DALIBORKA STANKOVIĆ, ET AL.
THE EFFECT OF A SIX-MONTH TRAINING PROCESS ON THE ANTHROPOLOGICAL STATUS OF THE FEMALE CADET VOLLEYBALL PLAYERS

SPORTS SCIENCE AND HEALTH **14**(V):26-33

THE EFFECT OF A SIX-MONTH TRAINING PROCESS ON THE ANTHROPOLOGICAL STATUS OF THE FEMALE CADET VOLLEYBALL PLAYERS

EFEKAT ŠESTOMESEČNOG TRENAŽNOG PROCESA NA ANTROPOLOŠKI STATUS ODBOJKAŠICA KADETSKOG UZRASTA

DALIBORKA STANKOVIĆ, KONSTANTINOS STRATAKIS

Faculty of Medicine, University of Belgrade

Correspondence:
Daliborka Stanković
Faculty of Medicine, University of Belgrade
daliborka7.ds@gmail.com

Medicinski fakultet, Univerzitet u Beogradu, Srbija

Korespondencija:
Daliborka Stanković
Medicinski fakultet, Univerzitet u Beogradu, Srbija
daliborka7.ds@gmail.com

Abstract: *The aim of this study was to determine any potential differences in the changes of individual anthropometric characteristics and motor skills of female volleyball players from the DIF volleyball school, aged between 12-15 years, who were tested before and after a continuous six-month training process. The sample consisted of 50 female volleyball players from the DIF volleyball school, aged 12-15 years, who trained four times a week for 90 minutes per session. All subjects were tested before and after the six-month continuous training process. Anthropometric characteristics, such as body height, body mass, body fat percentage, muscle percentage, body mass index, and arm span measurement, were determined for all subjects. Motor skills were also evaluated, including hand grip strength, flexibility of the muscles of the back of the thigh, flexibility of the shoulder girdle, explosiveness of the shoulder girdle muscles, explosiveness of the leg muscles (high jump), and agility. The results showed a statistically significant difference in body height, BMI, arm span, hand grip strength, overhead stick rotation, sit and reach, and medicine ball throwing. One of the limitations of this study was the insufficient sample size. However, despite this limitation, the results can be considered as a significant initial basis for examining the relationship between anthropometric parameters and motor skills, which can contribute to the existing knowledge in this area. It is important to note that only well-dosed and organized physical activity can lead to improvement in the results of young athletes.*

Keywords: *training, motor skills, anthropometric characteristics, continuous training process, physical activity.*

Sažetak: *Cilj ovog istraživanja je bio da se utvrdi da li postoji razlika u promeni individualnih antropometrijskih karakteristika i motoričkih sposobnosti odbojkašica škole odbojke DIF, uzrasta 12-15 godina, koje su testirane pre i posle kontinuiranog trenažnog procesa u trajanju od šest meseci. Uzorak je uključivao 50 ispitanika – odbojkašica škole odbojke DIF uzrasta 12-15 godina, koje su trenirale odbojku četiri puta nedeljno i svaki trening je trajao 90 minuta. Odbojkašice su testirane pre i nakon kontinuiranog trenažnog procesa u trajanju od 6 meseci. Svim ispitanicama su se određivale antropometrijske karakteristike - telesna visina, telesna masa, procenat telesnih masti, procenat mišića i indeks telesne mase, merenje raspona ruku. Zatim su procenjene motoričke sposobnosti: jačina stiska šake, fleksibilnost mišića zadnje lože buta, fleksibilnost ramenog pojasa, eksplozivnost mišića ramenog pojasa, eksplozivnost mišića nogu (skok uvis) i agilnost. Rezultati ukazuju na to da je postojala statistički značajna razlika u varijablama telesna visina, BMI, raspon ruku, jačina stiska šake, iskret palicom, pretklon u sedu i bacanje medicinke. Kao nedostatak ovog istraživanja, može da se navede nedovoljno veliki uzorak ispitanika. Uprkos ograničenjima ovog istraživanja, dobijeni rezultati mogu biti značajna inicijalna osnova za ispitivanje relacije antropometrijskih parametara i motoričkih znanja, što omogućava relevantan teorijski doprinos postojećim saznanjima u ovoj oblasti. Samo dobro dozirana i organizovana fizička aktivnost može dovesti do poboljšanja u rezultatima mladih sportista.*

Ključne reči: *trening, motoričke sposobnosti, antropometrijske karakteristike, kontinuirani trenažni proces, fizička aktivnost.*

INTRODUCTION

Each sport or sport branch has its unique set of factors that influence the outcome. Different types of

UVOD

Svaki sport, odnosno sportska grana ima svoju jedinstvenu strukturu faktora koji utiču na sportski rezultat. Sva-

