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Correlation between Morphological Characteristics and Bounce from Middle Position in Volleyball in Eleven-Year-Old Female Pupils

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Abstract

The research was carried out in order to determine the correlation between morphological characteristics and a representative curriculum topic Bounce from middle position in volleyball from the curriculum unit Games in the Croatian Physical Education curriculum for elementary school female students. In accordance with the above mentioned, a set of 16 anthropometric measurements to evaluate morphological characteristics as well as the test of motor skill Bounce from middle position in volleyball was used on the sample of 152 female students aged 11 (± 6 months). The results of multiple regression analysis showed a high degree of correlation between the set of predictors of applied morphological variables and the criterion variable Bounce from middle position in volleyball (R = .44). The analysis of the partial influence of certain morphological variables on the significance of the regression model showed that the statistically significant contribution is shown by the variables of the back skinfold, the mean chest circumference, the upper arm skinfold, the forearm circumference, the lower leg skinfold and the wrist diameter. The results of the research show the significance of choosing the curriculum topic Bounce from middle position in volleyball in planning the Physical Education lesson to transform certain morphological characteristics in order to achieve the desirable final conditions of the female pupils and also to achieve better results in grading this curriculum content.

Key words: *fifth grade elementary school female students; grading; motor skill; Physical Education; planning and programming.*

Introduction

Motor skills refer to the degree of acquiring particular motor structures that can be at different levels (Findak, 2003). Motor skills in kinesiology are the skills that require significant changes in morphological, motor and functional characteristics during their improvement, because these characteristics and abilities of students are the basis for success in Physical Education. That is why motor skills can also be used as an incentive to develop the aforementioned characteristics of students. Gross motor skills in kinesiology include those motor motion structures whose primary function is the development and promotion of individual basic functional, motor and morphological characteristics. In the realization of these motor skills, individual functional, motor and morphological abilities and characteristics are maximally activated or the active muscle mass growth and reduction of subcutaneous fat tissue is maximally stimulated (Findak, Metikoš, Mraković, Neljak, & Prot, 2000). The motor skills in physical education are cognitions that could be of great benefit because of the possibility of forming rational procedures for planning, programming and also monitoring and evaluation in Physical Education classes. In order to adequately apply motor skills to the transformation of individual anthropological characteristics of a student, it is certainly necessary to respect the biological degree of development of certain abilities in individual stages of students' growth and development. This is a prerequisite for appropriate motor skills to take up the function of an appropriate kinesiology stimulus in the development of students' anthropological characteristics.

According to Gabbard (1992) and Sanders (1992), special attention should be paid to the group of motor skills during childhood, i.e. in preschool education and in the early school age. Regarding the aforementioned, all the institutions participating in educational programs, parents and especially kinesiology teachers, play a decisive role (Venetsanou & Kambas, 2009). The optimum conditions for fulfilling the needs of exercising all forms and types of motor skills should be provided for students, and this should be taken into account in designing the Physical Education curriculum (Gallahue & Ozmun, 1998).

Babin (1985) applied 4 morphological measures as predictor variables and grades in Physical Education as the criterion variable, on the sample of 130 first year high school students (16 years of age). The results of the regression analysis in the manifest area showed that there was no significant relation between the morphological measures and success in Physical Education on the sample of students. Positive, but low correlations between the forearm circumference and body mass and grades in Physical Education were obtained, confirming the previous results of the correlation between the body volume and body mass measurements and success in the physical activities where strength factors dominate.

Babin, Bavčević, and Vlahović (2013) conducted research with the aim of determining the relation between motor abilities and motor skills of the representative curriculum topics from the Physical Education curriculum for fifth grade elementary school students. A total of 21 tests for the assessment of motor abilities and 7 tests for

the assessment of motor skills were conducted on the sample of 152 students at the age of 11. The correlation analysis results indicated a high degree of linear correlation between the two observed groups.

This research was carried out in order to determine the correlation between morphological characteristics and the motor skill *Bounce from middle position in volleyball*, which is a representative curriculum topic in the unit Games in the Physical Education curriculum for elementary school female students.

The results of this research will contribute to a better understanding of physical education, especially in the domain of planning and programming as well as the implementation and control of the process of physical exercise (Babin et al., 2013).

Methods

In accordance with the research purpose, the sample consisted of 152 female fifth grade elementary school students in Split, aged 11 (± 6 months). The subjects attended regular Physical Education classes according to the Curriculum for Elementary Schools (2006). All the participants were clinically healthy and with no aberrant behavior.

The variables applied in the evaluation of the morphological characteristics of the female students consisted of 16 standard anthropometric measurements, taken by nine educated evaluators according to the guidelines in the International Biological Program (IBP).

