

Specificity of the Physical Development in 7-14-year-old Schoolchildren from Sofia at the End of the 20th Century — Basic Body Diameters and Circumferences

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The results presented are a part of detailed anthropological, longitudinal investigation (1993-2000) of 7-14-year-old schoolchildren from Sofia. The number of the annual studied boys varies from 129 to 134, and of the girls — from 121 to 146. In the present work are analysed and assessed the metrical data of biacromial, bicristal and bispinal diameters, and chest, waist and abdomen circumferences. Measurements of separate features reached during the eight years under study are presented, as well as the intersexual differences, the growth velocity and the realized percentage of schoolchildren growth compared to the final measurements in adults. For the features about which there are literature data of past generations are assessed the secular changes. The results obtained, characterize and define the specificity of some fundamental characteristics of the physical development in 7-14-year-old schoolchildren from Sofia at the end of the 20th century. The results can be a base for comparative analysis and assessment of data from similar past and future studies.

Key words: physical development, schoolchildren, body diameters and circumferences, growth velocity, secular changes.

Introduction

The assessment of regularities and specificities in the physical development of children and youths from different generations, who have lived in various social and economic conditions, is a ceaseless problem for medical and biological specialists.

The aim of the present work is to be assessed: the metrical characteristics, the intersexual differences, the growth velocity and the secular trends of basic body diameters and circumferences in 7-14-year-old schoolchildren from Sofia, who are representatives of a generation which has lived in the years tied to the end of 20th century and the beginning of 21st one.

Table 1. Basic metrical data longitudinal investigation (1993-2000)

Age (years)	Boys										Girls						
	n	biacromial diameter			bicristal diameter			bispinal diameter			n	biacromial diameter			bicristal diameter		
		X	SD	incr. (cm)	X	SD	incr.(cm)	X	SD	incr.(cm)		X	SD	incr.(cm)	X	SD	incr.(cm)
7	134	27.5	1.4		19.2	1.7		14.7	1.4		146	27.1	1.4		18.9	1.4	
8	141	28.9	1.4	1.4	20.3	1.6	1.1	16.7	1.3	2.0	154	28.4	1.7	1.3	20.3	1.6	1.4
9	141	29.6	1.4	0.7	20.9	1.6	0.6	18.0	1.3	1.3	151	29.3	1.6	0.9	21.1	1.7	0.8
10	143	30.8	1.6	1.2	21.7	1.6	0.8	18.8	1.5	0.8	154	30.5	1.7	1.2	22.0	1.8	0.9
11	141	31.9	1.5	1.1	22.5	1.7	0.8	19.5	1.6	0.7	154	31.9	1.9	1.4	22.9	1.9	0.8
12	132	33.1	1.9	1.2	23.4	1.8	0.9	20.1	1.7	0.6	144	33.0	2.0	1.1	23.9	2.0	1.0
13	124	34.8	2.1	1.7	24.2	2.0	0.8	21.3	1.8	1.2	135	34.1	1.8	1.1	24.3	2.0	0.4
14	129	36.7	2.2	1.9	24.7	2.9	0.5	21.7	1.7	0.4	121	34.9	1.8	0.8	24.3	2.0	0.0
7 - 14				9.2			5.5			8.0			7.8				5.4

Age (years)	Boys										Girls						
	n	chest circumference			waist circumference			abdomen circumference			n	chest circumference			waist circumference		
		X	SD	incr. (cm)	X	SD	incr. (cm)	X	SD	incr. (cm)		X	SD	incr. (cm)	X	SD	incr. (cm)
7	134	59.6	3.4		54.4	4.0		57.2	4.5		146	58.2	4.2		52.9	4.6	
8	141	61.9	3.8	2.3	56.8	4.7	2.4	60.3	5.0	3.1	154	60.3	4.5	2.1	55.3	4.8	2.4
9	141	64.0	4.4	2.1	58.1	4.9	1.3	62.4	6.2	2.1	151	62.7	5.3	2.4	56.8	5.9	1.5
10	143	66.3	5.2	2.3	60.6	6.0	2.5	65.1	7.2	2.7	154	64.8	6.1	2.1	58.7	7.0	1.9
11	141	68.2	5.6	1.9	62.1	6.3	1.5	66.8	7.6	1.7	154	67.2	6.5	2.4	60.5	6.7	1.8
12	132	70.7	6.1	2.5	64.3	6.4	2.2	69.7	7.7	2.9	144	69.1	6.3	1.9	62.3	6.5	1.8
13	124	73.9	6.7	3.2	66.8	6.8	2.5	73.7	7.8	4.0	135	71.2	6.6	2.1	64.1	6.8	1.8
14	129	78.1	7.0	4.2	69.2	7.2	2.4	76.3	8.2	2.6	121	73.1	6.8	1.9	65.3	6.9	1.2
7 - 14				18.5			14.8			19.1			14.9				12.4

Table 2. Sex differences (%) according to the data from ISD (1993-2000)

Age (years)	Biacromial diameter	Bicristal diameter	Bispinal diameter	Chest circumference	Waist circumference	Abdomen circumference
7	98.5*	98.6	101.1	97.6*	97.2*	90.0
8	98.5*	100.4	101.7	97.3*	97.3*	101.1
9	99.0	100.8	101.5	98.0*	97.9*	100.7
10	99.2	101.2	101.8	97.7*	96.9*	100.7
11	100.1	101.5	102.1*	98.5	97.4*	100.6
12	99.8	102.0*	102.7*	97.7*	96.9*	102.7
13	98.0*	100.5	102.8*	96.4*	96.0*	101.3
14	95.0*	98.3	100.5	93.6*	94.3*	99.4

* Stat. sign. sex differences ($P \leq 0.05$) according to the absolute values of the features from the Table 1.

