candidates of the MASI skiing school on a ski simulator

Table 3 results show that the acquisition of skiing elements, just as Table 2 illustrates, depends on how difficult it is to perform a particular element. Although all ski elements are performed on an artificial surface, the difference is noticeable in 2-3 candidates, on average, which is certainly not a bad result. These are off-season results, which means that this group of candidates will need to further improve their skiing technique.

- Ski elements--	Fully acquired (+)	Satisfactorily acquired (+) / (-)	Not acquired (-)
Snowplough glide	50 candidates	2 candidates	x
Snowplough turn	45 candidates	5 candidates	2 candidates
Snowplough turn with side slipping	39 candidates	7 candidates	6 candidates
Basic carving	34 candidates	8 candidates	10 candidates

Table 4: The results of the MASI ski school candidates, using the combined training method

Table 4 results show the acquisition of skiing elements by a group of candidates attending the MASI ski school who continued to broaden, i.e., upgrade the knowledge acquired off-season in the season and on a natural surface (a combined training method). Based on the results, it is noticeable that there are no more candidates who have not acquired the basic ski element – snowplough glide. It is also noticeable that, on average, 7-9 more candidates completely master all skiing elements. On the other hand, not more than 4 candidates are able to properly master the skiing elements in comparison with the results from the previous tables.

Kruskal-Wallis (Table 5)

	χ^2	df	p
Carving	6.45	2	**0.040**
Turn with side slipping	4.64	2	0.098
Snowplough turn	3.27	2	0.195
Snowplough glide	6.53	2	**0.038**

Dwass-Steel-Critchlow-Fligner pairwise comparisons

Pairwise comparisons – **snowplough glide** (Table 6)

		W	P
Combined	snow	-3.274	**0.054**
Combined	exercise machine	-3.501	**0.036**
Snow	exercise machine	-0.273	0.980

Pairwise comparisons – **turn with side slipping** (Table 8)

		W	P
Combined	snow	-2.681	0.140
Combined	exercise machine	-2.706	0.135
Snow	exercise machine	0.0213	1.000

Sig. $p < 0.05$

The difference in group achievement was tested by the non-parametric Kruskal-Wallis test, the results of which are shown in Table 5. Statistical significance of the differences ($p < 0.05$) was obtained on the carving and snowplough tests. A series of post-hoc Dwass-Steel-Critchlow-Fligner tests (Tables 6, 7, 8, and 9) showed statistically significant differences ($p < 0.05$) between the group that combined the ski simulator and snow on the test and the group that only used the ski-simulator on the snowplough glide test, while the differences between these groups on the carving test are on the verge of statistical significance just as the difference between the groups that used the combined method and snow on the snowplough glide test.

Pairwise comparisons -**snowplough turn** (Table 7)

		W	p
Combined	snow	-1.991	0.337
Combined	exercise machine	-2.484	0.185
Snow	exercise machine	-0.484	0.938

Pairwise comparisons – **carving** (Table 9)

		W	p
Combined	snow	-2.965	0.091
Combined	exercise machine	-3.295	**0.052**
Snow	exercise machine	-0.345	0.968

Table 5-9. Nonparametric analysis of variables between groups

In terms of the simple ski elements, there is a partial statistically significant difference between the candidates from both schools, which is confirmed in Table 6. It can be seen that, following the combined training method at MASI ski school, there are differences in the acquisition of the snowplough glide technique, compared to both training methods separately.

The more difficult the task is, the fewer candidates are able to perform it. This can be seen in their ability to master the skiing elements such as snowplough glide with side slipping and the basic carving. In the case of a snowplough glide

with side slipping, 39 candidates of the MASI ski school fully/properly acquired the element, following the combined training method, while in the case of the Bjelogrivac ski school, 29 candidates were successful, but this difference is not statistically significant. Regarding the basic carving, 34 candidates of the MASI ski school fully/properly acquired this ski element, after the combined method, compared to 22 candidates of the Bjelogrivac ski school, which is, statistically speaking, a partially important difference (Table 9).

The results show that, when compared to Bjelogrivac, MASI provided a better training programme for some elements of skiing by using the combined method, which may be exclusively attributed to the possibility of having off-season and additional learning lessons on both artificial surface and ski simulators.

