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Anthropological Studies of Physical Development of Students at the Faculty of Biology at Sofia University "St. Kliment Ohridski"

*Ivo Vladimirov, Racho Stoev**

Department of Anthropology and Anatomy, Institute of Experimental Morphology, Pathology and Anthropology with Museum, Bulgarian Academy of Sciences, Sofia, Bulgaria

*Corresponding author e-mail: rastesto@abv.bg

The purpose of this study is to characterize anthropometrically physical development of Bulgarian students at the beginning of the XXI century, by comparison with the results of previous studies of students in Sofia. An anthropometric survey of 77 students, 18 to 25 years old, 31 males and 46 females, was conducted in 2016-2017. The results have been compared with data from investigations at 1986 and at 2002. The comparison shows stagnation of the secular changes in height, which should be attributed to the long-term negative impact on the growth and development of the students during the difficult years of their early childhood. Secular weight changes are positive, thus BMI increases sharply as well. This indicates that weight and BMI respond in a shorter time to changes in living conditions than height. Most physical development traits show the similar dynamics as weight and BMI. The observed secular changes are probably due to the large socio-economic changes during the period under review (1986-2017).

Key words: physical development, university students, height, young adults, secular changes.

Introduction

Anthropological studies on various sex and age groups of different parts of the Earth are constantly actual. They are the only sources of metric information for the physical form of human generations. The physical development of the population of each country bears a specificity which is not repeated anywhere in the world, neither because of the different historical development, nor because of the different natural-geographical and socio-economic conditions of life.

The period around and after the age of 20, is a time point when some of the anthropometric characteristics have completed their growth changes, such as height, and others, such as body weight, continue their development. The problems of physical development have been the subject of many researches. Their target are the regularities of natural biological changes, their dynamics, the impact of various economic, social and environmental factors on them. The secular growth changes to higher body length, greater body weight and earlier maturation are related, in addition to the increased

standard of living and improved nutrition and health care [1, 3, 5, 6, 8, 10, 15, 16, 17]. Thus the results of studies on such topics are not only of general biological significance, but also of importance for assessing the health status of the population studied.

In Bulgaria, several national surveys of the physical development of the population were conducted in 1960, 1970-1971, 1980-1982 and 1989-1993 [11, 18, 19, 21]**.** Unfortunately, a nationwide study of physical development has not been conducted since then in Bulgaria. Secular changes in physical development, and especially in the growth of the Bulgarian population, were traced from the end of the 19th century to the end of the 20th century [12, 13]. Due to the lack of nationwide research in recent decades, we have no nationally representative data on the growth and physical development of the adult population born after 1963. The physical development of younger generations can only be evaluated by the results of individual studies of university students or students in the upper classes of high school [13].

The purpose of this study is to characterize anthropometrically physical development of Bulgarian students at the beginning of the XXI century, by comparison with the results of previous studies of students in Sofia.

Materials and Methods

In the period November 2016 - May 2017, an anthropometric survey was conducted at the Faculty of Biology at Sofia University "St. Kliment Ohridski"- Sofia, where young men and girls from all over the country are trained. A total of 77 students (31 males, 46 females), aged 18-25, was investigated.

The anthropometric study was carried out according to the conventional methodology of Martin R. and K. Saller [7, 9, 20]. Standard anthropological instruments ("GPM Anthropologische Instrumente" manufactured by Siber Hegner Masohinen AG – Zurich) was used.

The survey was voluntary, according the principles of Helsinki declaration.

Results and Discussion

The metric data on the anthropological features give a general idea of the anthropometric characteristics of the studied Bulgarian students **(Table 1**). The results can contribute to complement the overall anthropological characteristics of the Bulgarian population, as nationwide physical development studies have been missing for decades.

The comparison of the data from the present study with the corresponding data for the adult Bulgarian population make it possible to discover the specifics of the physical development of the young generation of Bulgaria living in the new century. At the same time, they give an idea of the long-term impact of the socio-economic crisis in our country in the 1990s, when they were born.

A review of all anthropometric features – absolute and relative – indicates a good development of the students. This is in concordance with the results of other studies. According to more detailed and representative studies by foreign authors in contemporary Europe, students are on average about 3 cm higher than the average for young people of the same age group [2, 4].

The results show that most anthropometric features are larger in males. Particularly large intersex differences are observed in indicators that reflect the development of the musculoskeletal system. Subcutaneous adipose tissue is better developed in women. Large are also the sex differences in the thickness of the skin folds on the limbs.

Table 1. Main indicators for the physical development of students.

