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Professional paper

THE STRUCTURE OF SOME ANTHROPOMETRICAL CHARACTERISTICS OF 15-YEAR-OLD STUDENTS

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Abstract

Aiming at determining the structure of the anthropometrical characteristics, it has been conducted a research of 100 sample population of secondary school 15-year-old students at "Sami Frasheri" in Kumanovo. In conducting the foreseen objectives, there have been applied a total of 13 variables from anthropometrical space, namely: three variables to estimate the dimensionality of the longitudinal skeleton, three variables to estimate the dimensionality of the transversal skeleton, four variables to estimate the volume and mass of the body and three variables for the assessment of the skin folds of the body. On the basis of the obtained results of factorial analysis, it can be concluded that in latent space on anthropometrical characteristics of students of secondary education, there is an existence of three latent dimensions which can be defined as a: factor in the transversal dimension of the volume of the skeleton and the body, factor of the longitudinal dimension of the skeleton, and factor in skin folds of the body.

Keywords: Students, anthropometrical characteristics, factor analysis

1. Introduction

Nowadays there is a large number of professional and science newspapers that are oriented in confirmation of space of anthropometric size, especially of anthropometric and motor skills in which itcan be clear directly in achieving of sports results. To develop these dimensions in right way, it's necessary to be planned and programmed the work to be in harmonization with individual features, and features of children and younger. The control of relations of anthropometric dimensions in individual sport activity, and for other motor skills situations to the children and younger, which provides the plan and schedule of teaching physical education for primary and high school, it should be based on methodological science. In this way, the important received information, objective measuring instruments. Achieved with high safety to confirm transformation process that bring us in final results. Having in consideration the importance for anthropometrical characteristics, this research confirms the structure of students from the secondary school.Body height has a positive influence on all the body segment lengths and, in turn, athletic performance. Successful competition in sports has been associated with specific anthropometric characteristics, body composition and somatotype (Classens et al., 1991; Carter & Heath, 1990). Growth in anthropometry and body composition is influenced by chronological age and maturation. In both boys and girls, increase in chronological age induces growth-related changes in body size (height and body mass) and composition (lean body mass (LBM) and percent body fat (% Fat). Maturity-related variation in body size is most marked in an age span of between 13 and 15 years (Malina RM, et al….2004). In general, growth of body height is associated with increases in limb length and tissue mass, regardless of sex (Asmussen E, Heeboll-Nielsen K 1955; Asmussen E, Heeboll-Nielsen K, 1956). The purpose of this research is to determine the structure of the anthropometric characteristics of students 15 years of age.

2. Methods

Participants

The survey was conducted on a sample of 100 15-year-old male students, at "Sami Fraseri" high school in Kumanovo. The research used a system of 13 anthropometric variables, including: three longitudinal assessment of skeletal dimensionality, three assessment transversal dimensionality of skeleton, four to assess the volume and mass of the body and three to assess the subcutaneous adipose tissue.

Variables

In conducting the foreseen objectives, there have been applied a total of 13 variables from anthropometrical space, namely: three variables to estimate the dimensionality of the longitudinal skeleton, three variables to estimate the dimensionality of the transversal skeleton, four variables to estimate the volume and mass of the body and three variables for the assessment of the skin folds of the body.

Data analysis

Interconnectedness of the applied system of variables is determined by intercorrelation of matrix and its factorization is performed with Hotelingov method of principal components. In addition, the number of significant principal components is determined by Kaiser - Gutman - Conn's criterion for significant taking every possible component calculated characteristic root greater than or equal to 1. Significant main components transform with Varimax - rotation (orthogonal transformation) and direct oblimin position parallel and orthogonal projections.