Learning to ski on the "Skimagic" simulator has contributed to the MASI candidates beginning the season in good shape, by having achieved semi-automation of certain elements of the skiing technique. In comparison with the research of the Olymp ski school, it is clear why knowledge was successfully transferred from the ski simulator to the natural surface. The differences in demonstration and in the time it takes to learn a skiing element are very small. In a study conducted by Italian experts (Fausto, Panizzolo, Marcolin, & Petrone, 2013), several things coincide: the fact that skiing is a naturally limited sport and that it can only be practiced in winter. However, the solution to that problem is the emergence of ski simulators that give ski schools the possibility of unlimited training. The same research illustrates that the demonstration of complex skiing elements shows the identical body position on the ski simulator as on a natural surface, which immediately leads to the conclusion that exercising can help improve these skiing elements.

CONCLUSION

This research paves the way for considering the possibilities to improve ski training programmes, whose aim should be to enable its candidates to practice this sport throughout the year using the ski simulator. This would be a major advantage for recreational skiers who would be able to enjoy every moment on skis, and an even greater advantage for future competitors who would have all conditions necessary for achieving good results.The results of this or similar research can serve as a support for a more efficient way in approaching training and skiing as a sport in general. As a region that has extremely great potential and natural resources that can enable outstanding systems for the broad development of this sport, it would be a great pity to reduce everything to a commercial and budgetary level. The greatest wealth and essence of everything is the huge talent possessed by many children and young people who could surely become skiing champions. It would be desirable if sports workers in the field of skiing would take an active part in this and take advantage of the new research and new trends that could serve to create new trends in ski training and adequate training cycles for competitors. Finally, this research and some future ones could create a model that would raise this sport to a higher level in school education itself, which would result in more and more young people wanting to engage in this sport.

REFERENCES

1. Anderson, D. (2007). Ski school. London: New Holland Publishers Ltd.
2. Bokanović, S. (2020). Programi škola kod učenja i usavršavanja tehnike alpskog skijanja.Diplomski rad. Beograd: Fakultet fizičkog vaspitanja i sporta u Beogradu
3. Božić, I., Cigrovski, V., Bošnjak, G., Jakovljević, V., Tešanović, G. (2017). Contribution of inline skating to learning basics of alpine skiing. SportLogia, Jun 2017, Vol. 13 Issue 1, pp. 1-8.
4. Cigrovski, V. Martković B, et al. (2019). Sportovi na snijegu. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
5. Cigrovski, V. (2007). Učinkovitost različitih metoda u procesu učenja skijaških znanja. Doktorska disertacija. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
6. Fausto, A. Panizzolo, Marcolin, G., & Petrone, N. (2013). Comparative Evaluation of Two Skiing Simulators as Functional Training Devices for Recreational Skiers. Journal of Sports Science and Medicine, volume 12(1): 151–158.
7. Kuna, D. (2013). Ekspertni model usvajanja skijaških znanja. Doktorski studija. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
8. Lešnik, B., Žvan, M. (2010). Naše smučine.Teorija in mtodika alpskega smučanja. Ljubljana: Fakultet za šport i Institut za šport Ljubljana

9. Moon, J., Koo, D., Kim, K., Shin, I., Kim, H., & Kim, J. (2015). Effect of ski simulator training on kinematic and muscle activation of the lower extremities. J Phys Ther Sci, 27(8): 2629–2632. doi:10.1589/jpts.27.2629

10. Mladenović, D. (2016). Metodološki problemi valorizacije tehnike alpskog skijanja. Novi Sad: Aktuelno u praksi: bilten za stručna pitanja u fizičkoj kulturi, vol.26, No. 1, pp. 15-20.

11. Murovec, S. (2006). Na kanto. Kranj: Samozaložba, p. 112

12. Neljak, B. (2013). Opća kineziološka metodika. Zagreb: Gopal d.o.o, p. 512

13. Roman, B., Miranda, M. T., Martinez, M., & Jesus, V. (2009), Transfer from Inline skating to alpine skiing instruction in physical education. In Muller, E., Lindinger, S., & Stoggl, T. (Eds.). The Fourth International Congress on Skiing and Science, pp. 430–439. Oxford, UK: Mayer & Mayer Sport

14. Saks, R., Cigrovski, V., Maravić, D., Matković, B. (2015). Alpsko skijanje kao dopunski sport kod mladih sportaša. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.