Material and Methods

Data about biacromial, bicristal and bispinal diameters, as well as chest, waist and abdomen circumferences, as a part of detailed anthropological, longitudinal study carried out for 7-14-year-old schoolchildren from Sofia in the period 1993-2000, are analyzed and assessed. The numbers of the schoolboys investigated annually vary from 129 to 134, and those of the schoolgirls from 121 to 146, depending on their presence at school during the days of investigation. The investigation is carried out always in October by the same anthropological staff according to the classical methods of Martin, Saller [1]. The intersexual differences are evaluated by the intersexual index (ISD):

$ISD = (X \text{ girls} \times 100) / X \text{ boys}$. The growth velocity is assessed by the annual increment in *cm* for all features separately. For the assessment of the realized percentage of schoolchildren growth compared to the final measurements in adults, are used data unpublished till now for the population in Sofia (30-40 years old ones), carried out as a National Anthropological Programme (1989-1992). The secular changes are evaluated in virtue of literature data from investigations made in 1907, 1960, 1970 and 1980 [2, 3, 4, 5].

Results

In the present work, we shall restrict the results' description and their discussion, for being able to give the detailed metrical data of the investigated features in tables and figures. Such wide anthropological study, with such detailed metrical data for the present period is not carried out in Bulgaria till now. We hope that our data will be a base for the coming comparative analyses and assessments of children and adolescents' physical development.

Metric characteristics and intersexual differences

The particular metrical data of the studied body diameters and circumferences are presented in Table 1, and illustrated by Fig. 1—6. In the figures, the absolute values (in *cm*) are marked on the left side of the co-ordinates. The intersexual differences are assessed by the ISD-data and showed in Table 2, Fig. 7.

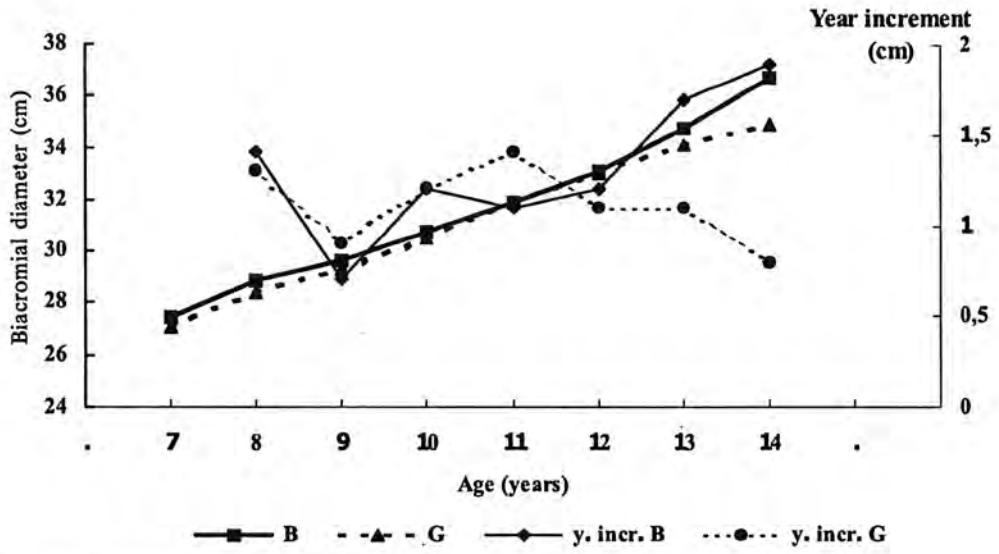


Fig. 1. Biacromial diameter (1993-2000)

