

*Original Contribution***SOMATOMETRIC CHARACTERISTICS OF STUDENTS OF HUMANITARIAN SUBJECTS REPRESENTING VARIOUS STATURE GROUPS. STANDARDS OF PHYSICAL DEVELOPMENT WITHIN THE STATURE NORM****Zh. Zhelev**

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ABSTRACT

Purpose: Somatometric research on 600 first-year students of humanitarian subjects (Pedagogy, Biology, and Ecology) of “Paisii Hilendarski” Plovdiv University was carried out following a standard and proven methodology in order to examine classical anthropometric indicators (height, weight, chest measurement, etc.) and the extent of their interrelation with the individual stature groups of students. **Results:** Twenty two percent of the boys and girls are short (up to 167,13 and 157,43 respectively) while 16% of the boys and 14,7% of the girls are tall (more than 179,35 and 167,19 respectively). The majority of the students are of middle height with weight between 56 and 97 for the boys and 45 and 88 for the girls. **Conclusion:** Based on the existing correlations between the anthropometric indicators, standards of the physical development of the students of middle height have been developed.

Key words: somatometrics, anthropometric indicators, students, standards, physical development

INTRODUCTION

The human physical appearance is developed both genetically and under the influence of socio-economic, professional, and geographical conditions. This is a complex and multilateral process involving different stages and processes of various intensity and nature. At the same time, many aspects of the theory and practice of human life need the anthropometric characteristics of the human body. This necessity determines the steady interest of the explorers of the 20th century and nowadays in the form and variations, as well as the body typology and the standardization of different groups of the global population. (1-17).

This research has been focused on the individual stature groups among students, in particular, the degree of interrelation of the different anthropometric indicators with the middle-height students, giving an idea of the

norm of the group being studied. This allows for the establishment of standards for the physical development of the students when using the existing correlations between the anthropometric indicators.

MATERIALS AND METHODS

Subjects of this research were 600 first-year students of “Paisii Hilendarski” Plovdiv University (major Pedagogy, Biology, and Ecology). Stature groups were determined with a deviation of 1S from the average arithmetic one for the body length of either sex. The margins of the individual groups were related to the following stature values:

	Short	Of middle height	Tall
Male	up to 167.13	167.13—179.35	more than 179.35
Female	up to 157.43	157.43—167.19	more than 167.19

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The program of this research includes the following indicators studied under the methodology of R. Martin- K. Saller (18): height, weight, chest measurement, torso – frontal length (sst- sy), biacromial width, distantia cristarum, length of the upper limb

(a- sty), length of the lower limb (tra).

The mathematical processing of the material was carried using variation-statistical and correlation analyses and the method of regressions (19-20), using MS Excel.

RESULTS AND DISCUSSION

22.33% of the men are short, 61.67% are of middle height, and 16% are tall. As for the women, 21.67% are short, 63.67% - of middle height, and 14.67% are tall. The average values of the main indicators (height, weight, chest measurement) show significant differences among men of different stature

groups. There is a common tendency – as the height increases the weight and the chest measurements also increase; however it is more evident with the weight than with the chest measurement (**Table 1**). The same conclusion is drawn when considering the parameters in the individual stature groups of women. The only exception is the tall women, where as height increases, the changes in the chest measurement are quite insignificant to result in a reliable difference compared to those of middle height.

Table 1. Variation Statistic Characteristic of the Studied Indicators with the Short Students

Indicator	Sex	Min-Max	\bar{X}	S	m	V_s	% of the stature
height	♂	155.0-167.0	164.55	0.94	0.11	0.57	–
	♀	147.0-157.0	154.60	2.66	0.33	1.70	–
weight	♂	54.0-89.0	64.22	1.14	0.14	11.78	39.02
	♀	44.0-66.0	54.21	5.49	0.68	10.10	35.06
chest measurement	♂	78.0-103.0	88.26	4.78	0.58	5.42	53.63
	♀	70.0-94.0	79.29	3.99	0.49	5.00	51.28
torso - frontal length	♂	44.0-57.0	49.74	2.64	0.32	5.31	30.22
	♀	38.0-52.0	48.30	2.37	0.29	4.90	31.28
biacromial width	♂	34.0-41.0	37.93	1.57	0.19	4.11	23.05
	♀	31.0-38.0	33.75	1.52	0.19	4.50	21.83
distantia cristarum	♂	24.0-34.0	27.78	1.72	0.21	6.16	16.88
	♀	25.0-31.0	27.80	1.37	0.17	4.90	17.98
length of the upper limb	♂	68.0-80.0	73.76	2.08	0.25	2.82	44.82
	♀	65.0-75.0	69.71	2.03	0.25	2.90	45.09
length of the lower limb	♂	73.5-86.5	81.94	2.66	0.32	3.25	49.79
	♀	68.0-84.0	76.51	3.01	0.37	3.90	49.48

Legend: \bar{X} - average means, S – standard deviation, m – standard error of the average means, V_s – variation coefficient.