Based on previous research (Medved, Mišigoj-Duraković, Marković, & Pavičić, 1987) the measurements were conducted by evaluating four latent anthropometric dimensions. Each of the hypothetical morphological dimensions was evaluated using four variables, and each variable was measured three times. In this way, a set of 16 anthropometric measurements used for this research was formed:

- Longitudinal dimensionality of the skeleton – 1) *Body height* (AVIS), 2) *Leg length* (ADŽN), 3) *Arm length* (ADŽR), 4) *Foot length* (ADŽS),
- Transversal dimensionality of the skeleton – 5) *Knee diameter* (ADKL), 6) *Elbow diameter* (ADLK), 7) *Wrist diameter* (ADRZ), 8) *Pelvis width* (AŠRZ),
- Body volume and mass – 9) *Body mass* (ATŽT); 10) *Forearm circumference* (AOPP); 11) *Lower leg circumference* (AOPT); 12) *Mean chest circumference* (AOGK),
- Subcutaneous fat tissue – 13) *Upper arm skinfold* (AKNN); 14) *Back skinfold* (AKNL); 15) *Abdominal skinfold* (AKNT); 16) *Lower leg skinfold* (AKNP).

Motor skills test *Bounce from middle position in volleyball* (MZVRO) was selected as a representative curriculum topic from the curriculum unit *Games* (Curriculum for Elementary Schools, 2006). The test was evaluated by seven independent competent evaluators by direct observation of female students' performance. The evaluators had previously been additionally educated on the way and the harmonization of the evaluation criteria. The test was formed according to the following description:

Aids: Volleyball, picture representing the task.
Place of performance: School gym.
Task: The test implies making several consecutive bounces above the head from the middle position in volleyball.

Description and proper test performance: The subject is in a diagonal position with weight equally distributed on both legs, knees are slightly bent, as well as elbows. Palms holding the volleyball are in front of the forehead, slightly pulled back and towards each other, fingers are separated and slightly tense. Now the subject throws the ball over her head and starts the bounce by stretching the legs, body and hands towards the ball, ending with active finger extension. The ball lies mostly on the thumbs, forefingers and middle fingers, while the ring finger and the small finger only support it. The ball is first slowed to a stop, then hit with fingers by swift hand extension and sent straight up above the head. Arm work should be assisted by leg stretching. Before bouncing the ball, the subject occupies such a position in space that she can bounce the ball above the head with several repetitions.

Grading: Test is performed once and is graded on a 1-5 scale.

Grading criteria:

GRADE	MOTOR SKILL TEST PERFORMANCE DESCRIPTION
5 (excellent)	- student performs correct, accurate and clean bounce without mistakes - student is well placed under the ball and has the correct posture, footwork, hands and fingers motion
4 (very good)	- student has stiff fingers at bouncing, so during the bounce an unclean hit on the ball can be heard
3 (good)	- arms and legs are rigid and motions are cut off, not fluid - fingers are stiff so, due to the weak amortization, a hit on the ball can be heard
2 (sufficient)	- student is incorrectly placed under the ball - fingers are stiff as well as the entire body movements - bounces the ball very stiffly or with too stiff fingers
1 (insufficient)	- student is incorrectly placed under the ball - incorrectly bounces the ball, "carries it" - bounces the ball with palms, pushes it - bounces the ball with double hit - has stiff knees - waits for the ball with stiff or overly bent arms - has no control over the ball

The measurement results of all tests were subjected to the analysis of descriptive parameters, as part of which the arithmetic mean (M), the minimum score (Min), the maximum score (Max), standard deviation (SD), the distribution asymmetry (Skew), elongation of distribution (Kurt) and the Kolmogorov-Smirnov test of distribution normality (Max D) were calculated.

In order to obtain information about the relations between the set of variables of morphological characteristics and the motor skill variable *Bounce from middle position in volleyball,* the multiple regression analysis was applied and within the analysis the following were calculated: multiple correlation coefficient (*R*), coefficient of

determination (R^2), standard error of the estimate (σ_e), F-test value (F), standardized regression coefficient (β), predictor variable linear correlation coefficient (r), t-test value (t) and the significance level (p).

Statistica for Windows 13.0 software package was used for data analysis.

Results

The analysis of the indicator value for the descriptive parameters of the variables in order to evaluate the morphological characteristics of the female students indicates that most variables show the expected parameters in morphological variables measurements in terms of distribution formation (Table 1). With a .01 error rate (KS-test = .13), we can determine that data distributions do not deviate significantly from the normal Gaussian distribution, showing all variables except the *Back skinfold* (AKNL, Max D = .17) variable.