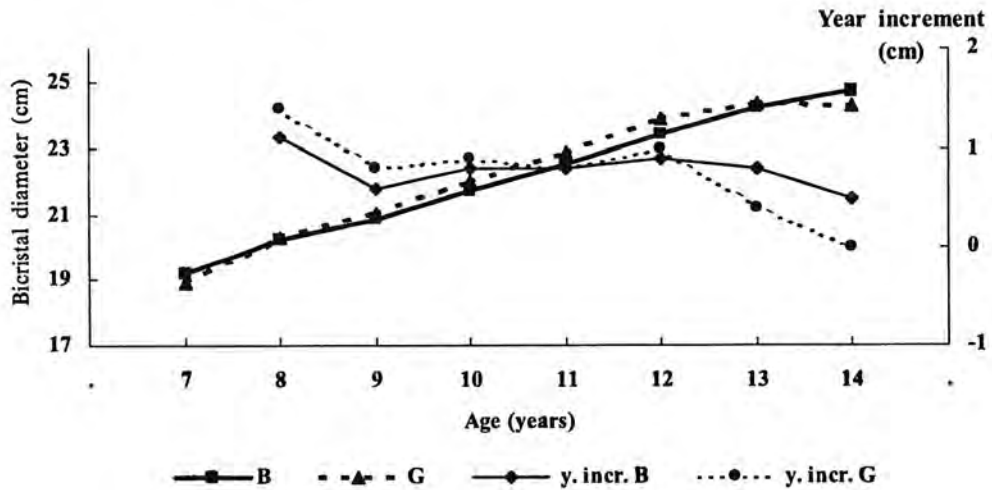


Fig. 2. Bicristal diameter (1993-2000)

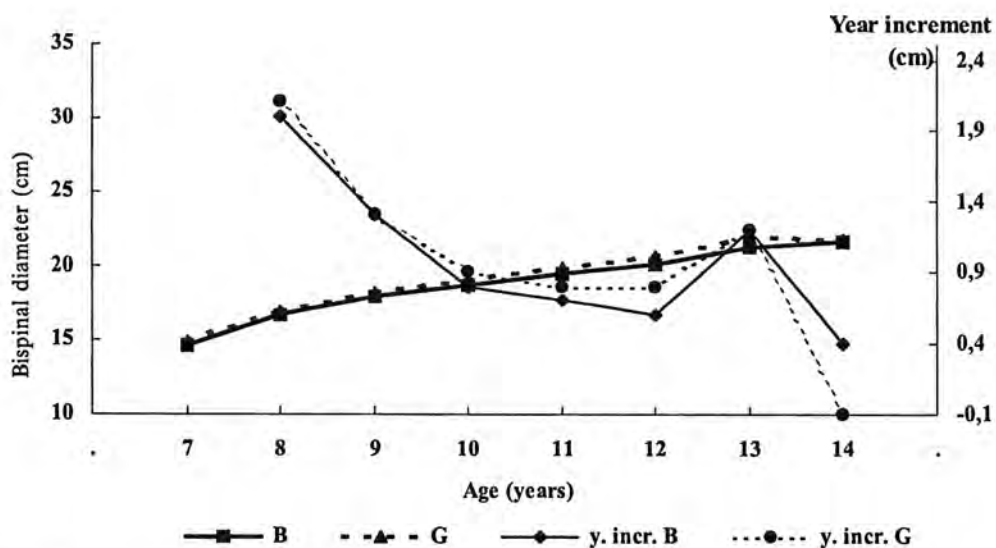


Fig. 3. Bispinal diameter (1993-2000)

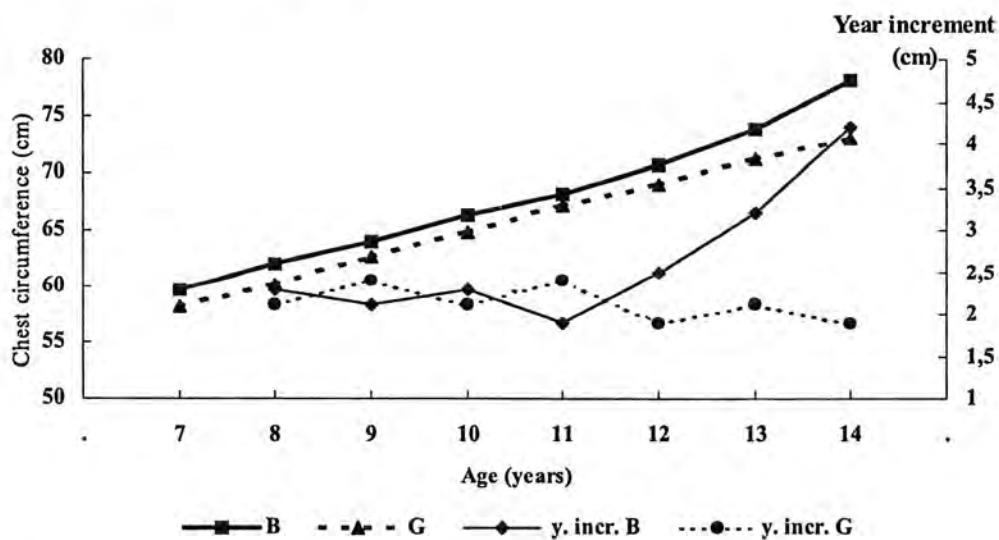


Fig.4. Chest circumference (1993-2000)