3. Results

Table 1. Descriptive statistical parameters of anthropometric variables

	N	**Min.**	**Max.**	**Mean**	**Std. Dev.**	**Skewness**		**Kurtosis**	
ABH	100	156.00	185.00	171.3900	6.49148	-.124	.241	-.650	.478
ASHB	100	76.00	95.00	89.7500	4.08588	-.940	.241	.661	.478
ALL	100	93.00	119.00	105.2100	4.63473	.469	.241	.644	.478
ASHW	100	30.60	45.00	39.0120	2.33659	-.325	.241	1.037	.478
AHW	100	23.80	39.00	28.8710	2.74437	.804	.241	1.599	.478
APW	100	26.00	37.20	31.9230	2.36036	-.134	.241	-.149	.478
ABW	100	40.00	100.00	61.4500	11.64923	1.041	.241	1.969	.478
AVTH	100	72.00	108.00	83.3220	7.16647	.878	.241	1.448	.478
AVA	100	19.00	33.00	23.5550	2.75873	.610	.241	.678	.478
AAVF	100	19.00	28.50	23.2550	2.08832	.283	.241	-.315	.478
ASFA	100	4.50	22.00	9.4450	3.96733	1.069	.241	.548	.478
ASFB	100	5.00	19.00	9.1810	2.77036	1.436	.241	2.352	.478
ASFA	100	3.50	33.00	10.8290	5.81123	1.601	.241	2.638	.478

In tables no. 1 are shown the results of basic statistical parameters of anthropometric variables: the minimum score, maximum score, mean as the main indicator, the standard deviation as the

main indicator, and major indicators of the shape of the curve, curve asymmetry or skewness indicator and the curve indicator or kurtosis.From this table we can conclude that the values of all variables had a major difference between the minimum and maximum results. Value standard deviations for anthropometric tests (ABW-body weight, AVTH - volume of the torax,ABH - body height) are in a high level, and it is about results, which are heterogeneous and that have high variability, while other anthropometric tests at a low level, indicating that discrimination is not good and theseresultsare homogeneous and had low variability.The asymmetry of the curve is small in almost all variables and the other with negative values (hipokurtic), which means that the distribution is normal (below 0), while the rounded value of the curve for most variables is below 2.75, so that all these values are platikurtic, meaning that the results are distributed arithmetic mean.

Table 2. Intercorrelation of the anthropometric variables

	ABH	**ASHB**	**ALL**	**ASHW**	**AHW**	**APW**	**ABW**	**AVTH**	**AVA**	**AVF**	**ASFA**	**ASFB**	**ASFA**
ABH	1.000												
ASHB	.683	1.000											
ALL	**.792**	.425	1.000										
ASHW	.516	.515	.317	1.000									
AHW	.202	.259	.088	.355	1.000								
APW	.484	.496	.348	.552	.617	1.000							
ABW	.493	.482	.322	.459	.593	.660	1.000						
AVTH	.412	.449	.263	.468	.559	.596	**.844**	1.000					
AVA	.274	.353	.136	.408	.512	.526	**.844**	**.723**	1.000				
AAVF	.424	.428	.275	.388	.415	.471	**.822**	.671	.834	1.000			
ASFA	.054	.285	-.020	.124	.321	.266	.503	.390	.543	.466	1.000		
ASFB	.164	.376	.035	.252	.337	.348	.612	.525	.612	.525	**.751**	1.000	
ASFA	.088	.308	-.060	.154	.296	.288	.584	.479	.624	.439	**.721**	**.710**	1.000

Table 2 shows the coefficients of intercorrelation for all anthropometric variables among 15-year-old students. Out of 78 coefficients intercorrelation , 68 coefficients are statistically significant. High correlations are presented between: ABW- body weight and AVTH -volume of torax, AVA -volume of the arm, AVF -volume of the forearm, with values (0.844, 0.844, and 0.822), and also between the variables ABH- body height with ALL-leg length, with a value 0.792, between AVF- volume of the forearm and AVA-volume of the arm , the value 0.834 , and between ASFA-the skin folds of the armand ASFB-the skin folds of the back, the value 0.751 , and between ASFA-the skin folds of the armand ASFA-the skin folds of the abdomen, 0.721 with a value, between AVTH- volume of torax and AVA-volume of the arm, with value 0.723, and between ASFB-the skin folds of the back and ASFA-the skin folds of the abdomen, with a value 0.710. We also have significant correlation coefficients with some coefficients with low correlations.