Anthropological trait	males		females		T st (m-f)	p
	mean	SD	mean	SD		
Weight – kg	80.75	16.45	56.36	8.29	7,63	0,001
Height – cm	178.21	8.44	161.58	6.14	9,42	0,001
BMI – kg/m^2	25.33	4.23	21.62	3.30	4,11	0,001
Sitting height – cm	91.04	4.57	83.93	3.76	7,18	0,001
Height to iliospinale – cm	100.99	5.50	95.83	4.99	4,19	0,001
Chest circuimference at pause – cm	97.46	8.74	80.95	6.12	9,12	0,001
Chest circumference at inspirium – cm	101.89	8.48	83.52	6.16	10,36	0,001
Chest circumference at exspirium – cm	95.25	8.75	79.19	5.98	8,91	0,001
Waist circumference – cm	84.68	11.47	74.52	7.76	4,31	0,001
Hips circumference – cm	102.71	8.93	96.52	7.42	3,19	0,01
Thigh circumference – cm	57.20	7.29	53.69	5.58	2,27	0,05
Calf circumference – cm	38.15	3.49	35.03	2.45	4,31	0,001
Upper arm circumference, relaxed – cm	30.92	3.16	25.69	2.53	7,70	0,001
Upper arm circumference, contracted – cm	33.82	3.24	27.27	2.97	8,99	0,001
Forearm circumference – cm	28.23	2.05	23.32	1.36	11,71	0,001
Biacromial diameter – cm	40.00	2.25	33.37	1.93	13,41	0,001
Chest diameter – transversal – cm	29.12	2.10	24.87	1.68	9,42	0,001
Chest diameter – sagital – cm	21.91	2.37	17.20	1.83	9,35	0,001
Bicristal diameter – cm	23.43	3.10	21.43	2.32	3,06	0,01
Bitrochanterial diameter – cm	33.36	2.55	31.53	1.90	3,41	0,001
Subscapular skinfold – mm	11.03	3.29	11.83	2.82	-1,11	Insign.
Triceps skinfold – mm	8.94	3.59	13.33	3.81	-2,79	0,01
Thoracal skinfold – mm	10.58	4.35	12.39	3.88	-1,87	Insign.
Suprailiac skinfold – mm	13.95	4.90	15.04	4.63	-0,98	Insign.
Thigh skinfold – mm	13.84	3.44	16.21	3.76	-2,86	0,05
Calf skinfold – mm	8.66	3.48	10.67	3.64	-2,44	0,05
Epicondilar diameter of humerus – cm	68.90	9.31	60.98	7.26	3,99	0,001
Epicondilar diameter of femur – mm	100.55	9.26	86.09	5.32	7,86	0,001
Lower limb length – cm	96.41	5.10	92.57	4.66	3,35	0,05
Relative chest circumference, %	54.74	4.74	50.14	4.04	4,43	0,001
Thoracal index, %	75.35	7.16	69.29	7.13	3,65	0,001
Relative sitting height, %	51.12	1.95	51.96	1.70	-1,95	Insign.
Relative biacromial diameter, %	22.49	1.54	20.66	1.12	5,68	0,001
Pelvic index – %	58.82	8.95	64.41	7.70	-2,84	0,01
Relative lower limb length, %	54.11	1.77	57.29	1.80	-7,68	0,001
Relative bicristal diameter, %	13.14	1.55	13.28	1.52	-0,39	Insign.

The predominant tendency for changes in anthropometric indicators for physical development is their decrease in the first half of the comparison period and their increase in the second half **(Tables 2 and 3, Figs. 1, 2, 3)**.

Table 2. Comparison of major physical indicators in Sofia students – males.