Table 1

Descriptive statistics parameters and the Kolmogorov-Smirnov test of distribution normality of morphological variables - female students (M – arithmetic mean, SD – standard deviation, Min – minimum score, Max – maximum score, Skew – asymmetry, Kurt – elongation, Max D – Kolmogorov-Smirnov test)

Variable	M	SD	Min	Max	Skew	Kurt	Max D
AVIS	154.44	7.83	137.40	178.90	0.45	-0.00	.06
ADŽN	83.34	4.86	79.43	105.00	0.47	0.13	.06
ADŽR	66.43	3.80	57.56	78.23	0.41	-0.05	.09
ADŽS	23.95	1.26	20.56	27.56	0.33	0.05	.07
ADKL	8.72	0.54	7.66	10.36	0.52	-0.15	.08
ADLK	5.81	0.35	5.10	6.70	0.24	-0.41	.08
ADRZ	4.87	0.29	4.06	5.60	-0.11	-0.08	.06
AŠRZ	24.50	2.07	20.46	30.43	0.39	-0.11	.07
ATŽT	46.06	10.71	30.00	80.50	0.95	0.53	.10
AOPP	20.48	1.87	16.40	25.63	0.35	-0.34	.07
AOPT	31.85	3.16	25.06	39.50	0.52	-0.24	.12
AOGK	75.78	7.78	62.06	100.46	0.81	0.52	.07
AKNN	15.22	5.26	6.20	31.73	0.71	0.19	.08
AKNL	11.29	6.17	4.46	34.40	1.72	2.97	.17
AKNT	19.11	8.54	4.13	44.73	0.47	-0.29	.06
AKNP	18.31	7.00	8.33	38.20	0.88	0.14	.10

Critical value of the KS-test = .13; p = .01

Legend: AVIS – Body height; ADŽN – Leg length; ADŽR – Arm length; ADŽS – Foot length; ADKL – Knee diameter; ADLK – EIbow diameter; ADRZ – Wrist diameter; AŠRZ – Pelvis width; ATŽT – Body mass; AOPP – Forearm circumference; AOPT – Lower leg circumference; AOGK – Medium thorax circumference; AKNN – Upper arm skinfold; AKNL – Back skinfold; AKNT – Abdominal skinfold; AKNP – Lower leg skinfold

By examining the values of the descriptive parameters (Table 2) of the analyzed variables for the motor skill *Bounce from middle position in volleyball* (MZVRO)

evaluation, it is obvious that there are no maximum deviations of the empirical results in relation to the theoretical relative cumulative frequencies (Max D) and that they do not exceed the critical value of the KS test (.13), so the distributions can be considered normal.

Table 2

Descriptive statistics parameters and the Kolmogorov-Smirnov test of distribution normality of the variable for evaluation of the motor skill bounce from middle position in volleyball (MZVRO) (M – arithmetic mean, SD – standard deviation, Min – minimum score, Max – maximum score, Skew – asymmetry, Kurt – elongation, Max D – the Kolmogorov-Smirnov test)

Variable	M	SD	Min	Max	Skew	Kurt	Max D
MZVRO	2.22	1.07	1.00	5.00	0.83	0.15	.12

Critical value of the KS-test = .13; p = .01

The results of the multiple regression analysis (Table 3) indicate a high degree of correlation between the predictor set of applied morphological variables and the criterion variable *Bounce from middle position in volleyball* (MZVRO). Multiple correlation coefficient (R = .44) indicates that a significant amount of variance of the criterion variable can be attributed to the influence of the set of predictor variables. The statistical significance of the regression model was confirmed using the F-test (F = 2.06; p = .01), so it can be determined that a defined set of predictor variables allows a valid prediction of the value of the criterion variable *Bounce from middle position in volleyball* (MZVRO). The determination coefficient (R^2 = .20) shows the value from which it can be determined that the criterion variable can be explained by 20% variance of the predictor set of variables. The standard error of the estimate (σ_e = 1.02), as an indicator of the standard deviation of the dispersion of score measurements over the regression path, indicates an unsatisfactory degree of representativeness of the regression model.

The analysis of the partial influence of individual variables on the significance of the regression model indicated that six predictor variables show statistically significant contribution. The *Back skinfold* (AKNL) variable has the highest values in the contribution of the criterion variable prediction with a regression coefficient β = -.55, and in correlation with the criterion variable shows the value r = -.25. Statistical significance was confirmed using the t-test (t = -3.02, p = .00). The variable *Mean chest circumference* (AOGK) is the second value in the contribution of the regression model with a standardized regression coefficient β = .63. The correlation relationship of the mentioned variable with the criterion variable is r = .22. Statistical significance confirms the values of the applied t-test (t = 2.61; p = .01). The third variable in the range of the contribution rate to the regression model significance is the *Upper arm skinfold* (AKNN) with a regression coefficient β = .51. The correlation between the relationship of the mentioned variable and the criterion is r = .20. Statistical significance was confirmed using the t-test (t = 2.43, p = .02). The fourth variable by the magnitude of the partial contribution to the regression model is the *Forearm*

circumference (AOPP) with a regression coefficient β = -.56 and a coefficient of correlation with a criterion of -.19. The obtained results were confirmed using the t-test (t = -2.20, p = .03). The fifth variable in the magnitude of the regression model significance is the *Lower leg skinfold* (AKNP) (β = -.38). The correlation between the mentioned variable and the criterion is r = -.17. The above mentioned was confirmed using the t-test (t = -2.06, p = .04). The last variable with the statistical significance in the value of the contribution rate of the criterion estimate is the *Wrist diameter* (ADRZ) with a regression coefficient β = .26 and a coefficient of correlation with a criterion r = .17. The results were confirmed using the t-test (t = -1.96; p = .05).