15. Stanišić, N. (2021). Razlike u obuci skijanja kod škola skijanja sa sezonskim i jednogodišnjim programom obuke koje koriste savremene tehnologije. Master rad. Beograd. Fakultet za fizičku kulturu i menadžment u sportu u Beogradu

16. Wu, E., Nozawa, T., Perteneder, F., Koike, H. (2020). VR Alpine Ski Training Augmentation using Visual Cues of Leading Skier. Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, pp. 878-879

RAZLIKE U EFIKASNOSTI OBUKE SKIJANJA NA SNIJEGU I SIMULATORU SKIJANJA

Skijaška obuka je program učenja skijanja koji zastupa svaka škola skijanja. Ona ima za cilj da svoje polaznike na što efikasniji način nauči osnovnim elementima tehnike skijanja. U ovom istraživanju će se uporediti efikasnost klasične obuke skijanja na snijegu i novi pristup u obuci skijanja putem simulatora skijanja koji se koristi prije, tokom i nakon skijaške sezone. Uzorak istraživanja su činili polaznici škole skijanja „Bjelogrivac" i instruktorske škole „MASI" tima. U istraživanju su korišteni ustaljeni elementi skijaške obuke koji su osnova za učenje tehnike skijanja poput: spusta u plugu, zaokreta u plugu, plužnog zaokreta sa otklizavanjem i osnovnog vijuganja. Istraživala se uspješnost obuke skijanja na snijegu i vještačkoj podlozi uz pomoć simulatora skijanja, a koja je najsličnija kretnjama skijaške tehnike na snijegu i poredile su se varijable između grupa. U slučaju istraživanja škole skijanja „Bjelogrivac", početnici većinom uspješno završavaju osnovnu obuku elemenata skijanja, ali jedan broj njih ne usvaja sve zadate elemente i ostaje na istom nivou znanja i sledeće skijaške sezone. Međutim, najbolji rezultati su dobiveni kombinacijom ove dvije metode. Jedna od prednosti simulatora skijanja je što se može koristiti za obuku tokom cele godine. Ovo zauzvrat može značajno povećati efikasnost izvođenja pravilne tehnike skijanja na snijegu.

Ključne riječi: skijanje, simulatori skijanja, polaznici, tehnika, obuka, ocjenjivanje

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DIFFERENCES IN MALE AND FEMALE STUDENTS' ATTITUDES TOWARDS HEALTHY LIFESTYLES

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ABSTRACT

The notion of a healthy lifestyle in students is observed in the context of a corresponding lifestyle which implies a broad area of physical activities, as well as social, psychological, educational, aesthetic, and other factors. The primary goal of this paper was to examine healthy lifestyles among the students of universities in FBiH. Specific goals of this paper were to determine dietary habits, physical activity and consumption of cigarettes, alcohol and dietary supplements in students of universities in FBiH. The research comprised 624 students from 4 different universities in FBiH (namely, the University of Sarajevo, "Džemal Bijedić" University, the University of Travnik and the University of Tuzla), and a specially designed anonymous survey questionnaire was used for data collection. The results point towards nutritional imbalance and an adverse lifestyle in the researched population, indicating a need for education with the goal of improving public health. Significant differences were observed in items belonging to general survey questions (going to a nightclub, lunch and exercise). For dietary habits, significant differences were obtained in items determining: the consumption of fat, vegetables, tea, alcoholic beverages, carbonated and energy drinks as well as dry-cured meat products. For student attitudes towards smoking, differences were obtained in items determining the time spent in places where smoking is allowed and concerns about the dangers of smoking. A difference in male and female students' attitudes towards the quality of life was also obtained.

