https://doi.org/10.7251/SSH2501089B
UDC: 796.325.015-055.2:796.012.1
Original scientific paper
Originalni naučni rad

Analysis of Quantitative Changes in Morphological Characteristics of Young Volleyball Players Under the Influence of an Experimental Program

Analiza kvantitativnih promjena morfoloških karakteristika mladih odbojkašica pod uticajem eksperimentalnog programa

Osmo Bajrić[1], Sara Obradović[2], Tatjana Drvenica[3], Senad Bajrić[1], Oliver Krička[1]

[1]Pan-European University Apeiron, Banja Luka, Bosnia and Herzegovina
[2]JU Elementary school "Aleksa Šantić" Vukosavlje, Bosnia and Herzegovina
[3]Student of the first cycle of studies at the Faculty of Sports Sciences, Pan-European University Apeiron, Banja Luka, Bosnia and Herzegovina

Correspondence:
Osmo Bajrić
Pan-European University Apeiron, Banja Luka, Bosnia and Herzegovina
osmo.s.bajric@apeiron-edu.eu

[1]Panevropski Univerzitet Apeiron, Banja Luka, Bosna i Hercegovina
[2]JU Osnovna škola „Aleksa Šantić" Vukosavlje, Bosna i Hercegovina
[3]Studentica prvog ciklusa studija Fakulteta sportskih nauka, Panevropskog Univerziteta Apeiron, Banja Luka, Bosna i Hercegovina

Korespondencija:
Osmo Bajrić
Panevropski Univerzitet Apeiron, Banja Luka, Bosna i Hercegovina
osmo.s.bajric@apeiron-edu.eu

Summary: *The study was conducted on a sample of 50 female respondents - girls from the Primary School "Sveti Sava" and the Primary School "Sutjeska" from Modriča, aged 10 to 12 years, who train volleyball in the Volleyball Club "Modriča - Novoprom" from Modriča, with the aim of determining partial and global quantitative changes in the applied morphological characteristics that occurred under the influence of a specially defined volleyball program lasting six months. The study used a set of 12 variables to assess morphological characteristics measured according to the instructions of the International Biological Program (IBP). To determine partial quantitative changes (differences) of the applied morphological characteristics, the results of the T test analysis were applied, and to determine quantitative changes (differences) of morphological characteristics at the global level, canonical discriminant analysis was applied. The results of the T test and canonical discriminant analysis show that under the influence of the programmed volleyball work for six months, statistically significant partial and global changes (differences) occurred in the space of morphological characteristics that can be attributed to the influence of the applied volleyball program, but changes in the biological growth and development of the subjects that are characteristic of the age group 10-12 years should not be ignored. The obtained results may be useful for coaches of younger volleyball selections in volleyball clubs and volleyball schools, and physical education teachers in quality programming of the training and teaching process with younger age categories of girls.*

Key words: *girls, canonical discriminant analysis, volleyball, changes, work program, T test.*

Sažetak: *Istraživanje je provedeno na uzorku 50 ispitanica - djevojčica JU OŠ „Sveti Sava" i JU OŠ „Sutjeska" iz Modriče, starosne dobi od 10 do 12 godina koje treniraju odbojku u OK „Modriča – Novoprom" iz Modriče s ciljem utvrđivanja parcijalnih i globalnih kvantitativnih promjena primijenjenih morfoloških karakteristika nastalih pod uticajem posebno definisanog programa odbojke u trajanju šest mjeseci. U istraživanju je primijenjen set od 12 varijabli za procjenu morfoloških karakteristika mjerenih prema uputama Internacionalnog Biološkog programa (IBP). Za utvrđivanje parcijalnih kvantitativnih promjena (razlika) primijenjenih morfoloških karakteristika primijenjeni su rezultati analize T testa a za utvrđivanje kvantitativnih promjena (razlika) morfoloških karakteristika na globalnom nivou primijenjena je kanonička diskriminativna analiza. Rezultati T testa i kanoničke diskriminativne analize pokazuju da je pod uticajem programiranog rada odbojke u trajanju šest mjeseci došlo do statistički značajnih parcijalnih i globalnih promjena (razlika) u prostoru morfoloških karakteristika koji se mogu pripisati uticaju primijenjenog programa odbojke ali se ne smiju zanemariti promjene biološkog rasta i razvoja ispitanica koje su karakteristične za uzrasnu dob 10 – 12 godina. Dobiveni rezultati mogu biti od koristi trenerima mlađih selekcija odbojkašica u odbojkaškim lubovima i školama odbojke, te profesorima tjelesnog odgoja u kvalitetnom programiranju trenažnog i nastavnog procesa sa mlađim uzrasnim kategorijama djevojčica.*

Ključne riječi: *globalne i parcijalne promjene, program rada, kanonička diskriminativna analiza,T test, učenici.*

Introduction

Morphological characteristics describe the body structure of a person based on a large number of anthropometric data. Morphological characteristics (anthropometric characteristics) are part of anthropological characteristics, and are defined as traits that are responsible for the dynamics of growth and development and the characteristics of the body structure to which they belong: bone growth in length, bone growth in width, muscle mass and subcutaneous fat tissue (Neljak et al., 2011). Taking into account the morphological characteristics of an individual child, it is possible to more easily assess the reason for success or failure in certain kinesiological activities.

Volleyball as a sport, according to its structural characteristics, belongs to the group of polystructural acyclic sports. The dynamics with which volleyball actions are performed, especially in today's modern top sport, is extremely emphasized, with almost incredible moves of individuals that sometimes take place literally in a split second. The characteristics of volleyball are multiple and multidimensional, with some properties that simply must be above average if one wants to achieve top sports results (Janković and Sabljak, 2004).

Bonacin et al., (2008) point out that for the realization of volleyball demands of top sport in senior age, three preconditions are needed that must be achieved in order to reach that goal, and they are articulated as sports models. The first precondition is knowledge of the volleyball model, i.e. the characteristics of the game that is realized and the characteristics of the players who are part of such realization. The second precondition is knowledge of the transformation process that leads beginners of e.g. 7, 8 years old to top results. And the third precondition is the identification of potentially especially gifted children for volleyball, in accordance with their characteristics (Bonacin and Smajlović, 2005).

The main problem addressed in this paper relates to the determination of quantitative changes (differences) in morphological characteristics of volleyball players aged 10-12 years under the influence of a six-month volleyball program. Transformational processes that produce changes in the anthropological characteristics and abilities of athletes that strive for their greatest values include planning, programming, implementation and control of those processes in order to achieve a predetermined goal, which is reflected in the achievement of the highest levels of anthropological characteristics.

All anthropological characteristics and abilities at the beginning of the implementation of an experimental program are at a certain level of development, which is treated

Uvod

Odbojka kao sport po svojim strukturalnim karakteristikama pripada grupi polistrukturalnih acikličnih sportova. Dinamika kojim se odbojkaške akcije izvode, a posebno u današnjem modernom vrhunskom sportu, iznimno je naglašena, uz gotovo nevjerovatne poteze pojedinaca koji se ponekad odvijaju doslovno u djeliću sekunde. Karakteristike odbojke su višestruke i multidimenzionalne, uz neka svojstva koja naprosto moraju biti iznad prosječna ukoliko se želi postizati vrhunski sportski rezultat (Janković i Sabljak, 2004).