Table 3

Multiple regression analysis; criterion variable – Bounce from middle position in volleyball (MZVRO),predictor set – morphological variables (R – multiple correlation coefficient, R^2 – determination coefficient, σ_e – standard error of the estimate, F – F-test value, β – standardized regression coefficient, r – predictor and criterion variable linear correlation coefficient, t – t-test value, p – significance level)

R = .44	R^2 = .20	σ_e = 1.02	F = 2.06	p = .01
Variable	β	r	t	p
AVIS	.01	.00	0.03	.97
ADŽN	-.12	-.05	-0.54	.59
ADŽR	.03	.01	0.13	.89
ADŽS	-.01	-.00	-0.04	.97
ADKL	.18	.09	1.02	.31
ADLK	.07	.05	0.56	.58
ADRZ	**.26**	**.17**	**1.96**	**.05**
AŠRZ	.01	.01	0.08	.93
ATŽT	-.39	-.07	-0.83	.41
AOPP	**-.56**	**-.19**	**-2.20**	**.03**
AOPT	.05	.02	0.20	.84
AOGK	**.63**	**.22**	**2.61**	**.01**
AKNN	**.51**	**.20**	**2.43**	**.02**
AKNL	**-.55**	**-.25**	**-3.02**	**.00**
AKNT	.19	.09	0.99	.32
AKNP	-.38	-.17	-2.06	.04

Legend: AVIS – Body height; ADŽN – Leg length; ADŽR – Arm length; ADŽS – Foot length; ADKL – Knee diameter; ADLK – Elbow diameter; ADRZ – Wrist diameter; AŠRZ – Pelvis width; ATŽT – Body mass; AOPP – Forearm circumference; AOPT – Lower leg circumference; AOGK – Medium thorax circumference; AKNN – Upper arm skinfold; AKNL – Back skinfold; AKNT – Abdominal skinfold; AKNP – Lower leg skinfold

Discussion and Conclusions

Data dispersion indicators show that the applied morphological variables successfully differentiate the subjects in terms of object of measurement. Analyzing the indicators of the distribution shape and normality, only the *Back skinfold* (AKNL) variable does not show a normal distribution in the measurement results and therefore

it can be determined that the system of applied anthropometric measurements in this study proved valid.

The results of descriptive indicator of the motor skill test *Bounce from middle position in volleyball* (MZVRO) show that it is possible to determine that the measuring instrument for assessing this motor skill is well constructed, i.e. that the measurement procedure is well elaborated and standardized, and as such it could be given a reasonable confidence in the processing and analysis of the results of this research.

The findings of the multiple regression analysis undoubtedly show that the morphological characteristics of eleven-year-old female students are important for the quality of motor test *Bounce from middle position in volleyball* (MZVRO) performance. Most information on the success of the aforementioned test of motor skill performance was provided by the skinfold, volume and mass of the body measurements.

The quality of the process of kinesiology education depends on the number of factors. One of the crucial factors is being acquainted with the actual condition, students' characteristics, skills and abilities, as well as the transformational values of certain kinesiology operators, i.e. curriculum content (Findak, 2003). The results obtained by this research provide an insight into the structure of the relationship between the curriculum topic *Bounce from middle position in volleyball* and the morphological characteristics of fifth grade elementary school female students. The aforementioned emphasizes the importance of choosing this curriculum in Physical Education teaching process for the transformation of certain morphological characteristics, all in order to achieve the desirable final condition of female students. Likewise, the results indicate which morphological characteristics should be primarily influenced in assessment and evaluation, in order for female students to achieve the best results in grading this curriculum content. Therefore, the results are directly applicable in Physical Education classes as a basis for understanding the specification models of certain kinesiology structures and consequently a significant factor in optimization of planning and programming as well as implementing and evaluating the kinesiology education process (Vlahović, Babin, B., & Babin, J., 2016).

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Povezanost morfoloških karakteristika i nastavne teme Vršno odbijanje iz srednjeg odbojkaškog stava kod jedanaestogodišnjih učenica