	1986			2002			2017			P
Anthropometric trait	N	M	SD	N	M	SD	N	M	SD	
Height – cm	297	175.61	5.78	72	178.78	6.63	31	178.21	8.43	<0.001
Weight – kg	297	75.01	10.4	72	70.4	8.63	31	80.75	16.45	<0.001
Sitting height – cm	297	90.88	3.93	72	93.17	3.76	31	91.04	4.57	<0.001
Lower limb length – cm	297	101.34	4.7	72	99.09	5.18	31	96.41	5.10	<0.001
Chest circumference at pause – cm	296	92.4	6.38	72	87.37	5.79	31	97.46	8.74	<0.001
Waist circumference – cm	297	80.54	7.82	72	77.53	6.11	31	84.68	11.47	<0.001
Hips circumference – cm	296	96.06	5.92	72	91.06	5.54	31	102.71	8.93	<0.001
Thigh circumference – cm	296	55.4	4.37	72	56.05	4.11	31	57.20	7.29	0.983
Calf circumference – cm	297	37.42	2.57	72	35.65	2.49	31	38.15	3.49	<0.001
Upper arm circumference, relaxed – cm	297	29.68	3.05	72	29.73	2.84	31	30.92	3.16	0.094
Forearm circumference – cm	297	27.85	2.04	72	27.11	1.62	31	28.23	2.05	0.007
Biacromial diameter –cm	296	40.01	1.97	72	41.19	2.05	31	40.00	2.25	<0.001
Chest diameter – transversal – cm	296	29.3	1.84	72	29.51	2.00	31	29.12	2.10	0.575
Chest diameter – sagital – cm	296	21.1	1.94	72	20.91	1.71	31	21.91	2.37	0.051
Bicristal diameter – cm	296	28.14	2.01	72	27.23	1.65	31	23.43	3.10	<0.001
Subscapular skinfold – mm	293	12.46	4.74	72	9.66	3.56	31	11.03	3.29	<0.001
Triceps skinfold – mm	293	11.28	4.14	72	9.39	3.48	31	8.94	3.59	<0.001
Thoracal skinfold – mm	293	11.49	5.11	72	7.08	2.87	31	10.58	4.35	<0.001
Suprailiac skinfold – mm	293	11.04	5.91	72	6.99	3.04	31	13.95	4.90	0.00
Thigh skinfold – mm	293	18.28	6.45	72	14.74	6.12	31	13.84	3.44	<0.001
Calf skinfold – mm	292	10.69	5.08	72	10.76	3.77	31	8.66	3.48	0.07
BMI –kg/m^2	297	24.29	2.93	72	22.04	2.56	31	25.33	4.23	<0.001
Relative sitting height, %	297	51.58	3.38	72	52.12	1.31	31	51.12	1.95	0.29
Relative lower limb length, %	297	51.7	1.49	72	55.41	1.67	31	54.11	1.77	<0.001
Relative chest circumference, %	296	52.66	3.72	72	48.92	3.49	31	54.74	4.74	<0.001
Relative biacromial diameter, %	296	22.8	1.10	72	23.06	1.21	31	22.49	1.54	0.06
Relative bicristal diameter, %	296	16.03	1.05	72	15.24	0.91	31	13.14	1.55	<0.001
Thoracal index, %	296	72.09	5.94	72	71.05	6.43	31	75.35	7.16	0.01
Pelvic index -%	296	70.38	4.73	72	66.22	4.43	31	58.82	8.95	<0.001

Table 3. Comparison of major physical indicators in Sofia students – females.

	1986			2002			2017			P
Anthropometric trait	N	M	SD	N	M	SD	N	M	SD	
Height – cm	580	162.55	5.59	70	164.05	5.06	46	161.58	6.14	0.044
Weight – kg	580	59.13	9.03	70	52.39	6.99	46	56.36	8.29	<0.001
Sitting height –cm	580	86.44	3.45	70	87.22	3.12	46	83.93	3.76	<0.001
Lower limb length – cm	579	93.36	4.25	70	89.97	3.91	46	92.57	4.66	<0.001
Chest circumference at pause – cm	578	85.33	6.58	70	73.05	4.45	46	80.95	6.12	<0.001
Waist circumference – cm	579	67.43	6.22	70	65.92	5.18	46	74.52	7.76	<0.001
Hips circumference – cm	580	95.54	7.07	70	87.21	5.43	46	96.52	7.42	<0.001
Thigh circumference - cm	580	55.38	5.20	70	54.13	4.42	46	53.69	5.58	0.023
Calf circumference - cm	579	34.90	2.65	70	33.1	2.65	46	35.03	2.45	<0.001
Upper arm circumference, relaxed – cm	578	24.98	2.85	70	24.72	2.29	46	25.69	2.53	0.167
Forearm circumference – cm	579	23.19	1.82	70	22.73	1.39	46	23.32	1.36	0.095
Biacromial diameter – cm	577	35.77	1.89	70	34.84	1.87	46	33.37	1.93	<0.001
Chest diameter – transversal – cm	576	25.46	1.77	70	24.91	1.56	46	24.87	1.68	0.006
Chest diameter – sagital – cm	577	18.17	1.66	70	17.72	1.48	46	17.20	1.83	<0.001
Bicristal diameter – cm	576	27.25	2.71	70	25.45	1.46	46	21.43	2.32	<0.001
Subscapular skinfold – mm	563	14.63	6.18	70	10.53	3.75	46	11.83	2.82	<0.001
Triceps skinfold – mm	562	15.93	5.46	70	13.62	3.53	46	13.33	3.81	<0.001
Thoracal skinfold – mm	563	13.45	6.19	70	8.79	3.34	46	12.39	3.88	<0.001
Suprailiac skinfold – mm	563	14.94	7.00	70	8.35	2.77	46	15.04	4.63	<0.001
Thigh skinfold – mm	562	25.49	6.14	70	19.29	4.50	46	16.21	3.76	<0.001
Calf skinfold – mm	560	21.61	6.24	70	14.61	3.37	46	10.67	3.64	<0.001
BMI –kg/m^2	580	22.36	3.12	70	19.44	2.21	46	21.62	3.30	<0.001
Relative sitting height, %	580	53.19	1.56	70	53.17	1.26	46	51.96	1.70	<0.001
Relative lower limb length, %	579	57.43	1.41	70	54.83	1.32	46	57.29	1.80	<0.001
Relative chest circumference, %	578	52.53	4.04	70	44.55	2.70	46	50.14	4.04	<0.001
Relative biacromial diameter, %	577	22.02	1.11	70	21.24	1.04	46	20.66	1.12	<0.001
Relative bicristal diameter, %	576	16.77	1.63	70	15.52	0.84	46	13.28	1.52	<0.001
Thoracal index, %	577	71.49	5.87	70	71.32	6.26	46	69.29	7.13	0.058
Pelvic index -%	576	76.19	6.63	70	73.16	4.68	46	64.41	7.70	<0.001