Table 3. Kaiser-Meyer-Olkin-ov adequacy ratio of the correlation matrix

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.851**
Bartlett's Test of Sphericity	Approx. Chi-Square	1.013E3
	Df	78
	Sig.	.000

Index adequacy correlation matrix is shown in table no. 3, where the ratio of Kaiser-Meyer-Olkin is high (.851), which indicates that is suitable for the factors.

Table 4. Matrix factors applied in anthropometric measures and its orthogonal rotation VARIMAX

	FACMAT				**VARIMAX**		
	H1	**H2**	**H3**	h^2	**V1**	**V2**	**V3**
ABH	0.575	**0.704**	0.283	0.906	0.037	0.222	**0.925**
ASHB	0.645	0.379	0.331	0.669	0.308	0.211	**0.728**
ALL	0.38	**0.716**	0.306	0.751	-0.077	0.076	**0.86**
ASHW	0.592	0.397	-0.16	0.534	0.028	0.541	0.49
AHW	0.627	-0.055	-0.569	0.72	0.137	**0.837**	-0.033
APW	**0.734**	0.252	-0.325	0.709	0.125	**0.749**	0.364
ABW	**0.932**	-0.043	-0.108	0.882	0.537	0.699	0.323
AVTH	**0.84**	-0.008	-0.204	0.747	0.413	**0.711**	0.266
AVA	**0.852**	-0.249	-0.125	0.804	0.612	0.644	0.123
AAVF	**0.818**	-0.057	-0.02	0.672	0.519	0.557	0.304
ASFA	0.61	-0.551	0.332	0.786	**0.878**	0.123	-0.003
ASFB	**0.708**	-0.449	0.296	0.79	**0.855**	0.222	0.101
ASFA	0.643	-0.541	0.281	0.785	**0.867**	0.184	-0.005

Table 5. Eigen values and contribution of latent dimension

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	6.429	49.456	49.456	6.429	49.456	49.456	3.494	26.875	26.875
2	2.242	17.244	66.700	2.242	17.244	66.700	3.472	26.704	53.578
3	1.085	8.346	75.046	1.085	8.346	**75.046**	2.791	21.468	75.046

Review of Tables no. 4 and 5, where according Hoteling - Lesser method, shown in the factor matrix (FACMAT) applied anthropometric variables and Varimax- rotation, communality (h2), the significant characteristic roots (Total), the percentage of total explained variance (% of variance), it is evident that the applied system variables formed three significant principal components that explain a total of 75.04 % of the variance of the research area. The first principal component has characteristics root LAMBDA = 6.429 and the total variability as described participates with 49.45 %. The second major component whose characteristic root is 2.24, as described in the total variability participates with 17:24 %. And the third major component whose characteristic root is 1.08, as described in the total variability participates in 8:34 %.

Table 6. Matrix assembly (direct parallel projections)

	OB1	**OB2**	**OB3**
ABH	.055	**.935**	-.036
ASHB	.019	**.725**	.263
ALL	-.072	**.898**	-.122
ASHW	**.512**	.404	-.114
AHW	**.931**	-.218	-.055
APW	**.751**	.223	-.056
ABW	**.606**	.187	.401
AVTH	**.661**	.125	.266
AVA	**.567**	-.015	.500
AAVF	**.452**	.198	.417
ASFA	-.066	-.038	**.917**
ASFB	.031	.052	**.866**
ASFA	.007	-.053	**.890**

After VARIMAX rotation and rotation OBLIMIN hair or rotation of the coordinate system applied variables in order to get a more appropriate structure of the latent space anthropometric also received three latent factors where more projections have received the oblimin rotation Table 6 and 7.

