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Physical Development, Blood Pressure and Menarche in Schoolchildren from Sofia City

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Data about two basic anthropometrical features of physical development (stature, body weight) and the changes of blood pressure and age of menarche in 7-13-year-old children (143 boys and 154 girls) from Sofia-town based on a longitudinal investigation carried out during 1993-1999 are analyzed. At the and of this century boys and girls have equal physical measurements up to their 9th years of age. The 10-12 years old girls outstrip considerably the boys at the same age, and at 13 years of age the common physical measurements equalize again at the both sexes. At this age the girls are nearer to the final stature and body weight of the adults than the boys are. The acceleration of stature and weight in 7-13 years old children from Sofia diminish between 70s and 80s years, and in the years after near the end of the century a gracilization is observed.

Key words: physical development, children, secular trends, blood pressure, menarche.

Introduction

The problems of specificity and stage of growth and development of modern man in historical and onthogenetical perspective have occupied experts minds for a long time. In 1931 Merrell has established that individual growth increases by fluctuations due to alternating short periods of slow and rapid growth.

The "Human Growth" monograph published in 1987 with Folkner and Tanner as its editors traces the various aspects of growth and development of modern man and supplies undisputable data from about the wave-like changes of the basic growth features in children from Northern Europe aged between 7 and 18 [2]. The analysis of these data leads to the conclusion that the positive secular changes are a reversible biological process and the reversal towards the growth characteristics of past generations should not be excluded.

To our regret in Bulgaria there are no representative data preserved from the past century so that we could study the specificity of the physical development of the Bulgarian children for a longer period of time. There are no data even from the last years of the present century and there are especially interesting due to the great socio-eco-

nomical changes that would most directly affect the physical development of the adolescent generation.

The aim of the study is to characterize the physical development, blood pressure changes and menarche in schoolchildren from Sofia at the XXth century and to assess the secular trends in this century in students from Sofia falling into the same age group.

Material and Methods

For analysis and evaluation in the present work, data for the basic anthropological features (height and body weight) have been used as well as for the blood pressure and onset of menarche in 7-13-year-old children from Sofia - a total of 143 boys and 154 girls. These data represent a part of an in-detail longitudinal anthropological study of children from three schools investigated during the period 1993-1999.

The survey was performed by a team in which each anthropometrist was measuring the same features. The anthropometry was carried out after the classical method of Martin - Saller [4]. The growing up intensity at every age is established according to the data from the index of growing up velocity which one helps the comparison of the polydimensional features $(\frac{x_2 - x_1}{x_2} \cdot 100)$, where x_1 is feature mean value about the year before; x_2 - feature mean value about the following year. The sexual dimorphism is assessed by the index about sexual differences $(\frac{x \text{ girls}}{x \text{ boys}} \cdot 100)$.

On tracing the secular trends are used the investigations of 7-13 years old children from Sofia by Wateff, Janev et al., and Slunchev et al. [10, 12, 13, 14].

Results and Discussion

Stature

The 7, 8 and 9 years old boys and girls have the same stature (Table 1, Fig. 1). From 10 till 12 years of age girls are higher than boys and the sexual differences are statistically significant. But at the age of 13, boys overtake girls stature and they are even a little higher — boys 160.3cm and girls 159.8cm. Interesting is also the fact that instead of the stature equalization in both sexes at 13 years of age, girls have reached at this age about 99.3% of the final stature of females from Sofia - town (160.8cm). The 13 years old boys, however, have to overtake some more (12.7cm) to reach the final stature of males from Sofia - town (173.02cm), as they have reached only 92.6% of their stature (the data about adults from Sofia - town are from a National Anthropological Investigation of the Bulgarian population carried out during 1989 - 1992). Regarding the stature high pick velocity, it occurs in girls at 11 years of age, and in boys at 13 years of age (Table 3).