From this trend deviates the height, which increased during the period 1986-2002 and stagnated and decreased during the period 2002-2017. Since most of the growth is formed during the period of birth and early childhood, this change is logical [8]. The growth of students measured in 2017 was definitely influenced by the decline in life conditions in the 1990s, as has been observed in other Eastern European countries [1, 2]. This is followed by a hip circumference (in women), triceps skin folds, a thigh and a thigh for both sexes, the average value of the relative sitting height, while growth is conservative.

Most physical development indicators show the same dynamics as weight and BMI (decrease towards 2002 and increase afterwards). That is because changes in the development of subcutaneous fat tissue and of the osteo-muscular system cause changes in body mass (BMI) and weight.

Data for 1986 and 2002 are taken from a previous article of Stoev, Atanasova-Timeva and Zhecheva [14].

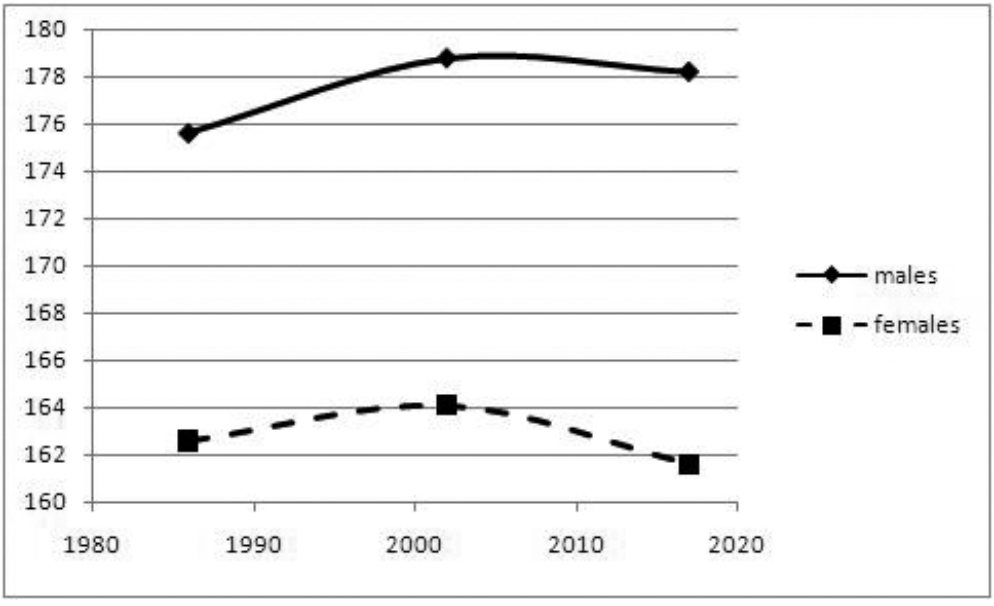

Fig. 1. Body height in students – 1986-2017, cm