Keywords: student, healthy lifestyles, physical activity, dietary habits, smoking, quality of life

INTRODUCTION

Healthy lifestyles represent an active concern over one's health and a responsible behaviour towards oneself, others and one's environment(Deliens, Clarys, De Bourdeaudhuij, & Deforche, 2014; Wills & Kelly, 2017). Health depends upon several factors called determinants of health, such as: genetic predispositions, psychological characteristics of an individual, social and environmental factors. Some risk factors can be Some risk factors can be affected, and therefore our activities must be directed towards changing unhealthy habits and adopting healthy lifestyles in all stages of life. Recommendations on a healthy lifestyle refer to the application of proper and balanced diet, regular movement and physical activity (at least 30 minutes per day) as well as avoiding and stopping the consumption of cigarettes, alcohol and drugs

(Almutairi et al., 2018; Tirodimos, Georgouvia, Savvala, Karanika, & Noukari, 2009). Dietary habits are learnt from infancy; however, student age is the period of growing up, filled with new responsibilities and often independence. Students often have poor nutrition. The level of physical activity decreases, and the sedentary lifestyle starts to dominate, leading to an increased risk of developing obesity and other diseases (Bouchard, Blair, & Haskell, 2012; Deliens, Deforche, De Bourdeaudhuij, & Clarys, 2015; Tremblay, Colley, Saunders, Healy, & Owen, 2010).

WORK METHOD

The aim of this paper is to determine the differences in healthy lifestyles in male and female students of certain universities in FBiH, namely: how much are the students familiarised with and how much do they practice healthy nutrition; which physical activities do the students engage in; which beverages and tobacco products do they consume; what is the students' satisfaction with the quality of life. The population defining the sample of respondents is comprised of students from universities in FBiH, namely: the University of Sarajevo, "Džemal Bijedić" University of Mostar, the University of Tuzla and the University of Travnik, all of whom study sports and physical education. The study included a total of 624 respondents (male - 312, female -338) aged 19 to 30. With the goal of conducting this research, a questionnaire was designed encompassing the following areas: general information (students' characteristics) - 7 items; characteristics of the nutritional level, general dietary habits, leisure time activities, and exercise - 7 items; dietary habits - 29 items; smoking - 7 items; and quality of life - 1 item. When entering the survey, the respondents were instructed on the goal of the research, the principle of anonymity, voluntariness, and consent for participation in the research. The survey was conducted in July 2020. The collected data was processed using the programme package SPSS 21. ANOVA was used for determining the differences in male and female students' attitudes for each item.

RESULTS

Table 1 illustrates the central and dispersion parameters of male and female students, namely: students' age, body height and body weight. A total of 624 (male - 312, female - 338) students were surveyed. The results of the age variable show that the male students' average age is 22.14, with the average age of female students being 22.14 years. The age range based on the minimum and maximum is between 19 and 30 years. The average height of the surveyed students is 183.98 cm for males and 169.57 cm for females. Standard deviation (SD) is somewhat higher having in mind the large range (min - max) in both male and female students. In other parameters, i.e., variables, the body weight average is 84.63 kg for male and 64.07 for female students. Standard deviation for both genders is also higher having in mind the great difference between the weight min and max. The results of skewness and kurtosis indicate that the results are normally distributed.

Table 1: Descriptive parameters of the male and female students' general information

Descriptive	Body height		Body weight		Age	
	male	female	male	female	male	female
Mean	183.98	169.57	84.63	64.07	22.14	22.06
Variance	55.189	35.449	166.447	93.006	5.775	5.088
SD	7.429	5.954	12.901	9.644	2.403	2.256
Minimum	158	155	60	46	19	19
Maximum	203	188	130	103	30	30
Skewness	.006	.265	.601	.625	1.153	.963
Kurtosis	.581	-.144	.589	.563	1.401	1.226

Insight into Table 2 enables us to see the frequency and percentages of the study year in which the students are enrolled. The first study year comprises 212 male and female students, i.e., 34%. The second study year comprises 108 male and female students, i.e., 17.3%, and the third study year comprises 114 male and female students or 18.3% of the respondents. From the fourth study year, we surveyed 126 male and female students (20.2%), and the fifth study year comprises 64 male and female students or 10.3% of respondents.

Table 2: Frequencies and percentage of male and female students per study year

	Study year	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	First year	212	34.0	34.0	34.0
	Second year	108	17.3	17.3	51.3
	Third year	114	18.3	18.3	69.6
	Fourth year	126	20.2	20.2	89.7
	Fifth year	64	10.3	10.3	100.0
	Total	624	100.0	100.0	

Analysis of Table 3 according to the frequency and percentage of responses to the survey question "During the studies and attending lectures at the faculty, I live" indicates that the largest number of students live with their family, namely, 438 or 70.2%, and 132 male and students or 21.2% of respondents live in private accommodation. 54 male and students or 8.7% live in student dormitory.