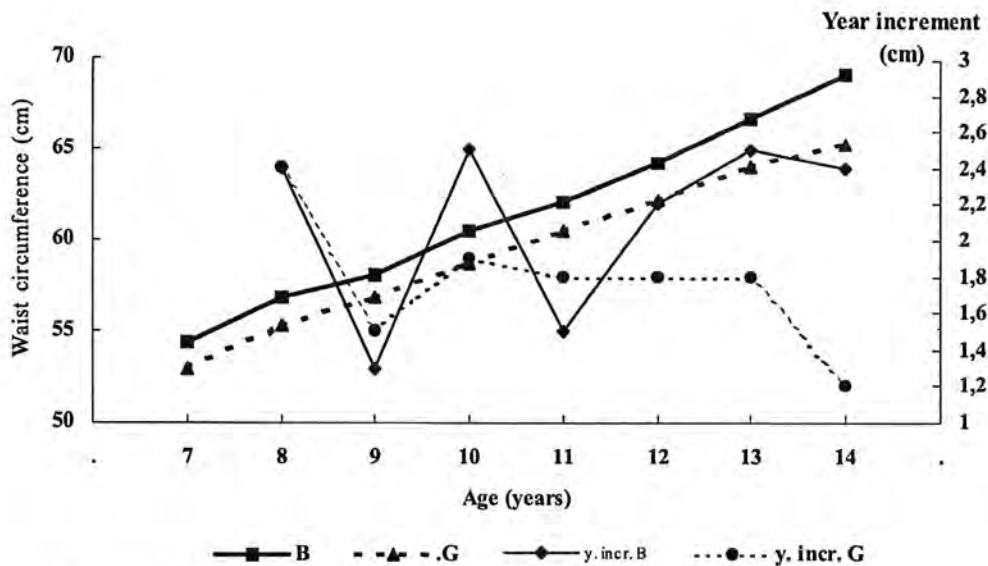


Fig. 5. Waist circumference (1993-2000)

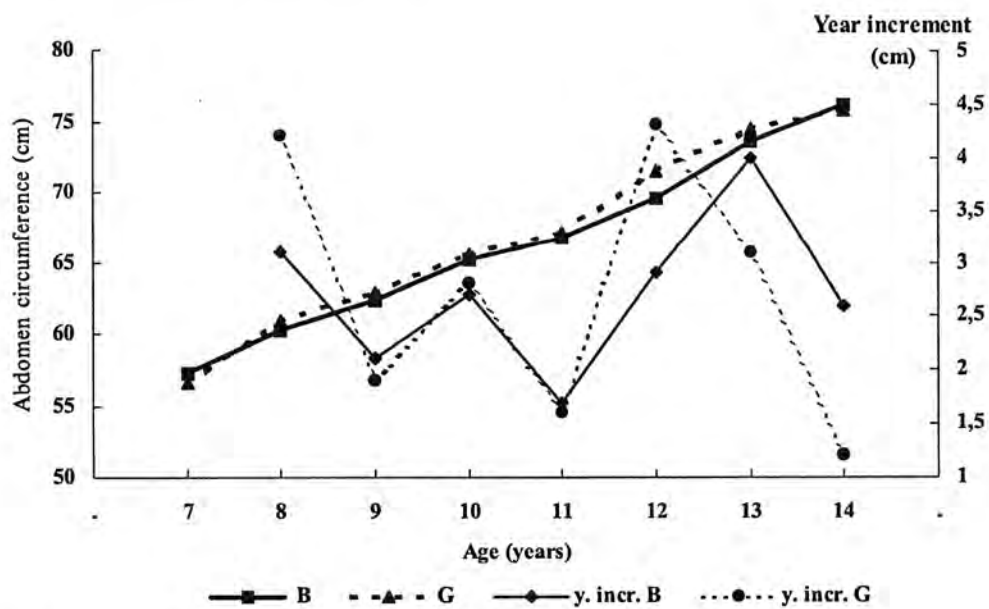


Fig. 6. Abdomen circumference (1993-2000)

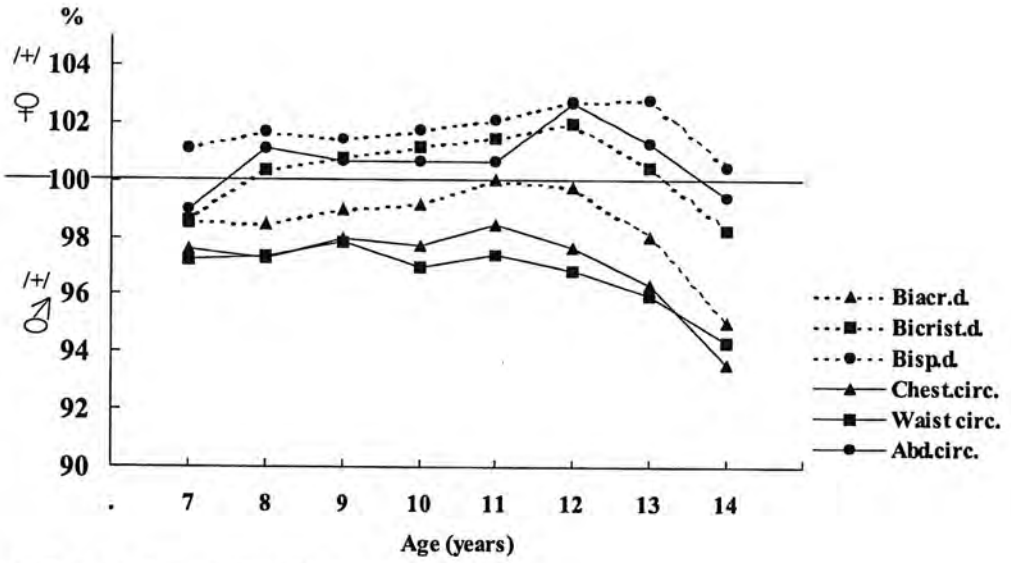


Fig.7. Sex Differences (1993-2000) (ISD data)