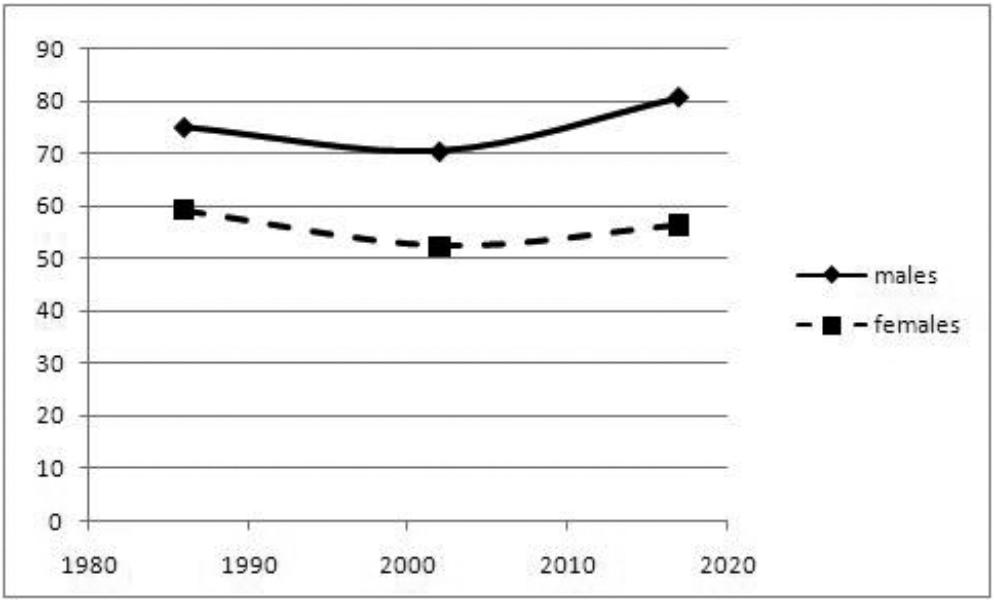

Fig. 2. Body mass in students – 1986-2017, kg

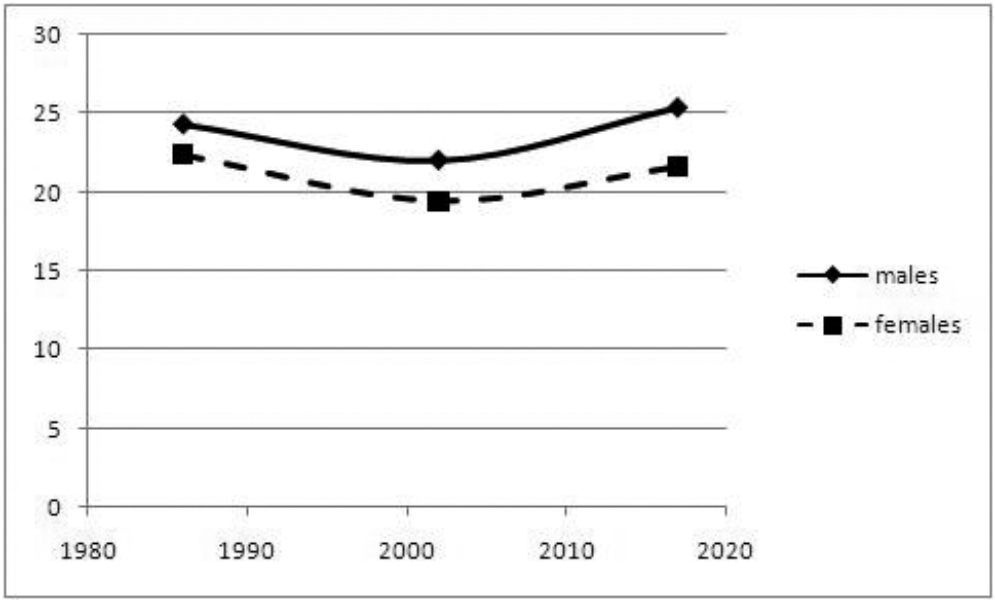

Fig. 3. Body mass index in students – 1986-2017

Conclusions

The comparison with data from previous surveys shows that at the beginning of the 21st century, there was a secular stagnation in height. This should account for the long-term negative impact on their development during the troubled years of their early childhood. In the early 21st century, secondary weight changes were positive. Combined with growth stagnation it causes a sharply BMI increase respectively. This trend is in contrast to the trend observed in students at the late 20th century. This fact indicates, respectively, that weight and BMI respond more quickly to changes in living conditions than height. The observed secondary changes are likely to be due to major socio-economic changes during the period considered (1986-2017).

Sex differences in growth over the comparison period (1986-2017) are increasing.

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