Body weight

The data about weight show that the boys and girls from Sofia have the same weight up to 10 years of age (Table 2, Fig.2). After this age girls overtake boys, however the differences are not statistically significant. Notwithstanding the lack of statistically significant, it should be notice that at 11 years of age girls are 1.5 kg more heavy than boys, and for the 12 years old children the difference is already 2 kg in girl's favour.

Stature

Table 1

AGE, years	Characteristics	BOYS 1907 St. Wateff	1960 B. Yanev et al.	1970 B. Yanev et al.	1980 P. Slunchev et al.	1993/1999 longit. data	secular changes 1907-1993/1999 cm	%	1907-1970 cm	%	GIRLS 1907 St. Wateff	1960 B. Yanev et al.	1970 B. Yanev et al.	1980 P. Slunchev et al.	1993/1999 longit. data	secular changes 1907-1993/1999 cm	%	1907-1970 cm	%
7	n	305	223	218	118	134					247	214	210	113	146				
	x	111.9	122.9	126.1	125.9	125.7	13.8	12.3	14.2	12.7	112.0	123.0	125.8	125.0	125.5	13.5	12.0	13.8	12.3
	SD		5.4	5.8	5.8	5.4						5.5	5.4	5.4	5.3				
8	n	368	190	206	119	141					343	202	213	121	152				
	x	116.0	128.7	131.5	131.1	131.0	15.0	12.9	15.5	13.4	115.9	127.8	131.5	129.6	130.7	14.8	12.8	15.6	13.5
	SD		5.8	6.0	7.4	5.5						5.7	6.4	5.6	5.4				
9	n	327	207	213	122	141					281	204	205	118	151				
	x	120.9	133.7	137.0	135.3	136.4	15.3	12.8	16.1	13.3	121.1	133.8	136.4	136.6	136.4	15.3	12.6	15.3	12.6
	SD		5.6	6.5	6.2	5.9						6.7	6.5	5.5	6.1				
10	n	288	216	197	119	143					317	202	204	114	153				
	x	126.2	139.2	141.2	141.2	141.7	15.5	12.3	15.0	11.9	126.6	139.9	142.2	142.7	142.4	15.8	12.5	15.6	12.3
	SD		6.7	5.9	6.2	6.2						7.1	7.3	7.1	6.6				
11	n	330	186	213	119	141					423	176	216	120	154				
	x	129.8	143.8	146.4	146.5	146.9	17.1	13.2	16.6	12.8	133.4	145.1	148.2	148.5	149.2	15.8	11.8	14.8	11.1
	SD		6.9	6.8	7.8	6.5						7.5	7.5	7.0	6.9				
12	n	387	209	210	120	132					513	209	200	120	144				
	x	137.1	148.8	151.4	152.5	152.8	15.7	11.4	14.3	10.4	139.5	151.9	153.9	154.7	155.4	15.9	11.4	14.4	10.3
	SD		7.3	7.7	7.9	7.6						6.7	6.3	6.7	6.8				
13	n	359	168	197	120	124					421	217	202	120	135				
	x	141.8	156.4	159.3	160.2	160.3	18.5	13.0	17.5	12.3	145.8	155.9	158.0	158.5	159.6	13.8	9.5	12.2	8.4
	SD		7.9	8.6	8.1	8.8						6.3	6.3	6.9	6.3				