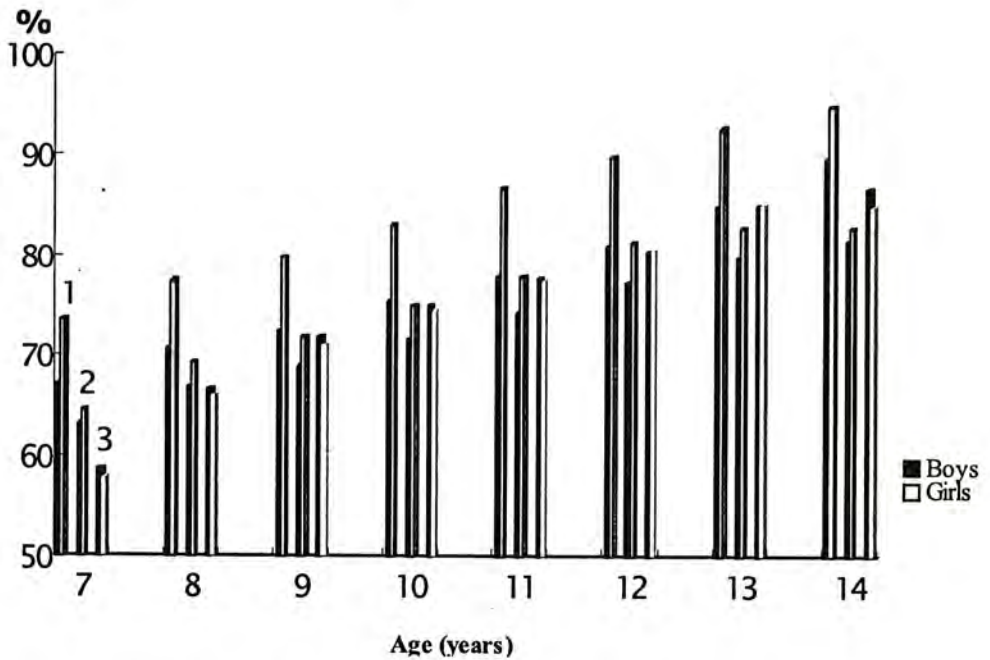


Fig. 8. The realized percentage of schoolchildren growth (1993-2000) compared to the final measurements in adults

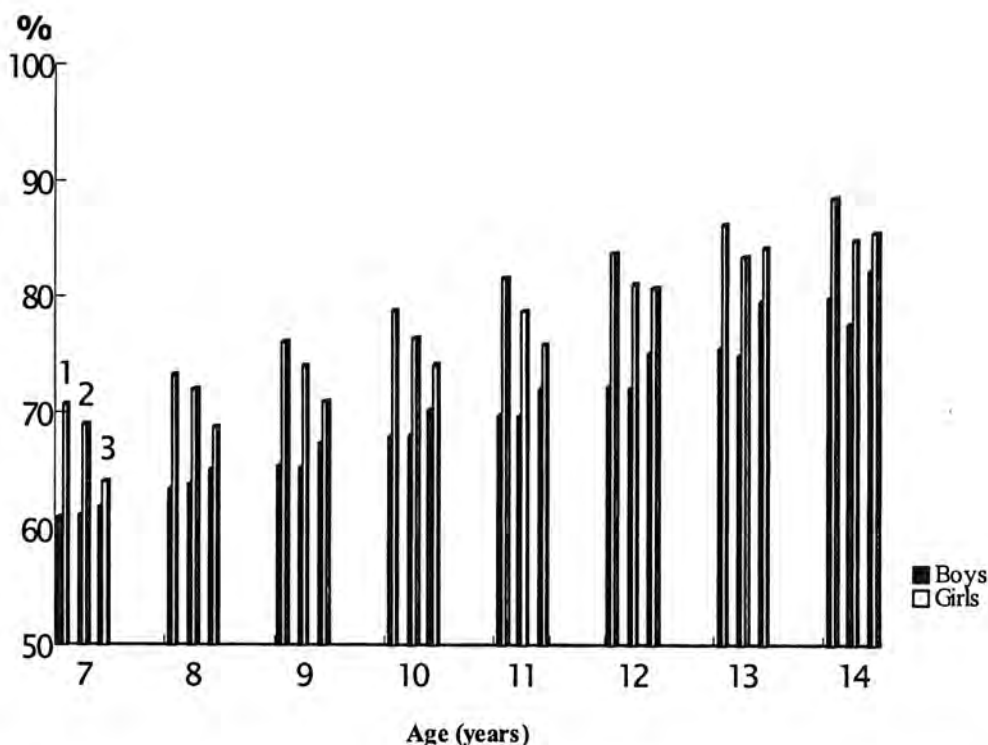


Fig. 9. The realized percentage of schoolchildren growth (1993-2000) compared to the final measurements in adults