Sažetak

Istraživanje je provedeno s ciljem utvrđivanja povezanosti morfoloških karakteristika i reprezentativne nastavne teme Vršno odbijanje iz srednjeg odbojkaškog stava iz nastavne cjeline Igre u službenom planu i programu Tjelesne i zdravstvene kulture za učenice petih razreda osnovne škole. U skladu s navedenim na uzorku od 152 učenice u dobi od 11 godina (± 6 mjeseci) primijenjen je skup od 16 antropometrijskih mjera za procjenu morfoloških karakteristika i test motoričkog znanja Vršno odbijanje iz srednjega odbojkaškog stava. Rezultati multiple regresijske analize pokazali su visok stupanj povezanosti prediktorskog skupa primijenjenih morfoloških varijabli s kriterijskom varijablom vršno odbijanje iz srednjeg odbojkaškog stava (R = ,44). Analiza parcijalnog utjecaja pojedinih morfoloških varijabli na značajnost regresijskog modela pokazala je da statistički značajan doprinos pokazuju varijable kožni nabor leđa, srednji opseg grudnog koša, kožni nabor nadlaktice, opseg podlaktice, kožni nabor potkoljenice i dijametar ručnog zgloba. Rezultati istraživanja pokazuju značaj odabira nastavne teme Vršno odbijanje iz srednjeg odbojkaškog stava u programiranju nastave Tjelesne i zdravstvene kulture radi transformacije pojedinih morfoloških karakteristika, a s ciljem postizanja poželjnih finalnih stanja učenica i u postizanju boljih rezultata pri ocjenjivanju tog nastavnog sadržaja.

Ključne riječi: *motorička znanja; ocjenjivanje; planiranje i programiranje; Tjelesna i zdravstvena kultura; učenice petih razreda osnovne škole.*

Uvod

Motorička znanja stupanj su usvojenosti pojedinih motoričkih struktura koje mogu biti na različitim razinama (Findak, 2003). Kineziološkim motoričkim znanjima smatraju se znanja koja tijekom svog usavršavanja zahtijevaju i značajne promjene morfoloških, motoričkih i funkcionalnih obilježja, jer su te karakteristike i sposobnosti

učenika osnova uspjeha u tjelesnoj i zdravstvenoj kulturi. Upravo zbog toga motorička znanja mogu se rabiti i kao podražaj za razvoj navedenih obilježja učenika. Opća kineziološka motorička znanja obuhvaćaju one motoričke strukture gibanja čija je primarna funkcija razvoj i promicanje pojedinačnih bazičnih funkcionalnih, motoričkih i morfoloških obilježja. Pri ostvarivanju tih motoričkih znanja maksimalno se aktiviraju pojedinačne funkcionalne, motoričke i morfološke sposobnosti i osobine ili se maksimalno stimulira porast aktivne mišićne mase i redukcija potkožnog masnog tkiva (Findak, Metikoš, Mraković, Neljak i Prot, 2000). Motorička znanja u kineziološkoj edukaciji predstavljaju spoznaje koje bi mogle biti od velike koristi zbog mogućnosti formiranja racionalnih postupaka za planiranje, programiranje, praćenje i vrednovanje u nastavi Tjelesne i zdravstvene kulture. Da bi se adekvatno primijenila motorička znanja radi transformacije pojedinih antropoloških obilježja učenika, svakako je potrebno respektirati i biološki stupanj razvoja određene sposobnosti u pojedinim fazama rasta i razvoja učenika. To je preduvjet da primjereno motoričko znanje poprimi funkciju primjerenog kineziološkog stimulusa u razvoju antropoloških obilježja učenika.

Prema Gabbardu (1992) i Sandersu (1992) skupu motoričkih znanja treba posvetiti posebnu pažnju tijekom djetinjstva, tj. u predškolskom odgoju i najmlađem školskom uzrastu. Za navedeno presudnu ulogu imaju kako roditelji tako i sve institucije koje ostvaruju odgojno-obrazovne programe, a posebno značajnu ulogu imaju nastavnici kineziologije (Venetsanou i Kambas, 2009). Učenicima se stoga moraju pružiti optimalni uvjeti za podmirenje potreba za uvježbavanjem svih oblika i vrsta motoričkog znanja, a o čemu se posebno mora voditi računa pri programiranju nastavnog procesa u Tjelesnoj i zdravstvenoj kulturi (Gallahue i Ozmun, 1998).

Babin (1985) je na uzorku od 130 učenika prvog razreda srednje škole (uzrast od 16 godina) primijenio 4 morfološke mjere kao varijable prediktora i ocjene iz predmeta Tjelesni odgoj koja je predstavljala varijablu kriterija. Rezultati regresijske analize u manifestnom prostoru pokazali su da nema značajne povezanosti morfoloških mjera i uspjeha u Tjelesnom odgoju na uzorku ispitivanih učenika. Dobivene su pozitivne, ali niske korelacije opsega podlaktice i mase tijela s ocjenom iz Tjelesnog odgoja, a što potvrđuje dosadašnje rezultate o povezanosti mjera volumena i mase tijela s uspjehom u kineziološkim aktivnostima gdje dominiraju faktori snage.

Babin, B., Bavčević i Vlahović (2013) proveli su istraživanje s ciljem utvrđivanja relacija između motoričkih sposobnosti i motoričkih znanja reprezentativnih nastavnih tema službenog plana i programa Tjelesne i zdravstvene kulture za učenike petih razreda osnovne škole. Na uzorku od 152 učenika u dobi od 11 godina primijenjen je 21 test za procjenu motoričkih sposobnosti i 7 testova za procjenu motoričkih znanja. Rezultati korelacijske analize ukazali su na visok stupanja linearne povezanosti dvaju promatranih skupova.