Table 2

Weight

AGE, years	Characteristics	BOYS 1907 St. Wateff	1960 B. Yanev et al.	1970 B. Yanev et al.	1980 P. Slunchev et al.	1993/1999 longit. data	secular changes 1907-1993/1999 cm	1907-1993/1999 %	1907-1970 cm	1907-1970 %	GIRLS 1907 St. Wateff	1960 B. Yanev et al.	1970 B. Yanev et al.	1980 P. Slunchev et al.	1993/1999 longit. data	secular changes 1907-1993/1999 cm	1907-1993/1999 %	1907-1970 cm	1907-1970 %
7	n	305	223	217	118	134					247	214	206	113	145				
	x	20.0	23.9	26.5	26.4	25.6	5.6	28.0	6.5	32.5	19.0	23.8	26.2	25.7	25.1	6.1	32.1	7.2	37.9
	SD		3.6	4.5	4.6	3.7						4.2	4.2	3.9	4.4				
8	n	368	189	204	119	141					343	201	205	121	153				
	x	20.0	27.0	30.0	28.0	27.9	7.9	39.5	10.0	50.0	20.0	26.2	29.1	28.3	27.8	7.8	39.0	9.1	45.5
	SD		4.4	5.7	4.8	4.3						4.6	6.0	5.2	5.1				
9	n	327	206	208	122	141					281	202	202	118	150				
	x	23.0	29.2	32.8	31.2	31.6	8.6	37.4	9.8	42.6	22.0	29.6	31.6	31.7	31.7	9.7	44.1	9.6	43.6
	SD		4.7	6.0	5.9	5.6						5.5	5.7	5.9	6.4				
10	n	288	215	195	119	143					317	199	203	114	152				
	x	26.0	32.7	35.9	35.4	35.2	9.2	35.4	9.9	38.1	25.5	33.3	36.8	35.8	35.5	10.0	39.2	11.3	44.3
	SD		5.6	6.8	6.3	6.5						5.7	7.5	6.8	7.4				
11	n	330	186	210	119	141					423	177	210	120	154				
	x	27.3	36.0	38.6	39.4	39.0	11.7	42.9	11.3	41.4	28.7	37.7	41.4	39.8	40.5	11.8	41.1	12.7	44.2
	SD		6.2	7.2	8.3	7.7						7.3	8.6	7.7	8.5				
12	n	387	210	207	120	132					513	206	201	120	144				
	x	29.8	39.2	42.9	44.8	44.1	14.3	48.0	13.1	44.0	32.0	43.1	45.6	46.0	46.1	14.1	44.1	13.6	42.5
	SD		6.4	7.9	8.8	8.8						8.4	8.8	8.3	9.5				
13	n	359	167	193	120	124					421	214	204	120	135				
	x	34.6	44.0	48.9	51.2	50.0	15.4	44.5	14.3	41.3	38.0	48.4	51.0	50.1	49.9	11.9	31.3	13.0	34.2
	SD		7.6	9.4	10.1	10.3						8.1	8.5	10.2	9.7				

Table 3. Growth velocity and sex difference — longitudianl data from 1993/1999

Age, years	Growth velocity, %						Sex differences according to the Data from JSD, (%)		
	Boys			Girls					
	stature	weight	chest circum-ference	stature	weight	chest circum-ference	stature	weight	chest circum-ference
7							99.8	98.0	97.7*
8	4.1	8.2	3.7	4.0	9.7	3.5	99.8	99.6	97.4*
9	4.0	11.7	3.3	4.2	12.3	3.8	100.0	100.3	98.0*
10	3.7	10.2	3.5	4.2	10.7	3.2	100.5	100.9	97.7*
11	3.5	9.7	2.8	4.6	12.3	3.6	101.6*	103.8	98.5
12	3.9	11.6	3.5	4.0	12.1	2.7	101.7*	104.5	97.7*
13	4.7	11.8	4.3	2.6	7.6	2.9	99.6	99.8	96.3*

* Stat. sign. sex differences

Weight catch up the value of 50kg for both sexes at 13 years of age. As about stature, in weight the 13 years old girls reach in a larger percentage (76.3%) the final weight of the females from Sofia too, whose mean weight is 65.4 kg. The 13 years old boys have reached only 63.3% from the final body weight of males from Sofia whose mean weight is 78.97kg. Regarding the growing up velocity girls at 11 years of age have higher weight velocity than boys (Table 3). Weight velocity is the same for both sexes in 12 years old children. The 13 years old boys have gained weight more quickly and their weight velocity is 11.8%, when in the 13 years old girls a decrease of body mass accumulation begins and their weight velocity index is 7.6%.