Table 2. Variation Statistic Characteristic of the Studied Indicators with the Students of Middle Height

indicator	sex	Min-Max	\bar{X}	S	m	V_s	% of the stature
height	♂	167.0-179.5	173.33	3.53	0.25	2.03	–
	♀	157.0-167.0	162.43	2.90	0.21	1.79	–
weight	♂	56.5-97.0	71.51	8.08	0.58	11.29	41.25
	♀	45.0-88.0	58.93	6.96	0.50	11.81	36.28
chest measurement	♂	79.0-113.0	91.37	5.72	0.40	6.26	52.71
	♀	71.0-100.0	81.90	5.22	0.38	6.37	50.42
torso - frontal length	♂	45.0-60.0	51.55	2.36	0.17	4.57	29.74
	♀	41.0-54.0	49.68	2.04	0.15	4.08	30.59
biacromial width	♂	35.0-44.5	39.31	1.79	0.12	4.55	22.67
	♀	31.0-40.0	34.81	1.57	0.11	4.51	21.43
distantia cristarum	♂	25.0-33.5	28.76	1.78	0.12	6.19	16.59
	♀	23.0-32.5	28.80	1.48	0.11	5.14	17.73
length of the upper limb	♂	71.5-85.0	77.51	2.56	0.18	3.30	44.71
	♀	66.5-79.0	73.09	2.18	0.16	2.98	44.99
length of the lower limb	♂	79.0-93.5	86.86	2.89	0.21	3.33	50.11
	♀	72.0-88.0	81.14	3.08	0.22	3.80	49.94

Legend: \bar{X} - average means, S – standard deviation, m – standard error of the average means, V_s – variation coefficient.

Almost the same differences in the stature of the three comparable groups of women involve a more conspicuous difference between the weight of the middle-height and the tall ones, and between the chest measurement of the short and the middle-

height (**Table 3**). Referring to men, the differences between the values of the middle-height and the tall ones are steadily higher under each of the three indicators.

Table 3. Variation Statistic Characteristic of the Studied Indicators with the Tall Students

<i>indicator</i>	<i>sex</i>	<i>Min-Max</i>	\bar{X}	<i>S</i>	<i>m</i>	<i>V_s</i>	<i>% of the stature</i>
height	♂	175.0-187.0	182.52	2.13	0.31	1.17	–
	♀	167.0-176.0	169.96	1.82	0.28	1.10	–
weight	♂	65.0-91.0	78.00	6.48	0.94	8.31	42.73
	♀	52.0-100.0	64.18	8.42	1.27	13.10	37.76
chest measurement	♂	85.0-105.5	94.88	4.74	0.68	5.00	51.98
	♀	73.0-107.0	83.09	4.90	0.74	5.90	48.88
torso - frontal length	♂	49.0-59.0	54.10	2.03	0.29	3.75	29.64
	♀	48.0-56.0	51.73	1.89	0.28	3.70	30.43
biacromial width	♂	35.5-44.0	40.54	1.81	0.26	4.46	22.21
	♀	32.0-40.0	36.21	1.57	0.24	4.40	21.30
distantia cristarum	♂	26.5-33.0	29.77	1.42	0.20	4.77	16.31
	♀	27.0-36.0	30.00	1.73	0.26	5.80	17.65
length of the upper limb	♂	76.5-87.0	81.85	2.27	0.33	2.77	44.84
	♀	72.0-79.0	76.50	1.76	0.22	2.30	45.01
length of the lower limb	♂	87.5-98.0	92.17	2.50	0.36	2.71	50.49
	♀	75.0-93.0	85.91	2.48	0.37	2.90	50.54

Legend: \bar{X} - average means, *S* - standard deviation, *m* - standard error of the average means, *V_s* - variation coefficient.