Table 7. Matrix structures (orthogonal projections)

	OB1	**OB2**	**OB3**
ABH	.403	**.951**	.130
ASHB	.413	**.773**	.383
ALL	.225	**.852**	-.015
ASHW	**.620**	.585	.166
AHW	**.823**	.135	.309
APW	**.814**	.507	.299
ABW	**.850**	.484	.688
AVTH	**.823**	.422	.567
AVA	**.774**	.282	.739
AAVF	**.706**	.437	.640
ASFA	.310	.077	**.883**
ASFB	.420	.196	**.887**
ASFA	.365	.086	**.885**

At first many significant factor projections retained variables to estimate the transversal dimensionality skeleton (ASHW-shoulder width, AHW-hip width, APW -pelvic width) and the variables to estimate the volume and the mass the body (ABW- body weight, AVTH- volume of thorax, AVA-volume of the arm, AVF-volume of the forearm). Saturation of all variables of F1

are high and positive, ranging from (.62) to (.85). From here the latent dimension can be defined as a factor of transversal dimensionality of skeleton volume and body.
Significant projections to the second factor (F2) retained variables to estimate the longitudinal dimensionality of skeleton (ABH-body height, ASHB-sitting height of the body, ALL-leg length), with very high saturation of positive (.77) to (.95) which can be defined as a factor of longitudinal dimensionality of the skeleton.
Also, significant projections to the third factor (F3) retained variables to assess the skin folds of the body (ASFA-the skin folds of the arm, ASFB-the skin folds of the back, ASFA-the skin folds of the abdomen), a very high and positive saturation of (.883) to (.887) which it can be defined as a factor of the skin folds of the body.

Table 8. Inter-correlation orthoblique factors

Component	**1**	**2**	**3**
1	1.000		
2	.388	1.000	
3	.426	.153	1.000

Table no. 8 shows inter-correlation factors, which may conclude that there is a significant correlation between F1 and F3, with a value of .426, also low correlation there between F1 and F2, worth .388, just between F2 and F3, we don't have significant correlation, which is logical since it is known that the longitudinal dimensionality of skeleton is independent of the relationship between latent dimensions according to the skin folds of the body.

4. Discussion

Although the growth process is complex the adolescents growth spurt is a constant phenomenon and occurs in all children, though it varies in intensity and duration from one child to another (Rogol AD, et al..2002). Most girls have completed the physical changes related to puberty by the age of 15, while boys are still maturing and gaining strength, muscle mass, and height and are completing the development of sexual traits (Bojadzieva S. et al..2015). The correlation coefficients between the BMI and the body fat percentage and the anthropometric measurements, body composition measurements and physical fitness abilities indicate that the male respondents achieved better test results in comparison to the female respondents (Deforche et al., 2003; Kim et al., 2005; Graf et al., 2004). By means of factor analysis of anthropometric measures, the entire system of the variables is reduced to only a few which represent latent dimensions of the skeleton. Factors and dimensions obtained this way can be used for any further analysis. A number of researchers have dealt with this subject matter. Momirović (1970) set up a four-dimensional model of morphological dimensions on adults: longitudinal dimensionality of the skeleton, transversal dimensionality of the skeleton, volume and body mass (circular) and subcutaneous adipose tissue. In adolescents, three-dimensional model was set up: skeleton dimensionality, volume and body mass and subcutaneous adipose tissue (Viskić-Štalec, 1974). When compared to the results obtained on older respondents, and as far as children are concerned

(Bala, 1981), a two-dimensional model of the morphological dimensions is normally used: skeleton dimensionality and subcutaneous adipose tissue. Preschoolers and younger school students are most often selected as respondents in the scientific papers. Analyzing the trend of growth and development of anthropometric characteristics and development of motor abilities, as well as the structure of these two spaces, Popović conducted his research (2008) which showed statistically significant differences between boys and girls. Statistically significant differences were determined in the matter of anthropometric characteristics referring to bone growth in length, in favor of boys. Anthropometric characteristics referring to voluminosity and subcutaneous fat are in favor of girls. As far as motor space is concerned, the same authors determined significant differences in functioning of a mechanism for the movement structure, mechanism for synergetic regulation and mechanism in charge of regulating the duration of excitation, all in favor of boys, while in the matter of functioning of the mechanism for muscle tone regulation the difference was determined in favor of girls (BrankaProtić-Gava, et al..2013).To conclude, data on the structure of anthropometric characteristics students 15 years of this age are clearly very important for both theory and practice.

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