Ovo istraživanje provedeno je s ciljem utvrđivanja povezanosti morfoloških karakteristika s motoričkim znanjem *Vršno odbijanje iz srednjeg odbojkaškog stava,* a

koje je predstavljalo reprezentativnu nastavnu temu u cjelini *Igre* iz službenog plana i programa Tjelesne i zdravstvene kulture za učenice petih razreda osnovne škole.

Rezultati ovog istraživanja pridonijet će boljem razumijevanju kineziološke edukacije, a posebice u domeni planiranja i programiranja te provedbe i kontrole procesa tjelesnog vježbanja (Babin, B., Bavčević i Vlahović, 2013).

Metode

Uzorak ispitanika, a u skladu s ciljem istraživanja, činile su 152 učenice petih razreda osnovnih škola u Splitu u dobi od 11 godina (± 6 mjeseci). Učenice su pohađale redovitu nastavu Tjelesne i zdravstvene kulture po službenom nastavnom planu i programu (Nastavni plan i program za osnovnu školu, 2006). Sve ispitanice bile su klinički zdrave i bez aberantnih pojava.

Varijable kojima je izvršena procjena morfoloških karakteristika učenica činilo je 16 standardnih antropometrijskih mjera, koje je izmjerilo devet educiranih mjeritelja prema naputcima Međunarodnoga biološkog programa (International Biological Program – IBP).

Na temelju dosadašnjih istraživanja (Medved, Mišigoj-Duraković, Marković i Pavičić, 1987) mjerenja su izvršena tako da procjenjuju 4 latentne antropometrijske dimenzije. Svaka od hipotetskih morfoloških dimenzija procijenjena je s četiri varijable, a svaka varijabla mjerena je po tri puta. Na taj je način formiran skup od 16 sljedećih antropometrijskih mjera koje su se koristile za potrebe ovog istraživanja:

- longitudinalna dimenzionalnost skeleta – 1. *Visina tijela* (AVIS), 2. *Dužina noge* (ADŽN), 3. *Dužina ruke* (ADŽR), 4. *Dužina stopala* (ADŽS),
- transverzalna dimenzionalnost skeleta – 5. *Dijametar koljena* (ADKL), 6. *Dijametar lakta* (ADLK), 7. *Dijametar ručnog zgloba* (ADRZ), 8. *Širina zdjelice* (AŠRZ),
- volumen i masa tijela – 9. *Težina tijela* (ATŽT), 10. *Opseg podlaktice* (AOPP), 11.*Opseg potkoljenice* (AOPT), 12. *Srednji opseg grudnog koša* (AOGK),
- potkožno masno tkivo – 13. *Kožni nabor nadlaktice* (AKNN), 14. *Kožni nabor leđa* (AKNL), 15. *Kožni nabor trbuha* (AKNT), 16. *Kožni nabor potkoljenice* (AKNP).

Test motoričkog znanja *Vršno odbijanje iz srednjeg odbojkaškog stava* (MZVRO) odabran je kao reprezentativna nastavna teme iz nastavne cjeline *Igre* (Nastavni plan i program za osnovne škole, 2006). Test je ocijenilo sedam neovisnih kompetentnih ocjenjivača neposrednim promatranjem izvedbe učenica. Ocjenjivači su prethodno bili dodatno educirani o načinu i usuglašavanju zadanih kriterija ocjenjivanja. Test je formiran prema sljedećem opisu:

Pomagala:	Odbojkaška lopta, slika zadatka.
Mjesto izvođenja:	Školska dvorana za Tjelesnu i zdravstvenu kulturu.
Zadatak:	Izvršiti više uzastopnih vršnih odbijanja lopte iznad glave iz srednjeg odbojkaškog stava.

Opis i pravilna izvedba testa: Ispitanik se nalazi u dijagonalnom stavu s ravnomjerno raspoređenom težinom na obje noge, koljena su malo savijena, kao i ruke u laktovima. Dlanovi, u kojima drži odbojkašku loptu, su ispred čela malo povučeni nazad i okrenuti jedan prema drugom, a prsti su rastavljeni i malo napeti. Sada ispitanik baca loptu iznad glave i započinje odbijanje s istodobnim opružanjem nogu, tijela i ruku prema lopti, a završava aktivnim opružanjem prstiju. Lopta naliježe uglavnom na palčeve, kažiprste i srednje prste, a prstenjak i mali prst je samo podržavaju. Lopta se najprije amortizira, a zatim udara prstima naglim pružanjem ruku i usmjerava iznad glave. Rad ruku pri odbijanju treba potpomognuti pružanjem nogu. Prije odbijanja lopte ispitanik zauzima u prostoru takav položaj da loptu može odbijati iznad glave u mjestu i s nekoliko ponavljanja.