Well-expressed intersexual differences of the studied body diameters and circumferences are established for the period between 7 and 14 years of age. In all ages, boys have bigger biacromial diameter, chest and waist circumferences. The girls have a bigger bispinal diameter throughout the period 8-13 years, but statistically significant are the intersexual differences only at 11, 12 and 13 years old children. Statistically significant intersexual differences are missing for the abdomen circumference and the bicristal diameter.

Metrical characteristics and growth velocity

The data about growth velocity (annual increment in *cm*) are presented in Table 1 and Figures from 1 to 6, on the right side of the co-ordinate.

The annual growth of the three body diameters throughout the 8-year period of investigation is unequal for both sexes. *The biacromial diameter* in boys for the whole period increases totally with 9.2 cm, as the growth is more intensive after 12 years of age, and it is most strongly manifested in the 14 years old boys. For girls, the growth of the biacromial diameter increases throughout the 8-year period totally with 7.8 cm, and the growth velocity is most high for the 11 years old girls, and smallest for the 14 years old ones. *The bicristal and bispinal diameters* have relatively equal increments for both sexes in the eight years period, respectively — 5.5/5.4 cm for the bicristal di-

ameter, and 7.0/7.0 cm for the bispinal one. The growth velocity for these diameters is also relatively equal up to 12 and 13 years of age respectively in boys and girls, and after these ages, it suddenly slows down especially for girls.

The increment of the three body circumferences throughout the 8 years of investigation is irregular and various for both sexes, as it is for the body diameters. *The chest circumference* in boys increases during the whole period of study commonly with 18.5 cm. The annual growth is uniform up to 11 years of age, followed by a sudden increase of the growth velocity with a maximum at 14 years of age. In girls, the chest circumference grows up commonly with 14.9 cm. The growth velocity is highest at 9 and 11 years of age, and lowest at the 14 years old girls. *The waist circumference* in boys increases throughout the 8 years of investigation with 14.8 cm. The growing picks are at 8 and 10 years of age, as the growth velocity rests intensive up to 14 years of age. The waist circumference increases during the whole period of investigation with 14.8 cm in girls. Its growing pick is at 8 years of age, and at 14 years — it is smallest. *The abdomen circumference* in boys increases during the 8 years of study with 19.1 cm. The intensive growing picks are established in the 8th and 13th years, after which the growth velocity slows down considerably. In girls during the 8-year period of investigation, the abdomen circumference increases with 19.1 cm. The growing picks are at 8 and 12 years of age, and again it is smallest at 14 years of age.

The realized percentage of schoolchildren growth compared to the final measurements in adults (Table 3, Fig. 8,9)

Interrelating the metrical data of the studied features of schoolchildren and the relevant data for adults was established that throughout 7 and 14 years of age, the girls came more nearly to the final measurements in adults concerning all diameters and circumferences. The bispinal diameter measurements in boys only as an exception are insignificantly closer to the final measurement in adults, than they are in girls.

Secular changes

The secular changes are evaluated on the base of our data, and the existing ones in the literature for past Bulgarian generations (Tabl. 4, Fig. 10-13). This assessment is

Table 3. The realized percentage of schoolchildren growth (1993-2000) compared to the final measurements in adults

Age (years)	Biacromial diameter		Bicristal diameter		Bispinal diameter		Chest circumference		Waist circumference		Abdomen circumference	
	boys	girls	boys	girls	boys	girls	boys	girls	boys	girls	boys	girls
7	67.1	73.6	63.0	64.3	58.5	57.7	61.1	70.7	61.2	68.9	61.8	64.1
8	70.6	77.3	66.7	69.3	66.5	66.0	63.5	73.2	63.9	72.1	65.1	68.9
9	72.4	79.7	68.8	71.7	71.8	71.1	65.5	76.2	65.3	74.1	67.4	71.1
10	75.2	83.1	71.6	74.9	74.9	74.4	67.9	78.7	68.1	76.5	70.4	74.2
11	77.9	86.8	74.2	77.9	77.7	77.4	69.9	81.7	69.8	78.8	72.1	76.0
12	80.9	89.9	77.2	81.4	80.3	80.6	72.4	83.9	72.3	81.1	75.3	80.9
13	84.9	92.7	79.8	82.9	85.0	85.3	75.7	86.5	75.1	83.5	79.6	84.3
14	89.8	95.0	81.5	82.8	86.7	85.1	80.0	88.8	77.8	85.1	82.4	85.7

ADULTS DATA (cm) - 30/40 YEARS OF AGE (~90s)