A generalized idea of the specificity in the intersexual differences of physical development at 7-13 years old children from Sofia at the end of XX th century can be exemplified best by the data about intersexual index (Table 3). Up to 10 years of age both boys and girls have relatively the same stature and weight. The 11 years old girls and especially those at 12 years of age highly outstrip the boys at the same age and differences are statistically significant. Girls of thirteen, however, decelerate and the boys of thirteen accelerate in growth rate and weight gain, so that at 13 years of age boys and girls are on level with one another again. Notwithstanding the equalization between both sexes of stature and body weight, girls of thirteen are nearer to the final height and body weight of adult females from Sofia, than boys of thirteen are near to those of adult males.

Secular trends

Data about secular trends of stature show that it increase from the beginning of the century till the 70s years at 7-13 old children from Sofia. In the years after the period of stabilization of stature follows, and even initial deceleration changes are observed in the 7, 8 and 9 years old children. During the whole period under investigation of increment of stature at the separate ages is between 13.8 cm and 18.5 cm in boys - most high the secular increase is at the boys of thirteen. The stature increment in girls is

Fig. 1. Stature (1993/1999)

Fig. 2. Weight (1993/1999)

from 13.5 cm to 15.9 cm, as the biggest secular one is established at the 12 years old girls.

According to data about secular changes of weight, the 7, 8, 9 and 10 years old children from both sexes and the 11 years old girls, increase their weight till the 70s years of the century, and during the years after a tendency to deceleration changes are observed. The pick of secular weight changes is moved in the 80s years of the century at 11, 12 and 13 years old boys, and deceleration changes occur again in the years after. During the whole period under investigation the increase of body weight at the separate ages in boys is from 5.6 kg to 15.4 kg and again it is higher at boys of thirteen. The increment of body weight in girls at the separate ages is from 6.1 kg till 14.1 kg, and as about stature, the pick of secular weight changes is at 12 years old girls.

Similar to our results about the secular changes in this century were obtained by a number of investigators from European countries close to Bulgaria according to the socio-economical conditions [3, 6, 8, 9]. These authors establish that the increase in height and body weight has faded away around the 1980s, simultaneously a tendency to gracilization in the pelvic area is being traced.

It is an open question to be discussed, whether the established from us and the cited authors diminution of secular growing up changes of basic body dimensions round about the 70-80s years shows that the biological limit of tolerable to the human body acceleration is reached. This can signify that the consecutive fluctuating top of physical development in modern children is reached. It can be presumed, however, that the secular growth diminution and the following deceleration tendency are only a temporary stop in the alternative occasional rhythm of secular trend. Only further investigations in the distance future can give an answer to these important questions.

Blood pressure

The changes found in blood pressure values are in direct liaison with age and rate of physical development. For the entire seven-year period of study the mean values for the systolic RR have grown by 23 mm Hg and the ones for the diastolic one by 20 mm Hg (Fig.3). An abrupt shift of the diastolic RR from 40-59 mm Hg to 60-79 mm Hg interval is recorded in the 9-year old children [Fig.4]. The systolic blood pressure grow more slowly and even after the 11th year the prevalent per cent is shifted to the category of 110-119 mm Hg (Fig.5). In the diastolic RR, the cases of marginal and pathological values increase earlier. (the categories are after the official bulletin of the Ministry of Health, 1996, XLII).

Comparing the data on both sexes it should be noted that boys aged between 7 and 10 years display though insignificantly (by about 2 mm Hg) higher mean values and the distribution in the categories is nearly identical. Between age 10 and 11 years the values both of the systolic and diastolic RR grow more rapidly in the girls' sample and at the age of 11-12 years they become equal with the ones of the boys. In the 13-year-old school children the systolic RR are again higher in the boys, one third of the cases (37.1%) being already with higher values of 120 mm Hg.