sports demand specific skills, which are developed through training. The scope, intensity, and type of training play a crucial role in shaping the human body and the movements it can perform. Thus, different sports create different motor skill profiles for each of them (Ferioli, Rampinini, Bosio, La Torre, Azzolini & Coutts, 2018). Volleyball is an engaging, interesting, complex, and dynamic sport. The game involves quick transfer of actions from one side of the court to the other, and teams strive to win by achieving a greater number of points through successful attacking or outsmarting the opponent. Volleyball demands a series of motor actions to be performed correctly and efficiently; therefore, training to improve those elements positively impacts the development of motor skills (Nešić, Sikimić, Ilić, & Stojanović, 2011). Volleyball training for children should not be a mini version of adult training. At the beginning, training should focus on the development of children's physical, cognitive, and social skills, not on volleyball game demands. Additionally, the training should follow a pedagogical approach towards children, as significant mistakes can occur otherwise (Janković & Marelić, 2003). Several scientific studies have recorded a significant number of similar studies demonstrating the influence of the training process on the anthropological status of female volleyball players. Nešić, Ilić, Majstorović, Grbić, & Osmankač (2013) examined quantitative changes in general and specific motor skills influenced by a three-month experimental treatment of volleyball training. The authors found that the experimental program contributed to a positive shift in all variables (standing long jump, block range, 20m run, Russell-Lange test - fingering, Russell - Lange's test - "bump," and Russell-Lange's test - serve) in a sample of 40 female volleyball players aged 13-14 years. In another study, Nešić, Majstorović, Osmankač, Milenkoski, and Uslu (2014) concluded that different ages of young volleyball players showed significant differences in motor skills such as agility, jumpiness, flexibility, and noticed anthropometric characteristics, a consequence of the positive effects of continuous training. Lehnert, Sigmund, Lipinska, Vařeková, Hroch, & Xaverová (2017) conducted a study where twelve young female volleyball players participated in an eight-week preseason training program. The results indicated numerous positive changes in physical performance and the risk of injury, despite the lack of body mass and its composition.

The aim of this study is to determine the potential difference in change of individual anthropometric char-

ka vrsta sporta, pred onoga ko se njome bavi, stavlja karakteristične zahteve u pogledu sposobnosti koje su potrebne za uspešno učestvovanje i takmičenje. Te sposobnosti se razvijaju i unapređuju kroz treninge koji svojim obimom, tipom i intenzitetom utiču na oblikovanje ljudskog tela i kretnji koje ono može da izvede, pa tako različite sportske grane kreiraju drugačije profile motoričkih sposobnosti kod svakog od njih (Ferioli, Rampinini, Bosio, La Torre, Azzolini, Coutts, 2018). Odbojka je vrlo atraktivna, interesantna, kompleksna i dinamična sportska grana, sa brzim transferom akcija sa jedne strane terena na drugi, u kojoj timovi nastoje da dođu do pobede postignuvši veći broj poena, putem uspešnog napada ili nadmudrivanjem protivnika. S obzirom da osnovni odbojkaški elementi uključuju i čitav niz motoričkih radnji kako bi njihovo izvođenje bilo pravilno, ujedno i efikasno, razumljivo je i potpuno opravdano očekivati da će trenažni rad na poboljšanju tih elemenata uticati i na razvoj motoričkih sposobnosti (Nešić, Sikimić, Ilić i Stojanović, 2011). Trening odbojke za decu nije „mala" verzija treninga za odrasle. U početku trening mora biti zasnovan na razvoju fizičkih, kognitivnih i socijalnih sposobnosti dece, a ne na zahtevima odbojkaške igre. Takođe, jako bitno je da se trening bazira na pedagoškom pristupu trenera u odnosu na dete, jer je moguće napraviti velike greške ukoliko se drugačije bude radilo (Janković i Marelić, 2003). Treneri mlađih kategorija moraju znati kada je optimalno vreme za početak bavljenja odbojkom, kada je vreme za specijalizaciju po igračkim funkcijama i u kojem uzrastu možemo očekivati vrhunske rezultate. Postoji nekoliko faza sportskog razvoja s obzirom na uzrast (Bompa, 2000): inicijacija (početna faza treninga za uzrast od 6 do 10 godina), oblikovanje sportiste (uzrast od 11 do 14 godina), specijalizacija (uzrast od 15 do 18 godina), vrhunski sport (uzrast od 19 godina i stariji). U dosadašnjim naučno-istraživačkim radovima, zabeležen je značajan broj sličnih studija koje su pokazale uticaj trenažnog procesa na antropološki status odbojkašica.

Nešić, Ilić, Mjstorović, Grbić i Osmankač (2013) ispitivali su kvantitativne promene u opštim i specifičnim motoričkim sposobnostima pod uticajem tromesečnog eksperimentalnog tretmana – trening odbojke. Na uzorku od 40 odbojkašica uzrasta 13-14 godina, autori su ustanovili da je eksperimentalni program doprineo pozitivnom pomaku u svim varijablama (skok u dalj iz stojećeg položaja, domet iz bloka, trčanje na 20 m, Rasel-Langeov test - prsti , Rasel – Langeov test – „čekić" i Rasel-Langeov test – servis), što je slučaj i kod naših odbojkašica testiranih nakon programa treninga od šest meseci. U drugoj studiji, koju su sproveli Nešić, Majstorović, Osmankač, Milenkoski i Uslu (2014) je zaključeno da među mladim odbojkašima različitog uzrasta postoje značajne razlike u motoričkim sposobnostima kao

DALIBORKA STANKOVIĆ, ET AL.
THE EFFECT OF A SIX-MONTH TRAINING PROCESS ON THE ANTHROPOLOGICAL STATUS OF THE FEMALE CADET VOLLEYBALL PLAYERS

SPORTS SCIENCE AND HEALTH **14**(V):26-33

acteristics and motor skills of female volleyball players from the "DIF" volleyball school, aged 12-15 years, who were tested before and after six months of continuous training.