Ocjenjivanje: Test se izvodi jednom i ocjenjuje ocjenom 1 – 5.

Kriteriji ocjenjivanja:

OCJENA	OPIS IZVOĐENJA TESTA MOTORIČKOG ZNANJA
5 (odličan)	- učenica bez pogrešaka izvodi pravilno, precizno i čisto odbijanje - dobro se postavlja pod loptu i ima pravilno držanje tijela, rad nogu, ruku i prstiju.
4 (vrlo dobar)	- ima krute prste pri odbijanju, pa se prilikom odbijanja čuje nečist udarac po lopti
3 (dobar)	- rad nogu i ruku je krut i odsječen - prsti su ukočeni te se zbog slabe amortizacije čuje udarac po lopti
2 (dovoljan)	- netočno se postavlja pod loptu - prsti su ukočeni, kao i pokreti cijelog tijela - loptu odbija jako ukočeno ili s previše ukočenim prstima
1 (nedovoljan)	- netočno se postavlja pod loptu - netočno odbija loptu „nosi je“ - loptu odbija dlanovima, gura je - loptu odbija dvojnim udarcem - ima ukočena koljena - dočekuje loptu ukočenim ili previše savijenim rukama - nema nikakvu kontrolu nad loptom

Rezultati mjerenja svih testova podvrgnuti su analizi deskriptivnih parametara, a u sklopu čega su izračunati: aritmetička sredina (AS), minimalni rezultat (Min), maksimalni rezultat (Max), standardna devijacija (SD), asimetričnost distribucije (Skew), izduženost distribucije (Kurt) i Kolmogorov-Smirnovljev test normaliteta distribucije (Max D).

S ciljem dobivanja informacija o povezanosti između skupa varijabli morfoloških karakteristika i varijable motoričkog znanja *Vršno odbijanje iz srednjeg odbojkaškog stava* primijenjena je multipla regresijska analiza, a u sklopu koje su izračunati: koeficijent multiple korelacije (R), koeficijent determinacije (R^2), standardna pogreška prognoze (σ_e), vrijednost F-testa (F), standardizirani regresijski koeficijent (β), koeficijent linearne korelacije prediktorske varijable (r), vrijednost t-testa (t) i razina značajnosti (p).

Za analizu podataka koristio se softverski paket Statistica for Windows 13,0.

Rezultati

Analizirajući vrijednosti pokazatelja deskriptivnih parametara varijabli za procjenu morfoloških karakteristika učenica vidljivo je kako većina varijabli pokazuje uglavnom očekivane parametre u smislu formiranja distribucije kod mjerenja morfoloških varijabli. Distribucije podataka (Tablica 1), za koje se može ustvrditi uz stupanj pogreške od .01 (KS-test = ,13) da ne odstupaju značajno od normalne Gaussove raspodjele pokazuju sve varijable osim varijable *Kožni nabor leđa* (AKNL; Max D = ,17).

Tablica 1

Pregledom vrijednosti deskriptivnih parametara (Tablica 2) analizirane varijable za procjenu motoričkog znanja *Vršno odbijanje iz srednjeg odbojkaškog stava* (MZVRO), uočljivo je da nema maksimalnih odstupanja empirijskih rezultata u odnosu na teorijske relativne kumulativne frekvencije (Max D) te ne prelaze kritičnu vrijednost KS-testa (,13), pa se distribucije mogu smatrati normalnima.

Tablica 2

Rezultati multiple regresijske analize (Tablica 3) ukazuju na visok stupanj povezanosti prediktorskog skupa primijenjenih morfoloških varijabli s kriterijskom varijablom *Vršno odbijanje iz srednjeg odbojkaškog stava* (MZVRO). Koeficijent multiple korelacije (R = ,44) ukazuje na to da je značajnu količinu varijance kriterijske varijable moguće pripisati utjecaju prediktorskog skupa varijabli. Statistička značajnost regresijskog modela potvrđena je primjenom F-testa (F = 2,06; p = ,01), pa je moguće ustvrditi da definirani prediktorski skup varijabli omogućuje valjanu predikciju vrijednosti kriterijske varijable *Vršno odbijanje iz srednjeg odbojkaškog stava* (MZVRO). Koeficijent determinacije (R^2 = ,20) pokazuje vrijednost iz koje je vidljivo da je kriterijsku varijablu moguće objasniti s 20% varijance prediktorskog skupa varijabli. Vrijednost standardne pogreške prognoze (σ_e = 1,02), kao pokazatelja standardne devijacije raspršenosti izmjerenih rezultata oko pravca regresije, ukazuje na nezadovoljavajuć stupanj reprezentativnosti regresijskog modela.