A comparative analysis can only be carried with data from a transversal studies, performed between the years 1950 and 1980 [11, 12, 13, 14]. The mean values of both systolic and diastolic blood pressure measured up till 1970 including, are characterized with significantly higher values in the early school age and with a slower rate of increase. Closest to our data are the ones from 1980 (Slunchev et. al.) for the age between 7 and 9 years after which RR remains with lower values by 3 mm Hg on the average.

Fig. 3. Age and sex differences in blood pressure

Fig. 4. Percentage distribution of diastolic blood pressure according to age

According to most contemporary authors 30% of the cases with higher blood pressure are genetically predetermined. Twice as much are the patients with secondary influences from various environmental factors [1]. The increase of the blood pressure is in a positive correlation with body constitution (body weight, BMI, etc.). The strong impact of the so-called "psychosocial stress" related to the studying process should also be mentioned.

The results obtained by us, tracing the changes in the blood pressure in one and the same children in the course of 7 years reflect the dynamic changes in the adolescent organism in close relationship with the physical development and sexual maturation.

Menarche

One of the tasks of the longitudinal study of the school children from Sofia is to trace the rate and the variations of sexual maturation in the boys and girls at the end of the XXth century. A total of 152 girls were studied, 127 of which with menstruation (83.55%) of the girls — without mensis till the last year only six (3.9%) are over 13.49 years old. The average age of menarche onset is 12.07+0.75 years. This value would probably increase by about 0.2 years in the next stages of the longitudinal study. The distribution among the age groups renders the highest percentage in the interval between 11.50 till 12.49 years - 44.1% of the girls, followed by the age group of 12.5 till 13.49 (31.5%) and the ones between 10.5 and 11.49 years (20.5%). Under 1% are the children who have had their menarche onset under the age of 10.5 and the ones over 13.5 years with menarche comprise only 3.1% of the girls for the present.

The comparison of the results obtained by us with data from the sexual maturation study of Sofia schoolgirls in 1939 by Mateev and in 1953 by Seizov (Fig.6) displays significant differences both in the mean age of menarche onset (13, 14 years and 12,72 years) and in the per cent distribution in the age groups [11]. In the year 1939 the highest value for menarche frequency is the 13-14 years interval (38,28%), followed by the 14-15 year olds (26.66%) and only after that come the girls between 12 and 13 years old (21.06%). In the year 1953 the per cent in the age group between 13 and 14 years remains the highest (38.2%) the girls aged 12-13 years ranking second now (28.8%) while the frequency sharply decreases after 14 years of age. Seasonal studies on menarche onset indicate to a marked prevalence of the summer months (July and August most often) — 37.8% followed by spring and autumn — 22.0% and 21.3% respectively (predominantly the months April and September). The shore allotted to winter is 18.9% of the cases most of which in January. The smallest is the per cent of menarche onset during the months December and February.

Also a sample of 104 mothers born between 1956-1963 was studied in which the average age of menarche onset 13, 14 +1.29 years. Seasonal distribution is similar in their case as well (41.6% in the summer, 28.7% in spring, 19.8% in the autumn, and 9.9% during the winter). Close to these values are the ones recorded by S t o e v [7] for Sofia schoolgirls, investigated during 1984-1987 with a mean menarche onset age of 12.86 years.

The comparison with data for Greek girls from Athens [5] shows a considerable similarity to our results. In their case menarche onset has been recorded at the age of 12.27+1.13 years and in the case of their mothers - 13.06+1.2 years.

Registering the changes in menarche onset since 1939 i.e. in the course of 60 years the accelerated maturation of Sofia girls by around two months per a decade must be noted.

Fig. 5. Percentage distribution of systolic blood pressure according to age

Fig. 6. Age of menarche

Conclusion

In conclusion it can be summarized that the results obtained by us represent a stage of the longitudinal study encompassing the age range between 7 and 13 years outline the main characteristics of the physical development, sexual maturation and health condition of the cardio-vascular system in school children from Sofia at the end of the XXth century.

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