Table 4. Comparative Characteristic of the Studied Indicators within the Various Stature Groups

<i>indicator</i>	<i>stature groups</i>	<i>male</i>		<i>female</i>	
		<i>absolute difference</i>	<i>p</i>	<i>absolute difference</i>	<i>p</i>
height	short / middle height	8.78	0.001	7.81	0.001
	middle height / tall	9.19	0.001	7.55	0.001
weight	short / middle height	7.29	0.001	4.71	0.001
	middle height / tall	6.49	0.001	5.25	0.001
chest measurement	short / middle height	3.11	0.001	2.61	0.001
	middle height / tall	3.51	0.001	1.19	0.001
torso - frontal length	short / middle height	1.81	0.001	1.37	0.001
	middle height / tall	2.55	0.001	2.04	0.001
biacromial width	short / middle height	1.38	0.001	1.06	0.001
	middle height / tall	1.23	0.001	1.38	0.001
distantia cristarum	short / middle height	0.98	0.001	1.00	0.001
	middle height / tall	1.01	0.001	1.20	0.001
length of the upper limb	short / middle height	3.75	0.01	3.38	0.001
	middle height / tall	4.34	0.02	3.41	0.001
length of the lower limb	short / middle height	4.92	0.001	4.63	0.001
	middle height / tall	5.31	0.001	4.77	0.001

Note *- level of significance of t, at $p \leq 0.05$

The relative variability of the weight is higher with the group of the tall, while for the other two indicators (height and chest measurement) – with the female students of middle height (**Table 2**). The smallest variations of the weight are observed with the tall men. However, they have a higher coefficient of stature variation (**Table 1**). The absolute

variability of the weight and the chest measurements of women progressively increase towards the tall ones, which results in expanding of the stature norm of indicators as the body length increases. With both sexes, the proportion of the weight in relation to the height is increasing, while the proportion of the chest measurement is decreasing.

Sexual dimorphism, preponderate among men, is most evident with the tall ones, especially in terms of weight (**Table 4**). The span of the variation lines for the frontal length of the torso with men is progressively decreasing, also evident by the decreasing relative variability of the characteristic toward the tall ones (**Table 1**).

With women there are closer variation lines, but the tendency in their changes, as well as the variation of the values are the same as with men (i.e., decreasing from short ones toward tall ones (**Table 2**). The differences in the average values of the stature groups with both sexes are reliable, but bigger when comparing students of middle and tall height. The proportion between the torso and the height is smallest with tall men and women, while the proportionally longest torso is found with short students of both sexes (**Tables 1, 2**).

Sex differences in the biacromial width, although of similar values, are more evident with men and women of middle height (**Table 2**). The average arithmetic values of this characteristic show reliable increase in

parallel to the height changes, but the absolute difference is greater between men of short and middle height, as well as between women of middle and tall height. With both sexes, height differences result in a general decrease of the proportion between the shoulder width and the height.

Women show slighter variations in the pelvis width (distantia cristarum) compared to men, as the height changes in the values of the variation coefficient for both sexes are opposite. With men, its value is decreasing being lowest with the tall individuals, while with tall women the indicator is characterized by the greatest relative variability. As the height increases, the value of distantia cristarum also increases. The difference in the average values of this characteristic is most significant between women of short and middle height (**Table 4**). Women of all stature groups have proportionally wider pelvis compared to men, but the difference in the absolute average value of both sexes is unreliable (**Table 5**).