METHOD

A prospective study was conducted to assess the motor skills and physical characteristics of 50 female volleyball players aged 12-15 years, who trained four times a week at the "DIF" volleyball school. The training sessions lasted 90 minutes and included technical elements of the spike, serve, fingering, and bump, as well as strength exercises. The focus was on the development and learning of the technique. The study included only those players who did not have any injury that could affect the results. Anthropometric characteristics such as body height, body mass, body fat percentage, muscle percentage, and body mass index were measured using appropriate instruments. Arm span was measured using a meter. Motor skills were assessed using various techniques such as hand grip strength using a dynamometer, hamstring flexibility using a box, shoulder girdle flexibility using a stick, shoulder girdle muscle explosiveness using a medicine ball, leg muscle explosiveness using high jump and vertical jump tests, and agility using the X test. The data obtained was analyzed using descriptive statistics, and all measurements were described by mean, standard deviation, minimum, maximum, coefficient of variation, and t-test for dependent samples. Excel and statistical programs were used for database preparation and processing. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1 displays the average body height of 161.5 cm at the initial measurement, while in Table 2, the final measurement shows an average height of 163 cm. The body mass did not show significant changes. The arm span was 162 cm in the first measurement and increased proportionally to 163 cm in the final measurement. As body height increases, there is a corresponding increase in arm span, which can sometimes exceed body height, as it did in the first measurement. The coefficient of variability for body height was the lowest at 5%, while for arm span, it was slightly higher at 7%.

As for the motor skills, Table 3 shows the smallest coefficient of variability was noticed in the test for assessing agility (X test), while the largest one appears in the flexibility test - sit and reach as well as in the leg muscle explosiveness test - squat jump.

što su agilnost, skočnost, gipkost, kao i u uočenim antropometrijskim karakteristikama, što je posledica pozitivnih efekata kontinuiranog trenažnog procesa.

Lehnert, Sigmund, Lipinska, Vařeková, Hroch I Xaverová (2017) sproveli su studiju u kojoj je dvanaest mladih odbojkašica učestvovalo u osmonedeljnom programu predsezonskog treninga. Rezultati studije ukazuju na brojne pozitivne promene u fizičkim performansama i riziku od povreda, uprkos nedostatku promena telesne mase i sastava.

Cilj ovog istraživanja je bio da se utvrdi da li postoji razlika u promeni individualnih antropometrijskih karakteristika i motoričkih sposobnosti odbojkašica škole odbojke „DIF", uzrasta 12-15 godina, koje su testirane pre i posle kontinuiranog trenažnog procesa u trajanju od šest meseci.

METOD RADA

Istraživanje je sprovedeno po tipu prospektivne studije. U ovom istraživanju je uključeno 50 devojčica – odbojkašica škole odbojke „DIF" uzrasta 12-15 godina, koje su trenirale odbojku četiri puta nedeljno i svaki trening je trajao 90 minuta. Na treningu su izvođeni tehnički elementi smeča, servisa, odigravanje prstima i čekićem, kao i elementi bloka, kombinovani sa vežbama snage. Takođe trening je bio usmeren na učenje i razvoj tehnike. Kriterijum za uključivanje u studiju bio je da ispitanici nemaju nikakve povrede koje bi mogle da utiču na rezultate studije. Odbojkašice su testirane pre i nakon kontinuiranog trenažnog procesa u trajanju od 6 meseci na Fakultetu sporta i fizičkog vaspitanja, Univerziteta u Beogradu. Svim ispitanicama su se određivale antropometrijske karakteristike (Macura, 2007) - pomoću Antropometra po Martinu merena je telesna visina (TV), pomoću vage „tanita BC545n" merene su telesna masa (TM), procenat telesnih masti (PM), procenat mišića (%M) i indeks telesne mase (BMI), pomoću metra izvršeno je merenje raspona ruku (RR). Zatim su procenjene motoričke sposobnosti: jačina stiska šake pomoću dinamometra (MS) (Zarić, Dopsaj i Marković, 2018), fleksibilnost mišića zadnje lože buta pomoću sanduka (PuS) (Ayán, Álvarez, González, & de Quel Martínez, 2018), fleksibilnost ramenog pojasa pomoću palice (IP), eksplozivnost mišića ramenog pojasa pomoću bacanja medicinke (BM) (Van den Tillaar i Marques, 2013), eksplozivnost mišića nogu (skok uvis, vertikalni skok) pomoću opto jump testa i Sardžent testa (SKOK i VS) (Heishman, Daub, Miller, Freitas, Frantz i Bemben, 2020) i agilnost pomoću X (iks) testa (X test) (Majstorović, Nešić, Grbić, Savić i Dopsaj, 2019)..

Analiza dobijenih podataka vršila se metodama deskriptivne statistike. Za pripremu baze podataka i statističku obradu je korišćen Excel i statistički program.