Bonacin i sar., (2008) ističu da su za realizaciju odbojkaških zahtjeva vrhunskog sporta u seniorskom uzrastu, potrebna tri preduslova koji se moraju ostvariti kako bi se taj domet i dostigao, a artikulišu se kao sportski modeli. Prvi preduslov je poznavanje modela odbojke, odnosno svojstva igre koja se realizuje i odlika igrača koji su dio takve realizacije. Drugi preduslov je poznavanje transformacionog procesa koji početnike uzrasta npr. 7, 8 godina dovodi do vrhunskih rezultata. I treći preduslov je identifikacija potencijalno posebno nadarene djece za odbojku, u skladu s njihovim odlikama (Bonacin i Smajlović, 2005).

Osnovni problem kojim se bavi ovaj rad odnosi se na utvrđivanje kvantitativnih promjena (razlika) morfoloških karakteristika odbojkašica uzrasne dobi 10-12 godina pod uticajem šestomjesečnog programa odbojke. Transformacioni procesi koji proizvode promjene antropoloških karakteristika i sposobnosti sportista koje teže njihovim najvećim vrijednostima obuhvataju planiranje, programiranje, provođenje i kontrolu tih procesa da bi se postigao unaprijed definisani cilj, koji se ogleda u postizanju najviših nivoa antropoloških obilježja.

Sve antropološke karakteristike i sposobnosti na početku realizacije nekog eksperimentalnog programa nalaze se na nekom nivou razvoja koji se tretira kao početni (inicijalni) nivo što predstavlja polaznu osnovu ili inicijalno stanje sportiste. Kada se utvrdi početni nivo osobina i sposobnosti na početku realizacije eksperimentalnog programa sa sportistom se ulazi u realizaciju programa u kojem su tačno definisani sljedeći elementi: opterećenje sa obimom i intenzitetom rada, trenažna sredstva, trenažne metode, oblici rada itd. Zbog toga u procesu trenažnog rada sa djecom i omladinom za razvoj pojedinih antropoloških obilježja (Srdić i sar., 2023) treba primjenjivati efikasne postupke u izboru sadržaja metoda rada, organizacionih oblika, intenziteta opterećenja i oporavka. Pozitivni efekti transformacionih procesa mogu se očekivati samo pod uslovom da je metodičko oblikovanje trenažnog rada prilagođeno

as the initial (initial) level, which represents the starting point or initial state of the athlete. When the initial level of characteristics and abilities is determined at the beginning of the implementation of the experimental program, the athlete enters the implementation of the program in which the following elements are precisely defined: workload with volume and intensity of work, training equipment, training methods, forms of work, etc. Therefore, in the process of training work with children and youth for the development of certain anthropological characteristics (Bala et al., 2018; Srdić et al., 2023), effective procedures should be applied in the selection of the content of work methods, organizational forms, intensity of load and recovery. Positive effects of transformation processes can be expected only on condition that the methodological design of training work is adapted to the individual abilities and characteristics of each individual (Sekulić and Metikoš, 2007).

By realizing the programmed contents conceived on the aforementioned basis and their realization over a certain period of time, it is realistic to expect changes in the level of initial abilities, characteristics and knowledge, which produce a new and better state (final state) compared to the initial state (initial state), provided that the programmed work was carried out according to plan.

With younger selections, changes occur during growth and maturation, especially during the development of physical abilities, sports technique and tactics, which plays a very important role in formation of habits and positive personality characteristics. According to Milanović (2010), body binding can influence the development of muscle mass and the reduction of subcutaneous fat tissue, while it is not possible to influence the longitudinal and transverse measurements of the skeleton.

When working with younger age categories of children, one should not be burdened with achieving premature sports results, but focus the training process more on improving specific abilities required for a specific branch of sport, adopting and mastering technique and game.

What should be the "guiding star" in working with younger age categories is that raising the necessary abilities, learning and perfecting the elements of the volleyball game are of primary importance, and the competition is what should come through the game (of secondary importance).

Methods

Sample of respondents

The study was conducted on a sample of 50 respondents - girls from the Primary School "Sveti Sava" and the Primary School "Sutjeska" from Modriča, aged 10 to

individualnim sposobnostima i osobinama svakog pojedinca (Sekulić i Metikoš, 2007).

Realizacijom programiranih sadržaja koncipiranih na navedenim osnovama i njihovom realizacijom kroz određeni vremenski period realno je očekivati promjene nivoa početnih sposobnosti, karakteristika i znanja, koje proizvode novo i kvalitetnije stanje (finalo stanje) u odnosu na početno (inicijalno stanje) pod uslovom da se programirani rad realizovao po planu.

Kod mlađih selekcija dešavaju se promjene tokom rasta i sazrijevanja, naročito tokom razvoja fizičkih sposobnosti, sportske tehinike i taktike, što ima veoma važnu ulogu u formiranju navika i pozitivnih karakteristika ličnosti. U radu sa mlađim uzrasnim kategorijama djece ne treba biti opterećen postizanjem preranih sportskih rezultata, već trenažni proces više usmjeriti na poboljšanje specifičnih sposobnosti potrebnih za konkretnu granu sporta, usvajanje i ovladavanje tehnikom i igrom.

Ono što treba biti „zvijezda vodilja" u radu sa mlađim uzrasnim kategorijama je da podizanje potrebnih sposobnosti, učenje i usavršavanje elemenata odbojkaške igre predstavljaju ono što je od primarnog značaja, a takmičenje je ono što što kroz igru treba da dođe (sekundarnog značaja).

Metode rada

Uzorak ispitanika

Istraživanje je provedeno na uzorku od 50 ispitanica - djevojčice JUOŠ „Sveti Sava" i JUOŠ „Sutjeska" iz Modriče, starosne dobi od 10 do 12 godina koje treniraju odbojku u OK „Modriča – Novoprom" iz Modriče. Po pitanju validnosti uzorka nije bilo nikakvih posebnih ograničenja izuzev osim što su djevojčice uključene u ovaj uzorak u trenutku testiranja i mjerenja, kao i provedbe programa rada morale biti zdrave i u cjelosti proći planirani trenažni program.

Uzorak varijabli

Za procjenu morfoloških karakteristika primijenjen je set od 12 morfoloških mjera koje relativno dobro pokrivaju istraživani prostor (Kurelić i sar. 1975; Mikić, 1999). Kod izbora varijabli vodilo se računa da budu prilagođene uzrasnoj dobi ispitanica.

12 years old, who train volleyball at the OK "Modriča - Novoprom" from Modriča. There were no special restrictions regarding the validity of the sample, except that the girls included in this sample had to be healthy at the time of testing and measurement, as well as the implementation of the work program, and had to fully complete the planned training program.

Sample variables

A set of 12 morphological measures was used to assess morphological characteristics, which relatively well covered the studied area (Kurelic et al. 1975). When choosing variables, care was taken to ensure that they were adapted to the age of the subjects.