Table 3: Frequencies and percentage of male and female students per place of residence

	Place of residence	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	with their family	438	70.2	70.2	70.2
	private accommodation (apartment)	132	21.2	21.2	91.3
	student dormitory	54	8.7	8.7	100.0
	Total	624	100.0	100.0	

Table 4 illustrates the results of differences between male and female students in age, body height, body weight, study year, and place of residence. Significant differences were obtained in variables "body weight" and "body height" with the significance at the level of p = .001. The obtained result is expected considering the fact that this concerns the population (males and females). Other variables did not show a significant difference which indicates that the groups are heterogeneous according to age, study year and place of residence.

Table 4: Differences between male and female students (age, body height, body weight, study year, and place of residence)

Variables	**ANOVA**				
	Sum of Squares	df	Mean Square	F	Sig.
Age	.208	1	.208	.039	.844
Body height	31584.410	1	31584.410	721.187	.000
Body weight	61395.870	1	61395.870	510.855	.000
Study year	.285	1	.285	.146	.702
Place of residence	1.092	1	1.092	2.668	.103

The difference between male and female students in attitudes expressed in general survey questions on habits (Table 5) in items "lunch" and "exercise" is statistically significant at the level of p = .001. The item "nutritional level, going to coffee shops, going to the cinema, dietary habits, breakfast, and dinner" indicates that there are no differences between male and female students treated in this research. The item "going to a nightclub" is statistically significant at the level of p = .023.

Table 5: Differences between male and female students in attitudes expressed in general survey questions on habits

Items	ANOVA				
	Sum of Squares	df	Mean Square	F	Sig.
Nutritional level	.067	1	.067	.452	.502
Going to coffee shops	.987	1	.987	.510	.475
Going to the cinema	2.375	1	2.375	1.549	.214
Going to a nightclub	10.010	1	10.010	5.186	.023
Dietary habits	.605	1	.605	.877	.349
Breakfast	7.351	1	7.351	3.537	.060
Lunch	30.815	1	30.815	12.847	.000
Dinner	.077	1	.077	.067	.795
Exercise	32.697	1	32.697	93.658	.000

Differences between male and female students in attitudes towards dietary habits (Table 6) are visible in items: "Have you had breakfast in the last month?" (FHA 01), which is statistically significant at the level of p = .044; "What type of fat do you most frequently use when preparing food at home?" (FHA 02), p = .036; "How often do you eat cabbage, kale, cauliflower, broccoli, etc.?" (FHA 15), p = .020; "How many cups of tea do you drink on a daily basis?" (FHA 07), p = .009; "How often do you eat legumes (French beans, peas, beans, lentils, soya beans, etc.?" (FHA 16), (sig. = .007); "How often do you eat preserved dry-cured meat products?" (FHA 19), p = .002; "How often do you eat cake, cookies or other sweets?" (FHA 20), p = .000; "Have you been advised to change your dietary habits in the past year?" (FHA 22), p = 000; "Have you consumed any alcoholic beverages in the past year?" (FHA 23), p = .000; "How often do you drink hard liquor?" (FHA 24), p = 002; "How often do you drink beer?" (FHA 26), p = 000; "How often do you consume energy drinks?" (FHA 27), p = 000; "How often do you consume carbonated drinks?" (FHA 28), p = 001. In other variables, there are no statistically significant differences observed between male and female students treated in this research.

Table 6: Differences between male and female students in attitudes towards dietary habits