Table 5. Results of the Statistical Processing of the Data on the Sex Dimorphism

indicator	stature groups	male		female		absolute difference	p
		\bar{X}	m	\bar{X}	m		
height	short	164.55	0.11	154.60	0.33	9.95	0.001
	of middle height	173.33	0.25	162.41	0.21	10.92	0.001
	tall	182.52	0.31	169.96	0.28	12.56	0.001
weight	short	64.22	0.14	54.22	0.68	10.00	0.001
	of middle height	71.51	0.58	58.93	0.50	12.58	0.001
	tall	78.00	0.94	64.18	1.27	13.82	0.001
chest measurement	short	88.26	0.58	79.29	0.50	8.97	0.001
	of middle height	91.37	0.40	81.90	0.38	9.47	0.001
	tall	94.88	0.68	83.09	0.74	11.79	0.001
torso – frontal length	short	49.74	0.32	48.31	0.30	1.43	0.001
	of middle height	51.55	0.17	49.68	0.15	1.87	0.001
	tall	54.10	0.29	51.72	0.28	2.38	0.001
biacromial width	short	37.93	0.19	33.75	0.19	4.18	0.001
	of middle height	39.31	0.12	34.81	0.11	4.50	0.001
	tall	40.54	0.26	36.20	0.24	4.34	0.001
distantia cristarum	short	27.78	0.21	27.80	0.17	-0.20	0.001
	of middle height	28.76	0.12	28.80	0.11	-0.04	0.001
	tall	29.77	0.20	30.00	0.26	-0.23	0.001
length of the upper limb	short	73.76	0.25	69.71	0.25	4.05	0.001
	of middle height	77.51	0.18	73.09	0.16	4.42	0.001
	tall	81.85	0.33	76.50	0.27	5.35	0.001
length of the lower limb	short	81.94	0.32	76.51	0.37	5.43	0.001
	of middle height	86.86	0.21	81.14	0.22	5.72	0.001
	tall	92.17	0.36	85.91	0.37	6.26	0.001

Legend: \bar{X} - average means, m – standard error of the average means.

Note *- level of significance of t, at $p \leq 0.05$

Table 6. Correlation Analysis – Results

correlations	sex	r	S _r	$\frac{r}{S_r}$
height / weight	♂	0.39	0.06	6.50
	♀	0.24	0.07	3.43
height / chest measurement	♂	0.20	0.06	3.33
	♀	0.15	0.07	2.14
height / torso	♂	0.43	0.06	7.16
	♀	0.38	0.06	6.33
height / biacromial width	♂	0.24	0.07	3.43
	♀	0.20	0.07	2.86
height / distantia cristarum	♂	0.22	0.07	3.14
	♀	0.37	0.06	6.17
height / lower limb	♂	0.53	0.05	10.20
	♀	0.63	0.04	15.75
height / upper limb	♂	0.57	0.05	11.40
	♀	0.55	0.05	11.00
upper limb / lower limb	♂	0.47	0.06	7.80
	♀	0.52	0.05	10.40

Legend: r – correlation coefficient, S_r – standard error of the correlation coefficient, $\frac{r}{S_r}$ – statistical significance of correlation

Table 7. Standards of the Male Students of Middle Height

	height	weight			chest measurement		
		$\bar{X} - S_r$	\bar{X}	$\bar{X} + S_r$	$\bar{X} - S_r$	\bar{X}	$\bar{X} + S_r$
-3S	162	58.23	61.72	65.21	84.32	87.85	91.38
	163	59.12	62.61	66.10	84.64	88.17	91.70
	164	60.01	63.50	66.99	84.96	88.49	92.02
	165	60.90	64.39	67.88	85.28	88.81	92.34
-2S	166	61.79	65.28	68.77	85.60	89.13	92.66
	167	62.68	66.17	69.66	85.92	89.45	92.98
	168	63.57	66.07	70.55	86.24	89.77	93.30
	169	64.46	67.95	71.44	86.56	90.09	93.62
-1S	170	65.35	68.84	72.33	86.88	90.41	93.94
	171	66.24	69.73	73.22	87.20	90.73	94.26
	172	67.13	70.62	74.11	87.52	91.05	94.58
\bar{X}	173	68.02	71.51	75.00	87.84	91.37	94.90
+1S	174	68.91	72.40	75.89	88.16	91.69	95.22
	175	69.80	73.29	76.78	88.48	92.01	95.54
	176	70.69	74.18	77.67	88.80	92.33	95.86
+2S	177	71.58	75.07	78.56	89.12	92.65	96.18
	178	72.47	75.96	79.55	89.44	92.97	96.50
	179	73.36	76.85	80.44	89.76	93.29	96.82
	180	74.25	77.74	81.33	90.08	93.61	97.14
+3S	181	75.14	78.63	82.22	90.40	93.93	97.46
	182	76.03	79.52	83.11	90.72	94.25	97.78
	183	76.92	80.41	84.00	91.04	94.57	98.10
	184	77.81	81.30	84.89	91.36	94.89	98.42
\bar{X}	173.33	71.51			91.37		
S	3.53						
S _r		3.49			3.53		

Legend: \bar{X} – average means, S – standard deviation, S_r – standard error.