Analiza parcijalnog utjecaja pojedinih varijabli na značajnost regresijskog modela ukazala je na to da statistički značajan doprinos pokazuje šest prediktorskih varijabli. Varijabla *Kožni nabor leđa* (AKNL) ima najviše vrijednosti u doprinosu prognoze kriterijske varijable s regresijskim koeficijentom od β = -,55, a u korelaciji s kriterijskom varijablom pokazuje vrijednost od r = -,25. Statistička značajnost potvrđena je primjenom t-testa (t = -3,02; p = ,00). Varijabla *Srednji opseg grudnog koša* (AOGK) druga je po vrijednosti doprinosa značajnosti regresijskog modela sa standardiziranim regresijskim koeficijentom od β = ,63. Korelacija povezanosti navedene varijable s kriterijskom varijablom iznosi r = ,22. Statističku značajnost potvrđuju vrijednosti primijenjenog t-testa (t = 2,61; p = ,01). Treća varijabla u nizu

količine doprinosa značajnosti regresijskog modela je *Kožni nabor nadlaktice* (AKNN) s regresijskim koeficijentom od β = ,51. Korelacija povezanosti navedene varijable s kriterijem iznosi *r* = ,20. Statistička značajnost potvrđena je primjenom t-testa (*t* = 2,43; *p* = ,02). Četvrta varijabla po visini značajnosti parcijalnog doprinosa regresijskom modelu je *Opseg podlaktice* (AOPP) s veličinom regresijskog koeficijenta od β = -,56 i koeficijentom korelacije s kriterijem od -,19. Dobiveni nalazi potvrđeni su primjenom t-testa (*t* = -2,20; *p* = ,03). Peta varijabla u količini doprinosa značajnosti regresijskog modela je *Kožni nabor potkoljenice* (AKNP) (β = -,38). Korelacija navedene varijable s kriterijem iznosi *r* = -,17. Navedeno potvrđuju rezultati t-testa (*t* = -2,06; *p* = ,04). Posljednja varijabla koja ima statističku značajnost u vrijednosti količine doprinosa prognoze kriterija jest *Dijametar ručnog zgloba* (ADRZ) s regresijskim koeficijentom od β = ,26 i koeficijentom korelacije s kriterijem od *r* = ,17. Nalazi su potvrđeni primjenom t-testa (*t* = -1,96; *p* = ,05).

Tablica 3

Rasprava i zaključak

Pokazatelji disperzije podataka ukazuju na to kako primijenjene morfološke varijable uspješno razlikuju ispitanice po predmetu mjerenja. Analizirajući pokazatelje oblika i normaliteta distribucije, uočljivo je da jedino varijabla *Kožni nabor leđa* (AKNL) ne pokazuje normalnu distribuciju u rezultatima mjerenja te se stoga može ustvrditi kako se sustav primijenjenih antropometrijskih mjera u ovom istraživanju pokazao validnim.

Rezultati deskriptivnih pokazatelja testa motoričkog znanja *Vršno odbijanje iz srednjeg odbojkaškog stava* (MZVRO) pokazuju kako je moguće ustvrditi da je mjerni instrument za procjenu tog motoričkog znanja dobro konstruiran, što znači kako je postupak mjerenja vrlo dobro razrađen i standardiziran te se kao takvom moglo dati opravdano povjerenje pri obradi i analizi rezultata ovog istraživanja.

Nalazi multiple regresijske analize nedvojbeno pokazuju da su morfološke karakteristike kod jedanaestogodišnjih učenica važne za kvalitetu izvođenja motoričkog testa *Vršno odbijanje iz srednjeg odbojkaškog stava* (MZVRO). Najviše informacija za uspješnost izvođenja navedenog testa motoričkog znanja pružile su neke od mjera kožnih nabora te volumena i mase tijela.

Kvaliteta procesa kineziološke edukacije ovisi o nizu čimbenika, a jedan od presudnih faktora jest poznavanje kako aktualnog stanja, sposobnosti, osobina i znanja učenika, tako i transformacijskih vrijednosti pojedinih kineziloških operatora, odnosno nastavnih sadržaja (Findak, 2003). Rezultati dobiveni ovim istraživanjem pokazuju uvid u strukturu povezanosti nastavne teme *Vršno odbijanje iz srednjeg odbojkaškog stava* i morfoloških karakteristika učenica petog razreda osnovne škole. Navedeno nam ukazuje na važnost pri odabiru te nastavne teme u procesu programiranja nastave Tjelesne i zdravstvene kulture za transformaciju pojedinih morfoloških karakteristika, a sve s ciljem postizanja poželjnih finalnih stanja učenica. Isto tako rezultati ukazuju

na koje morfološke karakteristike ponajprije treba utjecati da bi kod praćenja i vrednovanja učenice postizale što bolje rezultate pri ocjenjivanju tog nastavnog sadržaja. Stoga su rezultati izravno primjenjivi u nastavi Tjelesne i zdravstvene kulture kao osnova razumijevanja specifikacijskih modela pojedinih kineziološkim struktura, a zatim kao značajan faktor u optimizaciji planiranja i programiranja, kao i provedbe i vrednovanja procesa kineziološke edukacije (Vlahović, Babin, B. i Babin, J., 2016).

Napomena

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