Items	ANOVA				
	Sum of Squares	df	Mean Square	F	Sig.
FHA 01	1.273	1	1.273	4.086	.044
FHA 02	1.404	1	1.404	4.421	.036
FHA 03	.662	1	.662	.367	.545
FHA 04	1.994	1	1.994	1.814	.179
FHA 05	1.548	1	1.548	3.059	.081
FHA 06	.001	1	.001	.001	.974
FHA 07	2.263	1	2.263	6.772	.009
FHA 08	.017	1	.017	.016	.900
FHA 09	7.391	1	7.391	3.654	.056
FHA 10	.500	1	.500	1.132	.288
FHA 11	1.696	1	1.696	2.945	.087
FHA 12	.024	1	.024	.032	.858
FHA 13	1.772	1	1.772	1.979	.160
FHA 14	.310	1	.310	.688	.407
FHA 15	3.965	1	3.965	5.466	.020
FHA 16	4.048	1	4.048	7.254	.007
FHA 17	2.130	1	2.130	2.830	.093
FHA 18	.456	1	.456	.622	.431
FHA 19	5.293	1	5.293	9.250	.002
FHA 20	12.985	1	12.985	16.411	.000
FHA 21	2.813	1	2.813	7.838	.005

FHA 22a	.003	1	.003	.029	.865
FHA 22b	.081	1	.081	.974	.324
FHA 22c	3.444	1	3.444	14.522	.000
FHA 22d	2.367	1	2.367	11.561	.001
FHA 23	3.967	1	3.967	16.915	.000
FHA 24	11.160	1	11.160	10.135	.002
FHA 25	3.543	1	3.543	3.553	.060
FHA 26	80.007	1	80.007	56.800	.000
FHA 27	79.267	1	79.267	38.479	.000
FHA 28	21.997	1	21.997	10.959	.001
FHA 29a	.004	1	.004	.092	.762
FHA 29b	.001	1	.001	.030	.861
FHA 29c	.002	1	.002	.019	.891
FHA 29d	.000	1	.000	.004	.950

The difference between male and female students in attitudes towards smoking (Table 7) indicates the following: Items: "How many hours a day do you spend in a place where someone smokes?" (SMO 02), which has a statistically significant difference at the level of p = .009; "Are you concerned about the adverse effects smoking can have on your health?" (SMO 03), p = .000, while other variables did not have a noticeable statistically significant difference.

Table 7: Differences between male and female students in attitudes towards smoking

Items	ANOVA				
	Sum of Squares	df	Mean Square	F	Sig.
SMO 01	.015	1	.015	.065	.798
SMO 02	8.452	1	8.452	6.859	.009
SMO 03	14.259	1	14.259	13.905	.000
SMO 04	.065	1	.065	.257	.612
SMO 05	.175	1	.175	.259	.611
SMO 06	.474	1	.474	.993	.319
SMO 07	2.867	1	2.867	.411	.521

For differences between male and female students in attitudes towards the quality of life, the item - "How much are you generally satisfied with your life?" (QOL 01) indicates that there is a statistically significant difference at the level of p = .01 between the groups of male and female students.

Table 8: Differences in male and female students' attitudes towards the quality of life

Item	ANOVA				
	Sum of Squares	df	Mean Square	F	Sig.
QOL 01	49.518	1	49.518	21.327	.000

DISCUSSION

For the largest number of analysed characteristics, the results obtained in this research are in accordance with the existing knowledge on students' healthy lifestyles (Krolo, 2019; Macanović et al., 2013; Teofilović, 2019). The students from the analysed sample most frequently spend their leisure time in their own space at the faculty, most often working on a computer and listening to music. They express a relatively high satisfaction with the quality of life. The results on student health indicate the necessity for further research in this area so as to determine the significant correlates of the obtained results and design programmes (perhaps within the frame of the existing study programmes, e.g., by strengthening the courses or introducing a compulsory course of sports and physical education) which would be directed towards improving the physical and psychological health of students, as confirmed by other research (Carević, 2019; Stojković, Ralić, & Latas, 2010). Health is the fundamental and necessary right for the society as a whole (Borić, 2020). The state of physical, psychological and social welfare implies continuous improvement of the conditions pertaining to the