Results

Analysis of partial quantitative changes in morphological characteristics

Table 1 shows the results of the analysis of the T test results of 12 morphological characteristics, in which the arithmetic mean values and T test values for all applied variables for the assessment of morphological characteristics are presented. Based on the presented arithmetic mean values (Mean) of the applied morphological characteristics at the initial and final measurement, i.e. Before and after the implementation of a six-month volleyball program and based on the significance of transformation changes (p) tested by the T test for dependent variables, changes can be seen in measures for assessing the longitudinal dimensionality of the body (body height ATJVIS .058; arm length .000; leg length .007) and in measures for assessing the transverse dimensionality of the body (hand diameter ADIJZŠ .000; ankle diameter joint ADIJSZ .004 and knee joint diameter ADIJKO .005).

Further analysis of the significance of the changes (p) tested (T-test) shows that all measures of morphological characteristics that achieved a certain increase in the final measurement in the values of arithmetic means (Mean) achieved the corresponding coefficient of statistical significance (p). Variables of morphological characteristics tested by T-test that achieved their corresponding coefficient of statistical significance (p), thus show that there were statistically significant differences in those variables change.

The results of the T test show that out of the 12 applied morphological variables, there were significant changes in 6 variables, namely the variables for assessing the longitudinal and transverse dimensionality of the body, which are strongly influenced by the genetic code and are a product of the growth and development of the girls' organism. No

Rezultati

Analiza parcijanih kvantitativnih promjena morfoločkih karakteristika

U tabeli 1 prikazani su rezultati analize rezultata T testa morfoloških karakteristika u kojoj su przentirane vrijednosti aritmetičkih sredina i vrijednosti T testa za sve primijenjene varijable za procjenu morfoloških karakteristika. Na osnovu prezentiranih vrijednosti aritmetičkih sredina (Mean) na inicijalnom i finalnom mjerenju tj. prije i poslije realizacije šestomjesečnog programiranog rada odbojke i na osnovu značajnosti transformacionih promjena (p) testiranih T testom može se vidjeti da je primijenjeni program odbojke proizveo statistički značajne parcijalne promjene u svim testovima za procjenu longitudinalne dimenzionalnosti tijela (tjelesna visina ATJVIS .058; dužina ruku .000; dužina nogu .007). Takođe, statistički značajne promjene utvrđene su kod mjera za procjenu transverzalne dimenzionalnosti tijela (dijametar šake ADIJZŠ .000; dijametar skočnog zgloba ADIJSZ .004 i dijametar zgloba koljena ADIJKO .005). Na ivici statističke značajnosti nalazi se i varijabla tjelesne težine ATJTEŽ .061.

Daljom analizom značajnosti promjena (p) testiranih (T-testom) može se vidjeti da su svi testovi morfoloških karakteristika koji su postigli određeni porast u finalnom mjerenju tj. na kraju realizacije programa u vrijednostima aritmetičkih sredina (Mean) postigli su pripadajući im koeficijent statističke značajnosti (p). Varijable morfoloških karakteristika testirane T-testom koje su postigle pripadajući im koeficijent statističke značajnosti (p), time pokazuju da je u tim varijablama došlo do statistički značajnih parcijalnih promjena.

Na osnovu dobijenih rezultata T testa može se konstatovati da program rada odbojke proizveo parcijalne kvantitativne promjene u većem broju varijabli za procjenu morfoloških karakteristika.

Kod antropometrijskih mjera za procjenu cirkularne dimenzionalnosti tijela i kod kožnih nabora nisu utvrđene statistički značajne parcijalne promjene (razlike) što predstavlja iznenađenje.

Table 1. *Analysis of partial quantitative changes in morphological characteristics tested by the T test*

Tabela 1. *Analiza parcijalnih kvantitativnih promjena morfoloških karakteristika testiranih T testom*

	Wilks' Lambda	F	df1	df2	Sig
Anthropometry body height / ATJVIS	.965	.3672	1	102	.058
Anthropometry arm length / ADUŽRU	.860	16.560	1	102	.000
Anthropometry leg length / ADUŽNO	.932	7.453	1	102	.007
Anthropometry ankle joint diameter / ADIJSZ	.981	1.966	1	102	.004
Anthropometry knee diameter / ADIJKO	.975	2.663	1	102	.005
Anthropometry wrist joint diameter / ADIJZŠ	.800	25.456	1	102	.000
Anthropometry body weight / ATJTEŽ	.970	3.112	1	102	.061
Anthropometry chest circumference / ASROGK	.991	.956	1	102	.330
Anthropometry abdominal circumference / AOBTRB	.998	.166	1	102	.685
Anthropometry triceps skinfold / ANATRI	.999	.077	1	102	.782
Anthropometry calf skinfold / ANAPOT	.999	.104	1	102	.748
Anthropometry skinfold of the back / ANALEĐ	.995	.542	1	102	.463

statistically significant changes (differences) were found in the variables for evaluating the circular dimensionality of the body and skin folds, which is a surprise in this research considering the minor influence of genetic inheritance. Skin folds are less influenced by genetic inheritance, i.e. growth hormone (K = .50), which provides a greater possibility of their change under the influence of well-programmed kinesiology activities. On the transformation of circular dimensionality, as well as skin folds, programmed work can affect positive changes depending on the training contents and training operators of which it is composed, as well as the duration of the experimental treatment.

Analysis of global quantitative changes in morphological characteristics

To determine global quantitative changes (global quantitative effects of change) in morphological characteristics, canonical discriminant analysis was applied in this study. The criterion for the discriminant strength of the applied variables was the so-called Wilks' Lambda. The determination of the statistical significance of each discriminant variable was performed based on the Bartlett Chi-square test. Significant discriminant variables were used for interpretation and explained a certain percentage of the common variance.

The tables also show standardized discriminant coefficients as well as normalized coefficients of participation of morphological variables in the formation of significant discriminant functions of central groups on significant discriminant functions.

Box's test (table 2) in the initial and final measurements determined that there are statistically significant differences (Sig. .000) in the covariances of the analyzed matrices.

Analiza globalnih kvantitativnih promjena morfoločkih karakteristika

Za utvrđivanje globalnih kvantitativnih promjena (globalni kvantitativni efekti promjena) morfoloških karakteristika u ovom istraživanju primijenjena je kanonička diskiriminativna analiza. Kriterij za diskriminativnu jačinu primijenjenih varijabli bio je tzv. Wilksova Lambda. Određivanje statističke značajnosti svake diskriminativne varijable vršeno je na osnovu Bartletovog Hi-kvadrat testa. Za interpretaciju korištene su značajne diskriminativne varijable i one objašnjavaju određeni procenat zajedničke varijanse.

U tabelama su prikazani i standardizovani diskriminativni koeficijenti kao i normirani koeficijenti učešća morfoloških varijabli u formiranju značajnih diskriminativnih funkcija centralnih grupa na značajnim diskriminativnim funkcijama.

Boxovim testom (tabela 2) u inicijalnom i finalnom mjerenju utvrđeno je da postoje statistički značajne razlike (Sig. .000), u kovarijansama analiziranih matrica.