	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women		
	40.9	36.7	30.3	29.3	25.1	25.6	97.6	82.3	88.9	76.7	92.5	88.4

Table 4. Literature data for assessment of secular changes

Year of invest.	Age (years)	Boys						Girls					
		biacromial diameter			bicristal diameter			biacromial diameter			bicristal diameter		
		n	X	SD	n	X	SD	n	X	SD	n	X	SD
1960	7	225	26.9	1.9	224	20.1	1.4	213	26.8	1.7	213	20.0	1.4
	8	191	27.7	1.8	191	21.2	1.5	202	27.5	1.7	201	20.9	1.5
	9	207	28.5	2.0	207	21.5	1.6	204	28.6	2.1	204	21.8	1.7
	10	217	30.1	1.9	217	22.4	1.9	202	29.8	2.2	202	22.6	1.9
	11	186	30.9	2.0	186	22.7	1.7	176	30.8	2.1	175	23.2	2.0
	12	209	31.6	1.9	207	23.2	1.8	208	32.3	2.0	209	24.4	2.3
	13	168	33.3	2.1	168	24.4	1.8	217	33.6	1.9	217	25.5	2.2
1970	7	197	34.8	2.9	197	25.1	2.5	199	34.1	2.0	200	25.6	2.4
	7	218	26.3	2.3	218	18.8	2.1	210	26.3	2.2	210	19.1	2.1
	8	205	27.7	2.3	205	20.1	2.4	211	27.2	2.6	211	19.8	2.4
	9	211	28.6	2.3	212	20.3	2.1	201	28.4	2.2	201	20.2	2.2
	10	196	29.9	2.1	196	21.2	2.1	204	29.6	2.6	204	21.5	2.4
	11	212	30.6	2.1	207	22.1	2.3	212	31.0	3.3	213	22.8	2.8
	12	210	31.4	2.6	210	22.2	2.5	201	31.9	2.6	200	23.7	2.7
1980	13	198	33.1	2.8	198	23.8	2.7	205	32.8	2.7	206	24.4	2.1
	14	209	34.9	3.0	209	24.4	2.7	210	34.0	3.0	211	25.2	2.8

Year of invest.	Age (years)	Boys						Girls					
		chest circumference			waist circumference			chest circumference			waist circumference		
		n	X	SD	n	X	SD	n	X	SD	n	X	SD
1960	7	296	56.7	missing				231	54.8	missing			
	8	368	58.2	missing				314	56.0	missing			
	9	320	59.8	missing				268	57.3	missing			
	10	262	61.4	missing				262	59.5	missing			
	11	321	62.8	missing				226	61.1	missing			
	12	464	64.4	missing				228	63.7	missing			
	13	982	66.6	missing				186	66.0	missing			
1970	14	1456	71.6	missing				235	67.6	missing			
	7	224	60.2	3.5	223	53.0	4.1	214	58.9	3.8	214	52.3	4.3
	8	190	61.2	4.0	189	54.4	4.0	201	60.9	4.6	199	53.4	4.7
	9	207	63.9	4.3	206	55.8	4.4	201	63.3	4.7	201	55.3	4.8
	10	217	66.5	4.6	216	57.8	5.5	202	65.5	4.9	202	57.6	5.6
	11	187	68.3	4.7	187	59.2	4.8	176	68.0	5.2	176	59.3	5.6
	12	210	70.5	4.6	209	60.7	4.8	208	69.6	5.4	209	61.2	5.5
1980	13	168	73.3	5.3	166	62.4	5.7	217	72.6	5.4	215	62.6	5.3
	14	196	77.0	5.7	197	65.6	5.8	199	75.6	4.9	200	64.6	4.9
	7	218	61.1	3.9	210	55.3	4.6	208	59.7	4.4	207	54.4	5.1
	8	205	63.9	5.0	203	57.4	5.7	213	61.8	5.5	210	55.7	6.3
	9	212	65.2	4.6	213	58.3	5.4	207	63.4	5.2	207	56.9	5.8
	10	196	67.5	4.9	196	59.8	6.2	204	66.4	6.1	204	58.8	6.6
	11	212	69.0	5.3	212	61.4	6.1	216	68.4	6.4	214	61.1	7.4
1990	12	212	72.4	6.0	212	63.7	6.4	201	70.3	6.3	200	62.3	6.2
	13	198	75.3	6.9	198	66.4	6.8	207	72.4	5.9	205	64.3	5.8
	14	209	77.5	5.7	207	67.6	5.6	212	74.2	6.1	211	66.1	5.5
	7				118	57.1	4.9				113	54.2	4.5
	8				119	57.0	4.9				121	56.6	5.1
	9				122	58.4	6.2				118	57.8	5.8
	10				119	61.6	6.4				114	60.1	6.8
11				119	63.7	7.4				120	61.3	6.2	
12				120	66.8	7.6				120	64.7	6.7	
13				120	69.2	9.0				120	66.0	6.7	
14				120	70.5	5.9				119	68.5	6.8	