personal and social characteristics in which an individual is developed so as to achieve better and more successful quality of life. One of the fundamental and primary tasks of physical and health education professionals is promoting healthy lifestyles. The problem of youth nutrition is still one of the leading public health challenges both at the international level and in our region. The nutritional status of the youth is a reflection of their general health, i.e., their lifestyles. By improving healthy lifestyles, we build a better relationship and method of the very health, trends, social characteristics as well as life skills and habits (Deliens et al., 2014; Lee & Loke, 2005). Differences between male and female students in attitudes expressed in general survey questions on habits determine the lifestyle which, in its broadest sense, relates to the way of life and the attitude towards one's own life. Life habits greatly determine the health status - positive life habits enhance health and affect the quality of life, while negative ones harm health and create problems in everyday life (Kovačević et al.). By observing the differences between male and female students in attitudes towards dietary habits, it is visible that male and female students have poor dietary habits, which reflects in a relatively high prevalence of overweight and obesity in this population. The data obtained in other research also show that poor dietary habits are equally frequent among both genders (Bibić, 2018; Kujadin, 2016; Tomić, Fočić, Marijanović, & Topličanec, 2012). Differences in dietary habits probably sustain the students' lifestyle which can include eating away from home or the inability to prepare one's own meal due to time constraints. Data on the differences in student attitudes towards dietary habits impose the need to consider an adequate method of helping and supporting students and the general significance of higher education in promoting and maintaining physical and psychological health as well as proper nutrition so as to persevere and promote health. Differences between male and female students in attitudes towards smoking indicate that the students are aware of the adverse effects of smoking, as well as that a large number of students, alongside consuming cigarettes, spend their time in spaces where smoking is allowed. The majority of research conducted on attitudes towards smoking indicated that students consume cigarettes due to satisfaction, which is the main reason for smoking, followed by stress and curiosity (Cooke et al., 2016; Haddad & Malak, 2002; Patrick et al., 1994). Students' lifestyle and their habits often become worse during the years spent studying even though most students consider their habits to be proper. The factors placing students at risk are skipping meals, lack of a varied diet and frequent consumption of fast food (Driskell, Kim, & Goebel, 2005). Female students are more motivated and interested in their health, body weight and the overall appearance than male students (Lua & Elena, 2012).

CONCLUSION

Since this research is focused on male and female students who are in a period of transitioning form adolescence to a young adult age marked by specific life changes, it is possible to adopt undesirable forms of behaviour, including a decrease of physical activity. Considering that the student age is the last step in the educational process, offering great possibilities to systematically affect the adoption of healthy habits in life, and taking into account the evidence of the past research on numerous benefits of physical activity, it is necessary to target the increase of the students' physical activity levels. Additionally, the adopted habits of engaging in regular physical activity are transferred into adulthood, positively affecting health. Knowledge on the positive effect of physical activity on students' health and its contribution in explaining the health-related quality of life in students go in favour of positive health benefits of physical activity in the student population. The awareness of the quality of physical activity and dietary habits can be useful in planning the development of programmes aiming at increasing the very knowledge of students' healthy lifestyles. Since dissatisfaction with physical appearance can cause serious health problems, such as depression, obesity and eating disorders, the awareness of a positive relationship between physical activity and satisfaction with physical appearance can affect an increase in the level of physical activity, contributing to a positive perception of physical appearance, which will directly affect better health. Moreover, the positive relationship of happiness and life satisfaction with physical fitness and care for body weight as components of perceiving physical appearance have been proven. Therefore, an increase in the level of physical activity indirectly affects life satisfaction. The practical contribution of this research reflects in the fact that determining the level of physical activity, dietary habits, satisfaction with the quality of life, and attitudes towards the health status are the first step in the process of planning and implementing strategies directed towards increasing healthy lifestyles in male and female students. The fast lifestyle, as well as many other obligations lead students to stop engaging in physical activities. The time spent at the faculty is lengthy, which is why they often have insufficient time for studying, let alone engaging in some physical activity. This is not the only reason; there are more. The reason is poor habits the students acquired in life.