Table 2. *Box's test of statistical significance of changes in morphological characteristics*

Tabela 2. *Boxov test statističke značajnosti promjena morfoloških karakteristika*

	Rank	Log Determinant
Initially / Inicijalno	12	19.080
Final / Finalno	12	33.953
Pooled within-groups	12	32.215

Test Results

Box's M		581.285
F	Approx.	6.527
	df1	78
	df2	32854.097
	Sig.	.000

Based on the results presented in Table (3), the differences between the initial and final measurements in the quantitative effects of the volleyball program in the space of morphological characteristics of young volleyball players were analyzed. Table 3 shows the significance of the isolated discriminant function. The results obtained indicate that the discriminative power of morphological tests, as shown by the Wilks' Lambda test, is very high (.644), which indicates that the differences between the initial and final measurements of the subjects are statistically significant at the (Sig. .000) level.

The canonical correlation coefficient indicates that .597% of the significance of the canonical function is explained, or rather, the discriminative function, which shows us in what correlation the set of applied data on the basis of which we performed discriminative analysis and the results in the discriminative function are. The explained correlation coefficient for the entire set of morphological variables has a high value (Chi-square = 42.25).

Na osnovu rezultata prezentiranih u tabeli (3) analizirane su razlike između inicijalnog i finalnog mjerenja u kvantitativnim efektima programa odbojke u prostoru morfoloških karakteristika mladih odbojkašica. U tabeli 3 prikazana je značajnost izolovane diskriminativne funkcije. Dobiveni rezultati ukazuju da je diskriminativna jačina morfoloških testova prikazana testom Wilks' Lambda vrlo visoka (.644), što ukazuje da su razlike između inicijalnog i finalnog mjerenja ispitanica statistički značajne na nivou (Sig. .000).

Koeficijent kanoničke korelacije (Canonical Correlation) ukazuje da je .597% objašnjena značajnost kanoničke funkcije, odnosno diskriminativnost funkcije što nam ukazuje u kojoj su korelaciji skup primijenjenih podataka na osnovu kojih smo vršili diskriminativnu analizu i rezultati u diskriminativnoj funkciji. Objašnjeni koeficijent korelacije na cijeli set morfoloških varijabli ima visoku vrijednosti (Chi-square = 42,25).

Table 3. *Significance of the isolated discriminative function of morphological characteristics*

Tabela 3. *Značajnost izolovane diskriminativne funkcije morofloških karakteristika*

Fukction	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.553[a]	100.0	100.0	.597

Wilks' Lambda

Test of Functions (s)	Wilks' Lambda	Chi- square	df	Sig.
1	.644	42.253	12	.000

Legend: Eigenvalue-squares *of discrimination coefficients, Canonical R-coefficient of canonical correlation, Wilks Lambda-values of Bartlett's test, Chi-square-significance of the relationships investigated space, df-degrees of freedom*

Legenda: Eigenvalue-kvadrati *koeficijenata diskriminacije, Canonical R-koeficijent kanoničke korelacije, Wilks Lambda-vrijednsoti Bartletovog testa, Chi-square-značajnost veza istraživanih prostora, df-stepeni slobode*

In order to verify the effectiveness of the applied volleyball program, twelve morphological measures

Da bi se provjerila efikasnost primijenjenog programa odbojke izmjereno je na početku i na kraju

were measured at the beginning and end of the program, which are assumed to be good measures of the investigated morphological space.

An overview of the results shown in table 4 shows that the greatest contribution to the discriminative function is made by anthropometric measures for assessing the longitudinal dimensionality of the body (arm length, body height) and transverse dimensions of the body (hand diameter, knee diameter and ankle diameter).

programa dvanaest morfoloških mjera za koje se pretpostavlja da su dobra mjera istraživanog morfološkog prostora.

Pregledom rezultata prikazanih u tabeli 4 vidi se da najveći doprinos diskriminativnoj funkciji imaju antropometrijske mjere za procjenu longitudinalne dimenzionalnosti tijela (dužina ruku, tjelesna visina) i transverzalne dimenzionalnosti tijela (dijametar šake, dijametar koljena i dijametar skočnog zgloba).

Table 4. *Matrix of standardized coefficients of discriminative analysis of morphological characteristics*

Tabela 4. *Matrica standardizovanih koeficijenata diskriminativne analize morfoloških karakteristika*

	Funkcion 1
Anthropometry body height / ATJVIS	-.923
Anthropometry arm length / ADUŽRU	1.088
Anthropometry leg length / ADUŽNO	-.018
Anthropometry ankle joint diameter / ADIJSZ	.257
Anthropometry knee diameter / ADIJKO	.327
Anthropometry wrist joint diameter / ADIJZŠ	.715
Anthropometry body weight / ATJTEŽ	.143
Anthropometry chest circumference / ASROGK	.042
Anthropometry abdominal circumference / AOBTRB	-.279
Anthropometry triceps skinfold / ANATRI	-.103
Anthropometry calf skinfold / ANAPOT	-.392
Anthropometry skinfold of the back / ANALEĐ	.165

Table 5 shows the factor structure of the isolated discriminative function. The results presented in Table 5 indicate that the greatest contribution to the discriminative function, i.e. the difference between the initial and final measurement of the morphological characteristics of the subjects, is the diameter of the wrist joint (ADIJZŠ .672). In addition, the variables arm length (ADUŽRU ,542), leg length (ADUŽNO ,364), body height (ATJVIS ,255),

U tabeli 5 prikazana je faktorska struktura izolovane diskriminativne funkcije. Prikazani rezultati u tabeli 4 ukazuju da najveći doprinos diskriminativnoj funkciji tj. razlici između inicijalnog i finalnog mjerenja morfoloških karakteristika ispitanica ima dijametar zgloba šake (ADIJŠA .672). Pored nje s nešto nižim vrijednostima u diskriminaciji učestvuju varijable dužina ruku (ADUŽRU ,542), dužina nogu (ADUŽNO ,364), tjelesna

Table 5. *Matrix of the structure of the isolated discriminative function of morphological characteristics*

Tabela 5. *Matrica strukture izolovane diskriminativne funkcije morfoloških karakteristika*

	Funkcion 1
Anthropometry wrist joint diameter / ADIJZŠ	.672
Anthropometry arm length / ADUŽRU	.542
Anthropometry leg length / ADUŽNO	.364
Anthropometry body height / ATJVIS	255
Anthropometry body weight / ATJTEŽ	.235
Anthropometry knee diameter / ADIJKO	.217
Anthropometry ankle joint diameter / ADIJSZ	.197
Anthropometry chest circumference / ASROGK	.130
Anthropometry skinfold of the back / ANALEĐ	.098
Anthropometry abdominal circumference / AOBTRB	.054
Anthropometry calf skinfold / ANAPOT	-.043
Anthropometry triceps skinfold / ANATRI	.037

body weight (ATJTEŽ ,235) and knee diameter (ADIJKO ,217) participate in the discrimination with slightly lower values. The other measured morphological variables did not significantly participate in the discrimination of the initial from the final measurement in the space of morphological characteristics.