Daliborka Stanković, et al.
Efekat šestomesečnog trenažnog procesa na antropološki status odbojkašica kadetskog uzrasta

Sports Science and Health **14**(V):26-33

Table 1. Results of descriptive statistics of anthropometric characteristics - initial measurement

Tabela 1. Rezultati deskriptivne statistike antropometrijskih karakteristika – inicijalno merenje

	BH/TV	**AS**/RR	**BM**/TM	**BMI**/BMI	**FP**/PM	**%M**/%M
N/N	50	50	50	50	50	50
M/ SV	161.50	162.23	55.11	20.98	22.63	34.25
SD/ SD	8.98	10.75	11.24	3.13	6.68	2.30
Min/ Min	142.0	138.5	35	14.2	7.7	30.5
Max/ Max	177.4	187.4	79	27.1	33.1	39.2
cV%(x100)	0.05	0.07	0.20	0.15	0.30	0.07

BH- body height; **AS** – arm span; **BM** – body mass; **BMI** – body mass index; **FP** – fat percentage; **%M** –muscle percentage; **N** – total number of subjects; **M** – mean; **SD** – standard deviation; **Min** – minimum; **Max** – maximum; **cV%** - variable coefficient

TV- telesna visina; **RR** – raspon ruku; **TM** – telesna masa; **BMI** – indeks telesne mase; **PM** – procenat masti; **%M** – procenat mišića; **N** – ukupan broj ispitanika; **SV** – srednja vrednost; **SD** – standardna devijacija; **Min** – minimum; **Max** – maksimum; **cV%** - koeficijent varijacije

Table 2. Results of descriptive statistics of anthropometric characteristics - final measurement

Tabela 2. Rezultati deskriptivne statistike antropometrijskih karakteristika – finalno merenje

	BH/TV	**AS**/RR	**BM**/TM	**BMI**/BMI	**FP**/PM	**%M**/%M
N/N	50	50	50	50	50	50
M/ SV	163.16	163.44	55.42	20.56	22.69	34.29
SD/ SD	8.61	10.70	11.37	3.07	6.22	2.21
Min/ Min	145.00	142.00	31.00	13.61	10.70	30.06
Max/ Max	179.00	189.00	77.00	28.19	33.80	38.90
cV%(x100)	0.05	0.06	0.20	0.15	0.27	0.06

BH- body height; **AS** – arm span; **BM** – body mass; **BMI** – body mass index; **FP** – fat percentage; **%M** –muscle percentage; **N** – total number of subjects; **M** – mean; **SD** – standard deviation; **Min** – minimum; **Max** – maximum; **cV%** - variable coefficient

TV- telesna visina; **RR** – raspon ruku; **TM** – telesna masa; **BMI** – indeks telesne mase; **PM** – procenat masti; **%M** – procenat mišića; **N** – ukupan broj ispitanika; **SV** – srednja vrednost; **SD** – standardna devijacija; **Min** – minimum; **Max** – maksimum; **cV%** - koeficijent varijacije

Table 3. Results of descriptive statistics of motor skills - initial measurement

Tabela 3. Rezultati deskriptivne statistike motoričkih sposobnosti – inicijalno merenje

	R_MG/ D_MS	**L_MG**/ L_MS	**JUMP**/ SKOK	**OSP**/ IP	**SiR**/ PuS	**X_test**/ X_test	**MT**/ BM
N/N	50	50	50	50	50	50	50
M/ SV	234.34	216.78	27.76	74.56	21.49	9.08	5.82
SD/ SD	72.00	72.89	10.53	15.32	5.84	1.34	1.30
Min/ Min	96.00	98.00	9.8	25	7.0	1.60	3.00
Max/ Max	392.00	389.00	56.3	101	32.0	11.70	8.00
cV% (x100)	0.31	0.34	0.38	0.20	0.27	0.15	0.22

MG – maximum hand grip; **JUMP** – squat jump; **OSP** – overhead stick rotation, **SiR** – sit and reach, **MT** – medicine ball throwing; **R** – right ; **L** – left; **N** – total number of subjects; **M** – mean; **SD** – standard deviation; **Min** – minimum; **Max** – maximum; **cV%** - variable coefficient

TV- telesna visina; **RR** – raspon ruku; **TM** – telesna masa; **BMI** – indeks telesne mase; **PM** – procenat masti; **%M** – procenat mišića; **N** – ukupan broj ispitanika; **SV** – srednja vrednost; **SD** – standardna devijacija; **Min** – minimum; **Max** – maksimum; **cV%** - koeficijent varijacije

Sva merenja su opisana merama centralne tendencije, srednja vrednost (SV), standardna devijacija (SD), minimum (MIN), maksimum (MAX), koeficijent varijacije rezultata (%cV) i t test za zavisne uzorke (t test). Sve vrednosti p ispod 0.05 biće smatrane statistički značajnim.

Daliborka Stanković, et al.
The Effect of a Six-Month Training Process on the Anthropological Status of the Female Cadet Volleyball Players

Sports Science and Health **14**(V):26-33

Table 4. Results of descriptive statistics of motor skills - final measurement

Tabela 4. Rezultati deskriptivne statistike motoričkih sposobnosti – finalno merenje

	R_MG/ D_MS	L_MG/ L_MS	JUMP/ SKOK	OSP/ IP	SiR/ PuS	X_test/ X_test	MT/ BM
*N/*N	50	50	50	50	50	50	50
M/ SV	213.42	194.92	29.98	76.04	23.66	9.09	5.98
SD/ SD	56.88	58.12	6.87	15.23	6.36	.86	1.33
Min/ Min	100.00	79.00	14.00	28	7.00	7.17	3.00
Max/ Max	373.00	329.00	45.00	105	34.00	11.70	8.55
cV% (x100)	0.27	0.30	0.23	0.20	0.27	0.09	0.22