REFERENCES

1. Almutairi, K. M., Alonazi, W. B., Vinluan, J. M., Almigbal, T. H., Batais, M. A., Alodhayani, A. A., . . . Aboshaiqah, A. E. (2018). Health promoting lifestyle of university students in Saudi Arabia: a cross-sectional assessment. BMC public health, 18(1), 1-10.
2. Bibić, V. (2018). Prehrambene navike studenata. University of Split. University of Split, Faculty of science. Department of ....
3. Borić, N. (2020). SVJETSKA ZDRAVSTVENA ORGANIZACIJA I PRAVO NA ZDRAVLJE. Legal Thought/Pravna Misao.
4. Bouchard, C., Blair, S. N., & Haskell, W. L. (2012). Physical activity and health: Human Kinetics.
5. Carević, G. (2019). Znanje i stavovi studenata zdravstvenih studija o fizičkoj aktivnosti i pravilnoj prehrani. University of Split. University Department of Health Studies.
6. Cooke, M. E., Nasim, A., Cho, S. B., Kendler, K. S., Clark, S. L., & Dick, D. M. (2016). Predicting tobacco use across the first year of college. American journal of health behavior, 40(4), 484-495.
7. Deliens, T., Clarys, P., De Bourdeaudhuij, I., & Deforche, B. (2014). Determinants of eating behaviour in university students: a qualitative study using focus group discussions. BMC public health, 14(1), 1-12.
8. Deliens, T., Deforche, B., De Bourdeaudhuij, I., & Clarys, P. (2015). Determinants of physical activity and sedentary behaviour in university students: a qualitative study using focus group discussions. BMC public health, 15(1), 1-9.
9. Driskell, J. A., Kim, Y.-N., & Goebel, K. J. (2005). Few differences found in the typical eating and physical activity habits of lower-level and upper-level university students. Journal of the American dietetic association, 105(5), 798-801.
10. Haddad, L. G., & Malak, M. Z. (2002). Smoking habits and attitudes towards smoking among university students in Jordan. International journal of nursing studies, 39(8), 793-802.
11. Kovačević, E., Abazović, E., Ibrahimović, M., Mekić, A., Čaušević, D., Vrcić, M., . . . Bajramović, I. Pretilost studenata Univerziteta u Sarajevu.
12. Krolo, A. (2019). Povezanost između navika spavanja i prehrambenih navika u studenata medicine. University of Split. School of Medicine. Public health.
13. Kujadin, M. (2016). Prehrambene navike studenata Fakulteta za odgojne i obrazovne znanosti u Osijeku. Josip Juraj Strossmayer University of Osijek. Faculty of Education.
14. Lee, R. L., & Loke, A. J. Y. (2005). Health-promoting behaviors and psychosocial well-being of university students in Hong Kong. Public health nursing, 22(3), 209-220.
15. Lua, P. L., & Elena, W. D. W. P. (2012). The impact of nutrition education interventions on the dietary habits of college students in developed nations: a brief review. The Malaysian journal of medical sciences: MJMS, 19(1), 4.
16. Macanović, G., Marković, D., Ferati, A., Arsić, J., Jocić, I., Arsić, K., . . . Jocic, I. (2013). Fizička aktivnost studenata. PONS, 137.
17. Patrick, D. L., Cheadle, A., Thompson, D. C., Diehr, P., Koepsell, T., & Kinne, S. (1994). The validity of self-reported smoking: a review and meta-analysis. American journal of public health, 84(7), 1086-1093.
18. Stojković, T., Ralić, T., & Latas, M. (2010). Kvalitet života kod studenata medicinskog fakulteta: Engrami.
19. Teofilović, B. (2019). Prehrambene i životne navike studenata u Novom Sadu. Josip Juraj Strossmayer University of Osijek. FACULTY OF FOOD TECHNOLOGY ....
20. Tirodimos, I., Georgouvia, I., Savvala, T., Karanika, E., & Noukari, D. (2009). Healthy lifestyle habits among Greek university students: differences by sex and faculty of study. EMHJ-Eastern Mediterranean Health Journal, 15 (3), 722-728, 2009.
21. Tomić, M., Fočić, N., Marijanović, B., & Topličanec, J. (2012). Navike hrvatskih studenata u potrošnji brze hrane. Agronomski glasnik: Glasilo Hrvatskog agronomskog društva, 74(5-6), 231-241.
22. Tremblay, M. S., Colley, R. C., Saunders, T. J., Healy, G. N., & Owen, N. (2010). Physiological and health implications of a sedentary lifestyle. Applied physiology, nutrition, and metabolism, 35(6), 725-740.
23. Wills, J., & Kelly, M. (2017). What works to encourage student nurses to adopt healthier lifestyles? Findings from an intervention study. Nurse education today, 48, 180-184.

RAZLIKE U STAVOVIMA STUDENATA/ICA O ZDRAVIM ŽIVOTNIM STILOVIMA

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Ključne riječi: student, zdravi životni stilovi, tjelesna aktivnost, prehrambene navike, pušenje, kvaliteta života

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