Based on standardized centroids, the effects of a six-month volleyball program on the morphological characteristics of female participants who train in volleyball are observed in terms of the increase in longitudinal and transverse body dimensions. The position of the centroids of the initial and final measurements show that in this sample of respondents there are significant differences in morphological characteristics at the two measurements.

visina (ATJVIS ,255), tjelesna težina (ATJTEŽ ,235) i dijametar koljena (ADIJKO , 217). Ostale mjerene morfološke varijable nisu značajno učestvovale u diskriminaciji inicijalnog od finalnog mjerenja u prostoru morfoloških karakteristika.

Na osnovu standardizovanih centroida uočavaju se efekti djelovanja šestomjesečnog programa odbojke na morfološke karakteristike ispitanica koje treniraju odbojku u smislu prirasta lodgitudinalne i transverzalne dimenzionalnosti tijela. Položaj centroida inicijalnog i finalnog mjerenja pokazuju kako u ovom uzorku ispitanica postoje značajne razlike u morfološkim karakteristikama na dva mjerenja.

Table 6. *Centroid positions*

	Function / **Funkcija *1***
Initially / Inicijalno	-,736
Final / Finalno	,736

Tabela 6. *Položaji centroida*

Discussion

Knowing the structure of morphological characteristics is of great importance because it allows for an objective picture of the state of physical development of children and youth, monitoring the course of growth and development by comparing data from measurements conducted at appropriate intervals, and timely directing the child towards sports disciplines in which, given their morphological characteristics, they could achieve optimal results. According to Kosinac (2011), who deals with morphological and motor measurements through the method of collecting data on the child's physique and maturation, on the basis of which body dimensions are determined and judged, the four-dimensional model of morphological characteristics (Momirović et al., 1975) has been accepted as dimensions that can be directly measured and reliably describe the morphological status of a person, namely: longitudinal dimensionality of the skeleton, transverse dimensionality of the skeleton, circular dimensionality of the skeleton and subcutaneous fat tissue.

Programmed training activities in the form of experimental programs can produce certain transformational changes in certain anthropological features of the participants of such treatments to a greater or lesser extent, provided that the programmed activities represent optimal stimuli that are well adapted to the age characteristics and individual abilities and characteristics of each individual. The effects of such experimental programs that are applied are visible in the level of quantitative and qualitative

Diskusija

Programirane trenažne aktivnosti u vidu eksperimentalnih programa mogu proizvesti željene transformacione promjene antropološkog statusa učesnika takvih tretmana pod uslovom da programirane aktivnosti predstavljaju optimalne stimulanse koji su dobro prilagođeni uzrasnim karakteristikama i individualnim sposobnostima i osobinama svakog pojedinca. Efekti takvih eksperimentalnih programa koji se primjenjuju vidljivi su u nivou kvantitatitvnih i kvalitativnih promjena određenih segmenata antropološkog prostora.

Dosadašnja istraživanja problema transformacionih procesa uglavnom su se bavila utvrđivanjem efekata posebno programiranih kinezioloških aktivnosti u smislu kvantitativnih i kvalitativnih promjena određenih antropoloških karakteristika i sposobnosti subjekata koji se podvrgavaju takvim programima (Pejčić, 2001; Bajrić i sar., 2011, 2013, 2014; Šmigalović i sar., 2012; Malijević, 2012; Srdić i sar., 2021; Galić i sar., 2022, 2024). Pejčić (2001) u svom istraživanju konstatuje da svaka dobro programirana fizička aktivnost značajno utiče na promjene kako motoričkih sposobnoati tako i na promjene morfoloških odlika. Bajrić i sar. (2012) su na uzorku od 73 učenika uzrasta 13-14 godina OŠ „Tojšići" utvrđivali efekte četvoromjesečnog programa dodatne nastave na promjenu bazičnih i situaciono-motoričkih sposobnosti. Autori su konstatovali da je precizno definisani program vježbanja iz odbojke sa svojim operatorima, povoljno je djelovao na razvoj motorič-

changes in certain segments of the anthropological space.

The subject of research in this paper is the impact of a specially defined experimental volleyball program lasting six months, with the application of the content of technical elements of the volleyball game without a ball and with a ball, on changes in the morphological characteristics of girls aged 10-12 years. The purpose of this research was to determine whether positive changes in the morphological characteristics of the treated sample of test subjects could be achieved by applying the proposed experimental volleyball program.

The analysis of the results of the T test shows that in the period of six months in which the experimental volleyball program was implemented, there were significant changes in the variables for assessing the longitudinal and transverse dimensionality of the body, but not in the variables for assessing the circular dimensionality of the skeleton and skin folds. Similar results were obtained using canonical discriminant analysis. The results of the canonical discriminant analysis show that the discriminative power of the morphological tests shown by the Wilks' Lambda test is high (.644), which indicates that the differences between the initial and final measurements of the subjects statistically significant at the (Sig. .000) level. The biggest contribution to the discriminative function, i.e. the difference between the initial and final measurement of the morphological characteristics of the test subjects is the variable of the transverse dimensionality of the skeleton (diameter of the hand joint), and next to it, with slightly lower values, they participate in the discrimination variables of longitudinal dimensionality of the skeleton (length of arms, length of legs and height). The variables for evaluating the circular dimensionality of the skeleton and skin folds did not significantly participate in the discrimination of the initial from the final measurement in the area of morphological characteristics in the treated subjects.

Based on the obtained results of the T test and discriminant analysis, it can be concluded that the changes in the mentioned dimensions of the morphological status of the girls included in the experimental volleyball work program are not a surprise, because it is known that the longitudinal and transverse measurements of the skeleton cannot be influenced by physical exercise due to the high coefficient of the hereditary factor (Milanović, 2010). Therefore, the changes in the variables for assessing the longitudinal and transverse dimensionality of the skeleton that were determined in this study were more due to the growth and development of the girls' organism, and less or not at all due to the influence of the experimental volleyball program.

kih i situaciono-motoričkih sposobnosti učenika uzrasta 13-14 godina te je izazvao proces homogenizacije i reorganizacije funkcija koje su odgovorne za uspješne rezultate u testovima motoričkih i situacono-motoričkih sposobnosti. Doprinos globalnim kvantitativnim promjenama pored korištenih operatora u okviru programa može se pripisati i drugim trenažnim sadržajima koji su korišteni u procesu rada u vremenskom intervalu između inicijalnog i finalnog mjerenja. Srdić i sar. (2021) su utvrđivali efekte sadržaja dodatne nastave na promjene motoričkih sposobnosti učenika i utvrdili da je pod uticajem programskih sadržaja dodatne nastave došlo do značajnih promjena motoričkih sposobnosti kod tretiranog uzorka ispitanika. Galić i sar. (2024) su na uzorku 88 djevojčica-košarkašica uzrasta 13-15 godina utvrđivali kvantitativne promjene motoričkih sposobnosti nastalih pod uticajem tromjesečnog programiranog rada. Dobiveni rezultati ukazuju da je pod uticajem programiranog rada došlo do statistički značajnih globalnih promjena u prostoru motoričkih sposobnosti u smislu poboljšanja repetitivne snage, koordinacije i okretnosti. Nićin i Stijepić (2008) ističu da je za tjelesni razvoj djece mlađeg školskog uzrasta između 9. i 11. godine, povoljan odnos tjelesne visine i tjelesne težine kod dječaka i djevojčica. Autri smatraju da u ovom uzrastu vjerovatno zbog te činjenice ne postoje značajne razlike između dječaka i djevojčica u osnovnim morfološkim odlikama. U organizmu se dešavaju nešto manje promjene, a količina mišićne mase znatno manje zaostaje u odnosu na težinu tijela. Srdić (2012) je u svom istraživanju utvrđivao efekte eksperimentalnog programa kod juniora u plesu. Na osnovu dobivenih rezultata autor je utvrdio statistički značajne kvalitativne i kvantitativne promjene tretiranih antropoloških obilježja kod juniora u plesu.