The anthropometric examination of the upper limb and its parts shows bigger measurements with men compared to women. This is determined mostly by the bigger absolute

differences in the length of the arm pit. The length of the wrist is more important when calculating the difference in the total length of the limb between short and middle-height

men, as well as the short representatives of both sexes. With men, the total length of the limb increases proportionally to the height, while with women there is almost no change in the proportion relation (**Tables 4, 5**).

The differences in the length of the upper limb in the various stature groups are reliable. With men, they are determined mainly by the length of the shank. With women it is measured by the length of the thigh. These compound elements of the total length of the limb also determine the differences between the sexes, especially with the tall students' groups. The comparison of the average relative values of the lengths of the torso and the lower limb shows that with both men and women the increase in the height involves a decrease of the proportion of the torso and an increase of the proportion of the length of the lower limb.

Eight correlations, presented on **Table 6**, have been examined in the course of study, using the anthropometric indicators discussed herewith. The data show that all correlations, except for two particular ones with women, are rectilinear, positive, and significant. As for men, the relationship between height and weight is moderate. The correlation found during the study, showing that every change

in the height goes along with a change in the weight of 0.89 kg is valid for 15% of the cases. For the remaining 85%, the relationships are of different nature. With women, this correlation is slight, which could be explained by the specificity of the female constitution and the less developed musculature. Correlation between height and chest measurement is slight with both sexes. With men, such a slight correlation dependency is also found between the height and the width of pelvis and shoulders. The dependency between the height and distantia cristarum is a bit more significant with women. Moderate interdependence between the frontal length of the torso and the length of the body is found with 18% of the men and 14% of the women on the average. The very high degree of correlation between the height and the length of the lower limb is confirmed. With women, the length of the upper limb is less dependent on the height changes, while with men the degree of interdependence is close to that with the lower limb. There is a lower correlation between the length of the upper and lower limbs (i.e., they are very closely related to the height changes, but are relatively mutually independent during growth).

Table 8. Standards of the Female Students of Middle Height

	height	weight			chest measurement		
		$\bar{X} - S_r$	\bar{X}	$\bar{X} + S_r$	$\bar{X} - S_r$	\bar{X}	$\bar{X} + S_r$
-3S	153	50.82	53.71	56.60	76.57	79.47	82.37
	154	51.40	54.29	57.18	76.84	79.74	82.64
	155	51.98	54.87	57.76	77.11	80.01	82.91
-2S	156	52.56	55.45	58.34	77.38	80.28	83.18
	157	53.14	56.03	58.92	77.65	80.55	83.45
	158	53.72	56.61	59.50	77.92	80.82	83.72
-1S	159	54.30	57.19	60.08	78.19	81.09	83.99
	160	54.88	57.77	60.66	78.46	81.36	84.26
	161	55.46	58.35	61.24	78.73	81.63	84.53
\bar{X}	162	56.04	58.93	61.82	79.00	81.90	84.80
+1S	163	56.62	59.51	62.40	79.27	82.17	85.07
	164	57.20	60.09	62.98	79.54	82.44	85.34
	165	57.78	60.67	63.53	79.81	82.71	85.61
+2S	166	58.36	61.25	64.14	80.08	82.98	85.88
	167	58.94	61.83	64.72	80.35	83.25	86.15
	168	59.52	62.41	65.30	80.62	83.51	86.42
+3S	169	60.10	62.99	65.88	80.89	83.79	86.69
	170	60.68	63.57	66.46	81.16	84.06	86.96
	171	61.26	64.15	67.04	81.43	84.33	87.27
\bar{X}	162.43	58.93			81.90		
S	2.90						
S_r		2.89			2.90		

Legend: \bar{X} - average means, S - standard deviation, S_r - standard error.

Model normative tables about the students of middle height (**Tables 7, 8**) have been compiled using the data of the correlation analysis and applying the regression method. An assessment of the physical development of the students being studied has been carried out based on the three main indicators – height, weight, and chest measurement. The findings of this assessment show that:

- a) 14.79% of the men and 15,78% of the women are characterized by complete correspondence between the three indicators (i.e., their personal data overlap entirely with the developed standard);
- b) 27.54% of the men and 27,35% of the women are characterized by weight and chest measurement different from the ones corresponding to their height, but still remaining within the norm;
- c) 11.63% of the men and 6,28% of the women fall within the limits of the broader norm, with values higher than the standard;
- d) With the rest of the cases there have been various combinations of ratios between the studied indicators of physical development.

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