MG – *maxmum hand grip;* **VJ** – *vertical jump;* **OSP** – *overhead stick rotation,* **SiR** – *sit and reach,* **MT** – *medicine ball throwing;* **R** – *right ;* **L** – *left;* **N** – *total number of subjects;* **M** – *mean;* **SD** – *standard deviation;* **Min** – *minimum;* **Max** – *maximum;* **cV%** - *variable coefficient*

MS - *maksimalni stisak šake;* **VS** – *vertikalni skok;* **IP** – *iskret palicom,* **PuS** – *pretklon u sedu,* **BM** – *bacanje medicinke;* **D** – *desna ;* **L** – *leva;* **N** – *ukupan broj ispitanika;* **SV** – *srednja vrednost;* **SD** – *standardna devijacija;* **Min** – *minimum;* **Max** – *maksimum;* **cV%** - *koeficijent varijacije*

Table 5. Results of statistical difference (statistical significance) of subjects tested – initial and final testing comparison, assessment and evaluation of morphological characteristics and motor skills (t-test for small dependent samples)

Tabela 5. Rezultati statističke razlike (statistička značajnost) testiranih ispitanika – poređenje početnog i krajnjeg testiranja, procena i evaluacija morfoloških i motoričkih karakteristika i veština (t-test za male zavisne uzorke)

	T	df	P
BH −BH1 / TV −TV1	-8.32	49	**.001**
AS − AS1 / RR − RR1	-3.55	49	**.001**
BM − BM1 / TM − TM1	-0.65	49	.519
BMI − BMI1 / BMI − BMI1	2.10	49	**.040**
FP − FP1 / PM − PM1	-0.21	49	.834
%M - %M1 / %M - %M1	-0.46	49	.649
R_MG − R_MG1 / D_MS − D_MS1	3.62	49	**.001**
L_MG − L_MG1 / L_MS − L_MS1	3.48	49	**.001**
Jump− VJ / Skok − VS	-1.81	49	.077
OSP − OSP1 / IP − IP1	-3.71	49	**.001**
SiR − SiR1 / PuS − PuS1	-5.38	49	**.000**
X test − X test1 / X test − X test1	1.86	49	.069
MT − MT1 / BM − BM1	-0.02	49	**.024**

BH- *body height;* **AS** – *arm span;* **BM** – *body mass;* **BMI** – *body mass index;* **FP** – *fat percentage;* **%M** –*muscle percentage;* **MG** – *maximum hand grip*; **JUMP** – *squat jump;* **VJ** – *vertical jump;* **OSP** – *overhead stick rotation,* **SiR** – *sit and reach;* **MT** – *medicine ball throwing;* **R** – *right ;* **L** – *left;* **t** – *students' t-division;* **df** – *degree of freedom;* **p** – *possibility*

TV- *telesna visina;* **RR** – *raspon ruku;* **TM** – *telesna masa;* **BMI** – *indeks telesne mase;* **PM** – *procenat masti;* **%M** – *procenat mišića;* **MS** - *maksimalni stisak šake;* **SKOK** – *skok sa počučnjem;* **VS** – *vertikalni skok;* **IP** – *iskret palicom,* **PuS** – *pretklon u sedu,* **BM** – *bacanje medicinke;* **D** – *desna ; L – leva; t – studentova t-raspodela; df – stepen slobode; p – verovatnoća*

Table 5 shows the obtained statistically significant change in variables: body height, arm span and BMI, while based on the mean values of motor skills between the first and second measurements, a statistically significant change was obtained in variables: maximum hand grip (maximum force), overhead stick rotation, sit and reach and medicine ball throwing.

REZULTATI

U tabeli 1 vidimo da je prosečna telesna visina nakon inicijalnog merenja bila je 161.5cm dok je na finalnom merenju (tabela 2) prosečna visina 163cm, telesna masa se nije značajno promenila, raspon ruku je bio 162cm dok je na finalnom merenju bio 163cm (povećanjem telesne

Daliborka Stanković, et al.
Efekat šestomesečnog trenažnog procesa na antropološki status odbojkašica kadetskog uzrasta

Sports Science and Health **14**(V):26-33

Discussion

In terms of anthropometric characteristics, this study found that there were no statistically significant differences in body mass, body fat percentage, and muscle after six months of continuous training. However, differences were observed in body height, BMI, and arm span. Body height results obtained were somewhat expected, because in this sport, selection, among other things, is carried out in relation to the body height required for certain playing positions. Body height is of great importance in volleyball (Banković, 2023). As the arm span is biologically directly related to body height, this is also the reason for the statistically significant difference (Rahmayani, Rumapea, Tarigan, Fadlyana, Dhamayanti & Rusmil 2023).

According to a study conducted by Nikolaidis in 2012, physical exercise during early childhood does not seem to have a significant impact on controlling body fat, as evidenced by our study on female volleyball players. In terms of the coefficient of variation, both tests revealed that the variables of body weight and fat percentage had the highest values. This is because adolescents are considered a risk group when it comes to lifestyle and nutrition, according to Salam, Das, Ahmed, Irfan, Sheikh & Bhutta (2019). In terms of motor skills, the hand grip estimation variable had the highest coefficient of variation, which indicates moderately homogeneous results. Additionally, a statistically significant difference was observed in measuring the strength of the hand grip, before and after continuous training. This suggests that technical elements of the spike and serve had an impact on improving the strength of the hand and wrist, which is an important factor in volleyball. The study conducted on female volleyball players showed no statistically significant change in agility test. However, a study conducted on 20 female volleyball players, with an average age of 10.5±1.5 years, showed a statistically significant change in agility. Besides the aspect of motor skills, the morphological characteristics of the body, like body height, body mass, percentage of fat and muscles, etc., also affect agility. In our study, there was no statistically significant change in body mass, fat, and muscle percentage. Thus, this fact needs to be taken into account in terms of statistical significance of agility change. The results of the sit and reach test (SiR) and the test to assess the flexibility of the shoulder girdle (overhead stick rotation) showed a greater shift after the second measurement. This is because greater flexibility in volleyball is a result of larger amplitude movements. It's worth noting that stretching, particularly dynamic stretching as part of the warm-up