Upravo je ovo istraživanje imalo za cilj da se utvrde efekti posebno definisanog eksperimentalnog programa odbojke na promjene morfoloških karakteristika mladih odbojkašica u vidu kvantitativnih promjena na parcijalnom i globalnom nivou.

Na osnovu dobivenih rezultata može se konstatovati da je primijenjeni program odbojke povoljno djelovao na tretirane morfološke odlike, u prvom redu na priraštaj dijametra zgloba šake i dužine nogu i ruku, a zatim i na prirast tjelesne visine i tjelesne težine. Zbog toga bi trebalo transformacioni trenažni proces sa mladim odbojkašicama usmjeriti na prirast morfoloških karakteristika u skladu sa njihovim karakteristikama u pojedinim fazama razvoja.

Na osnovu prethodno navedenog može se kon-

No statistically significant changes (differences) were found in the variables for evaluating the circular dimensionality of the body and skin folds, which is a surprise in this research. Many previous studies confirm that circular dimensions, and especially subcutaneous fat tissue, are variable and less reliable measures than longitudinal and transverse dimensions for assessing the morphological status of subjects. Malacko (1985) points out that morphological characteristics are influenced by genetic and environmental factors, but that the influence of genetic factors is not the same on all morphological characteristics. The author also points out that the innateness coefficient for the longitudinal dimensionality of the skeleton is the highest and is about 98%, for voluminousness 90%, and for adipose tissue 50%. Đurašković (2001) points out that it is possible to achieve a greater impact on the reduction of skin folds, which depends on the scope and intensity of kinesiological activity, considering the lesser impact of the genetic code, i.e. growth hormone (K = .50). The same author indicates that positive changes occur under the influence of physical exercise. It multiplies muscle cells are activated, the number of capillaries increases, circulation improves, and fat tissue disappears from the muscles.

Essentially, experimental training programs can affect the transformation of the circular dimensionality of the skeleton and skin folds depending on the content and means that the specific program includes, as well as the duration of the experimental treatment. Malina, Bouchard, & Bar-Or, (2004) conclude in their research that special exercise programs do not produce positive effects on the longitudinal dimensionality factor of the skeleton, unlike the circular dimensionality factor of the skeleton and subcutaneous fat tissue.

Similar results on the positive impact of the experimental program on changes in morphological characteristics are presented in their research by Bala et al. (2018).

The obtained results point to the conclusion that the changes in the examined morphological characteristics of the female volleyball players who represented the sample of respondents in this study are primarily caused by the influence of growth factors and biological maturation, and partly by the influence of the experimental volleyball program. Morphological characteristics have a high genetic dependence and the influence of the experimental program is negligible, with the exception of body weight and subcutaneous fat tissue, where changes under the influence of the experimental program are possible.

The results of this research are similar to the results obtained by many researchers who have treated the problem of changes in morphological characteristics under the

statovati da su dobijene parcijalne i globalne kvantitativne promjene morfoloških odlika kod tretiranog uzorka ispitanica posljedica primijenjenog eksperimentalnog programa koji je realizovan u vremenskom periodu od šest mjeseci.

Mnoga istraživanja (Stojiljković i sar., 2010; Hrgetić i sar., 2016; Špirtović i sar., 2021; Bajrić i Adžemović, 2023) bavila su se utvrđivanjem efekata eksperimentalnih programa na promjenu sastava tijela kod vježbača i rekreativaca. Špirtović i sar. (2021) su utvrđivali efekte programiranog rada na promjene kompozicije tijela ispitanica rekreativnog vježbanja. Na osnovu dobivenih rezultata autori konstatuju da je programirani rad proizveo statistički značajne promjene u tjelesnoj kompoziciji rekreativnih vježbača a promjene su u prvom redu nastale u tjelesnoji mišićnoj masi kao i procentu masnog tkiva. Bajrić i Adžemović (2023) su na uzorku od 44 vježbača rekreativaca (27 ženskih i 17 muških) starosti od 25 do 40 godina, izvršili istraživanje s ciljem utvrđivanja efekata tromjesečnog Hard Body programa vježbanja na promjene tjelesne kompozicije. Primjenom analize rezultata T testa autori konstatuju da je tromjesečni Hard Body program vježbanja proizveo statistički značajne razlike u sastavu tijela vježbača žena i muškaraca, rekreativaca, odnosno da postoji razlika u tjelesnoj težini i kod muških i ženskih rekreativaca, obimu struka, postotku mišićnog tkiva i dnevnom unosu kalorija kod ženskih vježbača, rekreativaca, zatim postotku masnog tkiva, body mass indexu i postotku vode kod muških vježbača, rekreativaca. Autori na kraju konstatuju da je kvalitet života i životna putanja najveća borba koju vodimo sami sa sobom, ali kada je savladamo, koraci koje pravimo su laganiji i uspijevamo da vidimo dalje od drugih.

Zaključak

Osnovni cilj istraživanja bio je da se utvrde kvantitativne promjene morfoloških karakteristika mladih odbojkašica koje su činile uzorak ovog istraživanja na parcijalnom i globalnom nivou. U tu svrhu na uzorku od 50 ispitanica mladih odbojkašica primijenjen je set od dvanaest morfoloških varijabli koje hipotetski pripadaju odgovarajućim dimenzijama longitudinalnog, transferzalnog, cirkularnog prostora i varijabli za procjenu potkožnog masnog tkiva. Za utvrđivanje efekata šestomjesečnog programa rada odbojke koji se odražava na kvantitativne promjene morfoloških karakteristika mladih odbojkašica na parcijalnom i globalnom nivou primijenjeni su rezultati t testa za zavisne uzorke i kanonička diskriminativna analiza.

influence of programmed work, either in the teaching or training process (Bala, 1981; Babin et al., 1999; Pejčić, 2001; Zrnzević, 2007; Nićin and Stijepić, 2008; Srdić, 2012; Zrnzević and Zrnzević, J., 2015; Bala et al., 2018; Mitrović et al., 2021; Galić et al., 2022).