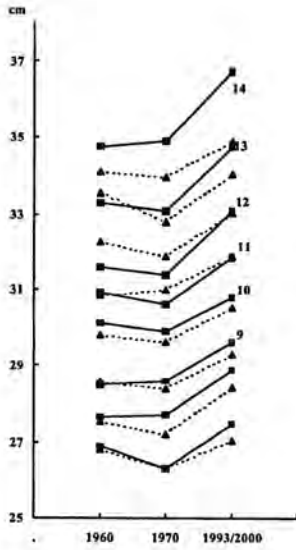


Fig. 10. Secular changes in Bia-cromial diameter

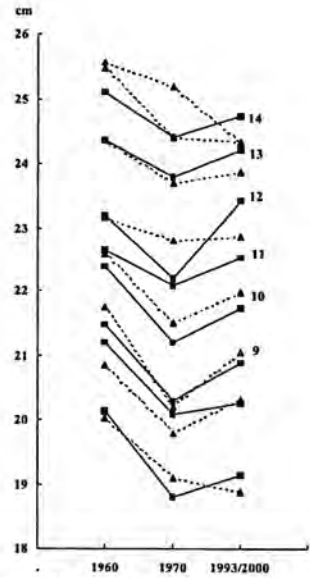


Fig. 11. Secular changes in bicristal diameter

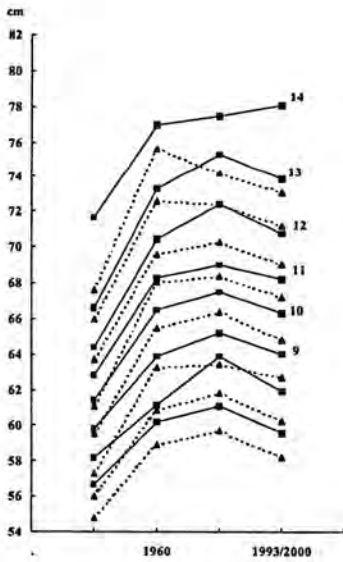


Fig. 12. Secular changes in chest circumference

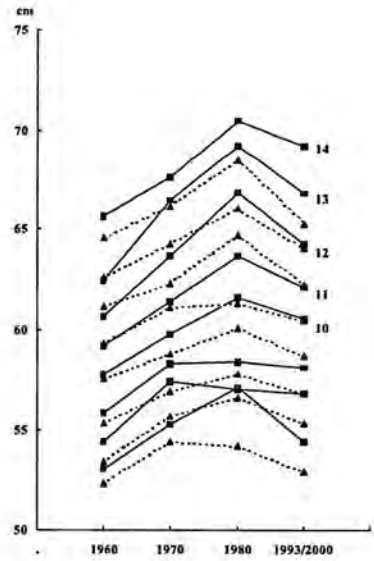


Fig. 13. Secular changes in waist circumference

made on condition that, it is impossible to be taken into consideration the errors of the research staffs back in the years, and that the differences between our methods and the methods of other authors are not existing. *Biacromial diameter* — after a slight stop of the acceleration between 60s and 70s, at the end of the 20th century a tendency of secular growth is observed in both sexes, and it is more strongly expressed in boys at 12, 13 and 14 years of age. *Bicristal diameter* — deceleration changes are observed between 60s and 70s for all investigated schoolchildren, and only in 7, 13 and 14 years old girls, this deceleration goes on up to the end of the 20th century. Slightly expressed increment of bicristal diameter for both sexes in the other age groups is available throughout the 70s and the end of the century. *Chest circumference* — from the beginning of the century up to the 70s, secular growth is available in all age groups and both sexes. Throughout the 70s and the end of the century, a tendency of deceleration is observed for both boys and girls at every age, excepting the boys at 14 years of age. *Waist circumference* — throughout the 60s and 80s, the waist circumference increases in both sexes and ages, but higher is the acceleration for boys and girls after 11 years of age. Throughout the 80s and the end of the century, a deceleration tendency is available more strongly expressed in both sexes after 11 years of age.

Conclusions

The generalized assessment of the physical development specificity for the 7-14 years old schoolchildren from Sofia City at the end of the 20th century, based on data about fundamental body diameters and circumferences shows that:

— In the course of all ages under investigation, boys have bigger biacromial diameter and chest and waist circumferences; but girls have bigger bispinal diameter throughout 8 and 13 years of age.

— The growing picks of biacromial diameter and chest circumference are at considerably earlier age in girls (11 years) than in boys (14 years). In girls, the smallest annual increment for all six features is at 14 years of age in contrast to boys, by whom at 14 years of age the annual increment for the biacromial diameter and chest circumference is highest.

— For girls at 14 years of age, the measurements of the biacromial and bicristal diameters, as well as the ones of the three body circumferences are much closer to the same measurements in adults, than they are for boys.

— The summarized assessment of secular changes for the investigated features in 7-14 years old boys and girls shows that, after some depression throughout the 60s and 80s, at the end of the 20th century the diameters of shoulder and pelvis increase and the chest and waist circumferences decrease.

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