visine, proporcionalno dolazi i do povećanja raspona ruku, pa čak varijabla raspon ruku u nekim slučajevima i premašuje telesnu visinu, kao što je bio slučaj u prvom merenju). Najmanji koeficijent varijabilnosti je za varijablu telesna visina i iznosi 5%, dok je za raspon ruku nešto viši – 7%.

Kada su u pitanju motoričke sposobnosti, u tabeli 3 vidimo da se najmanji koeficijent varijabilnosti primećuje u testu za procenu agilnosti (X test), dok se veći pojavljuje u testu fleksibilnosti - pretklon u sedu kao i u testu eksplozivnosti mišića nogu – skok sa počučnjem.

U tabeli 5 prikazana je dobijena statistički značajna promena kod varijabli: telesna visina, raspon ruku i BMI , dok je na osnovu srednjih vrednosti motoričkih sposobnosti između prvog i drugog merenja, statistički značajna promena dobijena kod varijabli: maksimalni stisak šake (maksimalna sila), iskret palicom, pretklon u sedu i bacanje medicinke

Diskusija

U ovom istraživanju je pokazano da za antropometrijske karakteristike statistički značajne razlike u telesnoj masi, procentu telesne masti i mišića ne postoje, dok su razlike uočene kod telesne visine, BMI i kod raspona ruku. Dobijeni rezultati telesne visine su donekle očekivani, jer se u ovom sportu selekcija, između ostalog, vrši u odnosu na telesnu visinu koja je potrebna za određene igračke pozicije. Telesna visina je od velikog značaja u odbojci (Banković, 2023). Kako je raspon ruku biološki direktno vezan za telesnu visinu, to je i razlog za statistički značajnu razliku (Rahmayani, Rumapea, Tarigan, Fadlyana, Dhamayanti i Rusmil 2023). Neka istraživanja (Nikolaidis, 2012) pokazuju da fizičko vežbanje u najranijem dobu, nema presudnu ulogu u kontroli telesne masti, što pokazuje i istraživanje na našim odbojkašicama. Kada je u pitanju koeficijent varijabilnosti, u oba testiranja je dobijeno da je najveći kod varijabli telesna masa i procenat masti, a razlog je što adolescenti predstavljaju rizičnu grupu kada je u pitanju stil života i ishrana (Salam, Das, Ahmed, Irfan, Sheikh i Bhutta, 2019).

Najveći koeficijent varijacije je zapažen kod varijable za procenu stiska šake i to ukazuje na umereno homogene rezultate. Takođe, uočena je statistički značajna razlika u merenju jačine stiska šake pre i nakon kontinuiranog treninga, što pokazuje da je izvođenje tehničkih elemenata smeča i servisa uticalo na poboljšanje jačine ruke i zgloba ručja koji predstavljaju bitan faktor u odbojkaškoj igri (Yulanda, Sepdanius, 2019).

U istraživanju na odbojkašicama nije došlo do statistički značajne promene u testu za procenu agilnosti, dok su u istraživanju (Elif i sar., 2010) sprovedenom na 20 odbojkašica prosečne starosti 10.5±1.5 godina, došli do zaključka

DALIBORKA STANKOVIĆ, ET AL.
THE EFFECT OF A SIX-MONTH TRAINING PROCESS ON THE ANTHROPOLOGICAL STATUS OF THE FEMALE CADET VOLLEYBALL PLAYERS

SPORTS SCIENCE AND HEALTH **14**(V):26-33

for training, is slightly more prevalent in training technology. For girls in the youngest category, flexibility is already at a satisfactory level and in line with other abilities. The period of flexibility development aligns with the age of tested female volleyball players (12-15 years), after which this motor ability reaches its maximum. In the medicine ball throw test (MT), which evaluates the strength of the trunk and shoulder girdle, a small but statistically significant increase in the tested age category was observed. This highlights the fact that through learning and developing volleyball technique, the strength of these muscles is also increased.

CONCLUSION

The study results show that there was a significant increase in anthropometric characteristics and motor skills of female volleyball players after six months of continuous training. Out of the 12 variables examined, female volleyball players showed a significant increase in 8 of them. These findings could be useful for coaches of young girls in defining the goals and tasks for better training. They can also help identify strengths and weaknesses, and monitor the level of preparedness of female athletes based on their biological and developmental characteristics. The primary goal is to highlight areas that would make a significant impact on developing abilities in which athletes lag behind. However, to ensure the success of athletes, further studies should include a larger number of subjects and an expanded variety of tests that include determinants of simple performance on the field. Despite the limitations of this study, such as the small number of subjects and the heterogeneity of the sample in terms of the level of training, the results obtained provide a significant initial basis for examining the relationship between anthropometric parameters and motor skills. This contributes to the existing knowledge in this area.

da postoji statistički značajna promena u agilnosti. Kada je u pitanju agilnost, osim sa aspekta motoričkih sposobnosti, kao opravdanje za dobijene rezultate treba uzeti u obzir i morfološke karakteristike tela koje utiču na agilnost (telesnu visinu, telesnu masu, procenat masti i mišića, i dr.). U našem istraživanju nije došlo do statistički značajne promene u telesnoj masi, procentu masti i mišića, pa moramo uzeti u obzir i tu činjenicu kada pogledamo statističku značajnost promene agilnosti.