In his research, Pejčić (2001) states that any well-programmed physical activity significantly affects changes in both motor skills and morphological characteristics. Nićin and Stijepić (2008) point out that for the physical development of children of younger school age between 9 and 11 years, the ratio of body height and body weight in boys and girls is favorable. The authors believe that at this age, probably due to this fact, there are no significant differences between boys and girls in basic morphological characteristics. Slightly smaller changes occur in the organism, and the amount of muscle mass lags significantly less in relation to body weight. Srdić (2012) in his research determined the effects of an experimental program in juniors in dance. Based on the results obtained, the author determined statistically significant quantitative and qualitative changes in the treated anthropological characteristics in juniors in dance.

Also, some studies (Stojiljković et al., 2010; Hrgetić et al., 2016; Špirtović et al., 2021; Bajrić and Adžemović, 2023) have investigated the effects of experimental programs on changes in body composition in exercisers and recreational exercisers. Špirtović et al. (2021) have determined the effects of programmed work on changes in body composition of recreational exercisers. Based on the results obtained, the authors conclude that programmed work produced statistically significant changes in the body composition of recreational exercisers, and the changes primarily occurred in body muscle mass and the percentage of fat tissue. Bajrić and Adžemović (2023) conducted research on a sample of 44 recreational exercisers (27 female and 17 male) aged 25 to 40 years with the aim of determining the effects of a three-month Hard Body exercise program on changes in body composition. By applying the analysis of the results of the T test, the authors state that the three-month Hard Body exercise program produced statistically significant differences in the body composition of female and male exercisers, recreationists, that is, there is a difference in body weight in both male and female recreationists, waist circumference, percentage of muscle tissue and daily calorie intake in female exercisers, recreationists, then the percentage of fat tissue, body mass index and percentage of water in male exercisers and recreationists.

Analiza rezultata T testa pokazuje da je šestomjesečni program rada odbojke proizveo parcijalne kvantitativne promjene u sedam od ukupno dvanaest varijabli za procjenu morfoloških karakteristika. Najznačajnije parcijalne promjene su se desile kod varijabli za procjenu longitudinalne i trasverzalne dimenzionalnosti tijela. Iznenađenje predstavlja podatak da parcijalne promjene nisu utvrđene kod varijabli za procjenu kod kožnih nabora.

Rezultati kanoničke diskriminativne analize pokazuju da je došlo do značajnih promjena morfoloških karakteristika ispitanica na globalnom nivou a najveći doprinos diskriminativnoj funkciji tj. razlici između inicijalnog i finalnog mjerenja morfoloških karakteristika ispitanica ima dijametar zgloba šake (ADIJŠA .672). Pored nje s nešto nižim vrijednostima u diskriminaciji učestvuju varijable dužina ruku (ADUŽRU ,542), dužina nogu (ADUŽNO ,364), tjelesna visina (ATJVIS ,255), tjelesna težina (ATJTEŽ ,235) i dijametar koljena (ADIJKO , 217). Ostale mjerene morfološke varijable nisu značajno učestvovale u diskriminaciji inicijalnog od finalnog mjerenja u prostoru morfoloških karakteristika.

Generalno, dobiveni rezultati pokazuju da je definisani program odbojke u trajanju šest mjeseci proizveo značajne kvantitativne promjene morfoloških karakteristika mladih odbojkašica kako na parcijalnom tako i na globalnom nivou. Ovakvi rezultati upućuju na činjenicu da eksperimentalni programi mogu proizvesti značajne željene promjene antropološkog statusa ispitanika ali mora biti strukuriran tako da programirane aktivnosti predstavljaju optimalne stimulanse koji su dobro prilagođeni uzrasnim karakteristikama i individualnim sposobnostima i osobinama svakog pojedinca. Dobiveni rezultati se odnose na tretirani uzorak ispitanica a za generalizaciju rezultata potrebno je izvršiti veći broj istraživanja koji bi podrazumijeva ovaj ili sličan uzorak i veći broj ispitanica.

Rezultati istraživanja mogu predstavljati dobru osnovu i poticaj drugim istraživačima za istraživanje i definisanje strukture morfološkog prostora i utvrđivanje mogućih odnosa morfoloških karakteristika sa drugim dimenzijama antropološkog prostora kod odbojkašica različite uzrasne dobi. Svakako da bi takvi rezultati mogli doprinijeti boljoj selekciji i kvalitetnijem planiranju i programiranju trenažnog rada sa mladim odbojkašicama uvažavajući osobenosti morfoloških karakteristika za svaku uzrasnu dob ispitanica.

Conclusion

The main goal of the research was to determine whether and to what extent positive changes (at partial and global levels) in the morphological characteristics of female volleyball players aged 10-12 years can be achieved by applying a specially defined experimental volleyball program. For this purpose, a set of twelve morphological variables was applied to a sample of 50 young female volleyball players, which hypothetically belong to the corresponding dimensions of the longitudinal, transferal, circular space and variables for assessing subcutaneous fat tissue. To determine the effects of the six-month volleyball program on quantitative changes in the morphological characteristics of young female volleyball players at partial and global levels, the results of the T test for dependent samples and canonical discriminant analysis were applied.

Based on the analysis of the differences in the arithmetic means (Mean) of the results of the applied morphological characteristics at the beginning and at the end of the experimental program, the significance of the changes was tested by the T-test for dependent samples and partial quantitative changes were analyzed for each applied variable. The results of the T test show that changes were achieved in the measures for assessing the longitudinal and transverse dimensionality of the body. The surprise is the fact that changes were not determined in the variables for assessing circular dimensionality and skin folds.

As the results of the T test show, the results of the canonical discriminant analysis show that significant changes in the morphological characteristics of the subjects occurred at the global level, and the greatest contribution to the discriminant function, i.e. the difference between the initial and final measurement of the morphological characteristics of the test subjects is the variable of the transverse dimensionality of the skeleton (the diameter of the hand joint, and next to it, with slightly lower values, the variables participate in the discrimination longitudinal dimensions of the skeleton (arm length, leg length and body height). The variables of the circular dimensionality of the skeleton and skin folds did not participate in the discrimination of the initial from the final measurement in the space of morphological characteristics.

Based on the results obtained and the results of previous research, we can conclude that the changes in the examined morphological characteristics of female volleyball players are primarily caused by the influence of growth factors and biological maturation, and partly by the influence of the experimental volleyball program. Given that morphological characteristics have a high genetic conditionality, the influence of experimental programs is negligible, with the exception of subcutaneous fat tissue, where changes are possible provided that the content of the program, operators, load and training methods are well selected and adapted to the age categories of the subjects. Therefore, a lot of knowledge and experience are needed, and above all, good programming of training work, adequate load and knowledge of the age characteristics and abilities of the participants undergoing experimental programs. Even the best concept will not significantly affect the efficiency of training work if the training content, training operators, forms of training work, training methods are not modernized and the volume and intensity of the load is not adjusted. For these reasons, it is necessary to monitor and control the achieved effects of experimental programs, the achievement of the desired results, as well as the necessary corrections of such training programs.

The results of the research can represent a good basis and incentive for other researchers to research and define the structure of morphological space and determine possible relationships of morphological characteristics with other dimensions of anthropological space in volleyball players of different ages. The results of such research could contribute to better selection and better planning and programming of training work with young volleyball players, taking into account the characteristics of morphological characteristics for each age group of the respondents.