Rezultati testa pretklon u sedu (PuS) i testa za procenu fleksibilnosti ramenog pojasa (iskret palicom) pokazali su veći pomak nakon drugog merenja, što se može objasniti da je u odbojci veća fleksibilnost posledica pokreta većih amplituda. Takodje, u samoj trenažnoj tehnologiji malo je veća zastupljenost rastezanja (dinamičko rastezanje kao deo zagrevanja za trening). Kod devojaka je fleksibilnost u najmlađoj kategoriji već na zadovoljavajućem nivou i u skladu sa ostalim sposobnostima. Period razvoja gipkosti se poklapa sa uzrastom testiranih odbojkašica (12-15 godina), nakon čega ova motorička sposobnost dostiže svoj maksimum (Koprivica, 2009).

Prethodni autori su takođe posmatrali vertikalni skok kod odbojkašica i došli su do sličnih rezultata kao u ovoj studiji (Lidor, Côte i Hackfort, 2009; Lidor i Ziv, 2010; Schaal, Ransdell, Simonson i Gao, 2013; Mielgo-Ayuso, Calleja-González, Clemente-Suárez i Zourdos, 2015; Paz, Gabbett, Maia, Santana, Miranda i Lima, 2017), a to je da ne postoji statistički značajna razlika u promeni ove varijable. Ovo se može objasniti činjenicom da metodika učenja odbojkaške tehnike ne obuhvata mnogo vežbi koje zahtevaju maksimalno angažovanje vertikalne komponente brzine, snage i eksplozivnosti ekstenzora nogu.

Kada je u pitanju test bacanje medicinke (BM), kojim se procenjuje snaga trupa i ramenog pojasa, pokazao se mali ali statistički značajan prirast testirane uzrasne kategorije, što upućuje na činjenicu da kroz učenje i razvoj tehnike dolazi i do povećanja snage tih mišića.

ZAKLJUČAK

Iz dobijenih rezultata istraživanja može zaključiti statistički značajan porast antropometrijskih karakteristika i motoričkih sposobnosti odbojkašica. Odbojkašice su ostvarile statistički značajno povećanje u 8 od 12 ispitivanih varijabli. Dobijeni rezultati mogu biti od pomoći trenerima koji rade sa mladim devojčicama, kao smernica za bolje definisanje ciljeva i zadataka u treningu, identifikovanja prednosti i slabosti, odnosno praćenja nivoa pripremljenosti svojih sportistkinja, a sve na osnovu poznavanja bioloških i razvojnih karakteristika ovog uzrasta. Iskonski cilj se ogleda u akcentovanju onih sadržaja koji će bitno uticati na razvijanje upravo onih sposobnosti u kojima sportisti zaostaju. Međutim, dalja istraživanja bi trebalo da uključe veći broj ispitanika, kao i proširenu bateriju testova koja bi sadržala odrednice jednostavnog izvođenja u terenskim uslovima jer bi se na taj način obezbedio širi pristup koji je esencijalan za uspešnost sportista. Pored toga što imamo mali broj ispitanika, kao nedostatak može se navesti i heterogenost uzorka u pogledu nivoa treniranosti. Uprkos ograničenjima ovog istraživanja, dobijeni rezultati mogu biti značajna inicijalna osnova za ispitivanje relacije antropometrijskih parametara i motoričkih znanja, što omogućava relevantan teorijski doprinos postojećim saznanjima u ovoj oblasti.

DALIBORKA STANKOVIĆ, ET AL.
EFEKAT ŠESTOMESEČNOG TRENAŽNOG PROCESA NA ANTROPOLOŠKI STATUS ODBOJKAŠICA KADETSKOG UZRASTA

SPORTS SCIENCE AND HEALTH **14**(V):26-33

REFERENCES

Banković, V. (2023). Relacije efikasnosti igre, telesne strukture i specifičnosti fizičke pripremljenosti kod elitnih odbojkašica: četvorogodišnja longitudinalna studija. *Univerzitet u Beogradu.* https://nardus.mpn.gov.rs/handle/123456789/21978

Bompa, T. O. (2000). *Total training for young champions*. Human Kinetics.

Öz, E. L. İ. F., Pekel, H. A. C. I., Altunsoy, M., Öz, E., & Pekel, A. Y. L. İ. N. (2010). The effects of 4 month volleyball training on flexibility, jump, speed and agility in preadolescent girls. *Science, Movement and Health*, *10*(2).

Ferioli, D., Rampinini, E., Bosio, A., La Torre, A., Azzolini, M., & Coutts, A. J. (2018). The physical profile of adult male basketball players: Differences between competitive levels and playing positions. *Journal of sports sciences*, *36*(22), 2567-2574. doi: 10.1080/02640414.2018.1469241. Epub 2018 Apr 26. PMID: 29697296.

Heishman, A. D., Daub, B. D., Miller, R. M., Freitas, E. D., Frantz, B. A., & Bemben, M. G. (2020). Countermovement jump reliability performed with and without an arm swing in NCAA division 1 intercollegiate basketball players. *The Journal of Strength & Conditioning Research*, *34*(2), 546-558. doi: 10.1519/JSC.0000000000002812. PMID: 30138237.

Janković, V., & Marelić, N. (2003). *Odbojka za sve*.

Koprivica, V. (2009). *Senzitivni periodi u razvoju motorike*. Univerzitet u Beogradu

Lehnert, M., Sigmund, M., Lipinska, P., Vařeková, R., Hroch, M., Xaverová, Z., ... & Zmijewski, P. (2017). Training-induced changes in physical performance can be achieved without body mass reduction after eight week of strength and injury prevention oriented programme in volleyball female players. *Biology of Sport*, *34*(2), 205-213. doi: 10.5114/biolsport.2017.65995. Epub 2017 Feb 19. PMID: 28566815; PMCID: PMC5424461.

Lidor, R., & Ziv, G. (2010). Physical and physiological attributes of female volleyball players-a review. *The Journal of Strength & Conditioning Research*, *24*(7), 1963-1973. doi: 10.1519/JSC.0b013e3181ddf835. PMID: 20543736.

Lidor, R., CôTé, J. E. A. N., & Hackfort, D. (2009). ISSP position stand: To test or not to test? The use of physical skill tests in talent detection and in early phases of sport development. *International journal of sport and exercise psychology*, *7*(2), 131-146. doi: 10.1080/1612197X.2009.9671896

Majstorović, N., Nešić, G., Grbić, V., Savić, Z., & Dopsaj, M. (2019, November). Assessment of specific agility in volleyball: Reliability and validity of modified X running test. In *4th International Conference on Innovations in Sports, Tourism and Instructional Science (ICISTIS 2019)* (pp. 143-146). Atlantis Press. https://www.atlantis-press.com/proceedings/icistis-19/125922475

Mielgo-Ayuso, J., Calleja-González, J., Clemente-Suárez, V. J., & Zourdos, M. C. (2015). Influence of anthropometric profile on physical performance in elite female volleyballers in relation to playing position. *Nutricion hospitalaria*, *31*(2), 849-857. doi: 10.3305/nh.2015.31.2.7658. PMID: 25617573.

Macura, M. (2007). *Praktikum Biologija razvoja čoveka*. Beograd. Fakultet sporta i fizičkog vaspitanja.

Nešić, G., Ilić, D., Majstorović, N., Grbić, V., & Osmankač, N. (2013). Training effects on general and specific motor skills on female volleyball players 13-14 years old. *Sport Logia*, *9*(2), 201.

Nešić, G., Majstorovic, N., Osmankac, N., Milenkoski, J., & Serdar, U. S. L. U. (2014). Differences in anthropometric characteristics and motor abilities between volleyball players and untrained boys 17 years old. *International Journal of Sport Culture and Science*, *2*(4), 103-109.

Nesic, G., Sikimic, M., Ilic, V., & Stojanovic, T. (2011). Play structure of top female volleyball players: Explorative factorial approach. *British Journal of Sports Medicine*, *45*(6), 541-541.

Nikolaidis, P. T. (2012). Elevated body mass index and body fat percentage are associated with decreased physical fitness in soccer players aged 12–14 years. *Asian journal of sports medicine*, *3*(3), 168.

Paz, G. A., Gabbett, T. J., Maia, M. F., Santana, H., Miranda, H., & Lima, V. (2016). Physical performance and positional differences among young female volleyball players. *The Journal of sports medicine and physical fitness*, *57*(10), 1282-1289.

Salam, R. A., Das, J. K., Irfan, O., Ahmed, W., Sheikh, S. S., & Bhutta, Z. A. (2020). Effects of preventive nutrition interventions among adolescents on health and nutritional status in low-and middle-income countries: A systematic review. *Campbell Systematic Reviews*, *16*(2), e1085. doi: 10.3390/nu12010049. PMID: 31878019; PMCID: PMC7019616.

Schaal, M., Ransdell, L. B., Simonson, S. R., & Gao, Y. (2013). Physiologic performance test differences in female volleyball athletes by competition level and player position. *The Journal of Strength & Conditioning Research*, *27*(7), 1841-1850. doi: 10.1519/JSC.0b013e31827361c4. PMID: 22990572.

Yulanda, N., & Sepdanius, E. (2019). Contribution of Explosive Power of Arm Muscles And Flexibility to Smash Ability of PB. Semen Padang Athletes. *Jurnal Stamina, 2*(6), pp.40-49.

Rahmayani, R., Rumapea, F., Tarigan, R., Fadlyana, E., Dhamayanti, M., & Rusmil, K. (2023). Correlation between anthropometric measurements of height and arm span in Indonesian children aged 7-12 years: a cross-sectional study. *The Turkish Journal of Pediatrics*, *65*(1), 13-23. doi: 10.24953/turkjped.2021.5103. PMID: 36866981.

Zarić, I., Dopsaj, M., & Marković, M. (2018). Match performance in young female basketball players: Relationship with laboratory and field tests. *International Journal of Performance Analysis in Sport*, *18*(1), 90-103. doi: 10.1080/24748668.2018.1452109