Refernces

Bajrić, O., Bajrić, S., Bašinac, I. & Kovač, R. (2013). Latentna struktura morfoloških obilježja polaznica rukometne škole. U O.Bajrić, i V.Srdić (ur.) *III Međunarodna konferencija „Sportske nauke i zdravlje*“ (str.53 -60). Banja Luka: Panevropski univerziete Apeiron. [in Serbian]

Bajrić, O., Bajrić, S., Lolić, D. & Srdić, V. (2011). Faktorska struktura motoričkih sposobnosti mladih rukometašica. U A. Biberović (ur.*) IV Međunarodni simpozijum Sport i zdravlje* (str.94-100). Tuzla: Fakultet za tjelesni odgoj i sport. [in Serbian]

Bajrić, O., Bajrić, S., Lolić, V. (2014). *Odbojka u teoriji i praksi.* Banja Luka: Panevropski Univerzitet „Apeiron“. [in Serbian]

Bajrić, O., Šmigalović, M., Bašinac, I. & Bajrić, S. (2012). Globalne kvantitativne promjene bazičnih i situaciono-motoričkih sposobnosti pod uticajem programa odbojke, *„Sportske nauke i zdravlje“,* str. 22-28. Banja Luka: Panevropski Univerzitet „Apeiron.“ [in Serbian]

Bajrić,O. & Bašinac, I. (2020). *Metodika fizičkog vaspitanja*. Banja Luka: Panevropski Univerzitet „Apeiron“.

Bonacin, D. & Smajlović, N. (2005). Univerzalni model selekcije za vrhunsko sportsko stvaralaštvo. *Homo sporticus,* (8), 36-40.

Bajrić, S. & Adžemović, M. (2023). Efekti HARD BODY programa na promjene sastava tijela kod rekreativaca. U O.Bajrić i V.Srdić (ur.) *XII Međunarodne konferencije- Sportske nauke i zdravlje,* str. 37-48. Banja Luka: Panevropski univerziete Apeiron. [in Serbian]

Bonacin, D., Bonacin, Da. & Bašinac, I. (2008). Simulacija nekih biomotoričkih dimenzija za selekciju odbojkaša uzrasta 7 godina. *Sport science,* (2), 49-51. [in Serbian]

Bonacin, D., Bilić, Ž. & Bonacin, Da. (2008). *Uvod u antropološku analizu.* Travnik: Kineziološki fakultet. [in Croatian]

Galić, M., Korjenić, A. & Vučić, A. (2022). Efekti primjene trenažnog programa rada na transformaciju morfoloških karakteristika košarkašica ŽKK "Ljubuški". U O.Bajrić i V.Srdić (ur.) *XII Međunarodna konferencija „Sportske nauke i zdravlje*", str.79 -87. Banja Luka: Panevropski univerziete Apeiron. [in Serbian]

Galić, M., Korjenić, A., Vučinić, A. & Kukić, A. (2024). Analiza kvantitativnih promjena u prostoru istraživanih motoričkih sposobnosti kod mladih košarkašica. U O.Bajrić i V.Srdić (ur.) *XIV Međunarodna konferencija „Sportske nauke i zdravlje*", str.79 -87. Banja Luka: Panevropski univerziete Apeiron. [in Serbian]

Hrgetić, M., Dadić, M., Milanović, M. & Skoblar, J. (2016). Utjecaj tromjesečnog fitness programa vježbanja na antropološki status žena srednje životne dobi. U V.Findak (ur.) *XXV Ljetna škola kineziologa Republike Hrvatske*, str. 354-357. Zagreb: Hrvatski kineziološki savez. [in Croatian]

Janković, V. & Sabljak, M. (2004). *Elementi tehnike odbojke i metodika*, Zagreb: Vlastita naklada. [in Croatian]

Kurelić, N., Momirovič, K., Stojanović, M., Šturm, J., Radojević,Đ. & Štalec-Viskić, N. (1975). *Struktura i razvoj morfoloških i motoričkih dimenzija omladine.* Beograd: Institut za naučna istraživanja Fakulteta za fizičko vaspitanje Univerziteta u Beogradu. [in Serbian]

Malijević, G. (2012). *Efekti transfoemacionih procesa kod fudbalera uzrasta od 10 do 12 godina.* [Magistarski rad]. Panevropski Univerzitet „Apeiron."Banja Luka. [in Serbian]

Mahmutspahić, A. (2013). *Metodika učenja osnovnih tehničko – taktičkih elemenata u odbojci.* [Diplomski rad]. Panevropski Univerzitet „Apeiron."Banja Luka. [in Serbian]

Nićin, Đ. & Stjepić, R. (2008). Senzitivne faze razvoja antropometrijskih karakteristika dečaka 7-15 godina. *Glasnik Antropološkog društva Srbije*, 43: 532-538. [in Serbian]

Pejčić, A. (2001). Razlike između dječaka i djevojčica od prvog do četvrtog razreda u morfološkim karakteristikama i motoričkim sposobnostima. U V.Findak (ur.) X ljetna škola kineziologa Republike Hrvatske, str. 137.-142. Zagreb: Hrvatsko društvo pedagoga tjelesne kulture. [in Croatian]

Sekulić, D. & Matikoš, D. (2007). *Osnove transformacionih postupaka u kineziologiji.* Split: Fakultet prirodoslovno-matematičkih znanosti i kineziologije. [in Croatian]

Srdić, V. (2012). *Efekti transformacinih procesa kod juniora u plesu.* [Doktorska disertacija]. Panevropski univerzitet Apeiron u Banja Luci. [in Serbian]

Srdić, V., Bajrić, O., Bajrić, S. & Ilić, N. (2023). *Teorija i metodika sportskog treninga*. Banja Luka: Panevropski Univerzitet Apeiron. [in Serbian]

Srdić, V., Jeličić, B., Bajrić, S. & Hasić, A. (2021). Promjene motoričkih sposobnosti pod uticajem programa dodatne nastave fizičkog vaspitanja. U O. Bajrić i V. Srdić (ur.) *XI Međunarodna konferencija "Sportske nauke i zdravlje,* str. 91-100. Banja Luka: Panevropski Univerzitet „Apeiron". [in Serbian]

Stojiljković, S., Mandarić, S., Katarina, T. & Mitić, D. (2010). Efekti primene „omnibus" aerobika na telesnu kompoziciju žena. *Fizička kultura,* 64(2), 59-67. [in Serbian]

Šmigalović, M., Bajrić, O. & Lolić, D. (2012). Uticaj programa odbojke na bazične i situacionomotoričke sposobnosti učenika uzrasta 13 – 14 godina. *Sportske nauke i zdravlje,* 2 (1): 35-40. [in Serbian]

Špirtović, O., Bajrić, S. & Hadžić, R. (2021). Uicaj programiranog vježbanja na pokazatelje tjelesne kompozicije rekreativnih vježbača. *Sportske nauke i zdravlje*, 11(2), (237-244) [in Serbian]

Primljen: 20. mart 2025. / Received: March 20, 2025
Izmjene primljene: 20. maj 2025. / Changes Received: May 20, 2025
Prihvaćen: 03. jun 2025. / Accepted: June 03, 2025