

AGE AND SEXUAL DIFFERENCE IN SOME BASIC BODY CIRCUMFERENCES THROUGHOUT 9 – 15 YEARS OF AGE

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ABSTRACT. This is a part of a complex anthropometrical study of 569 boys and 573 girls aged from 9 to 15 carried out in 2001 – 2002 in three Sofia schools. The following anthropometrical features are taken by a standard millimetres' band: chest circumference in pause, waist, abdominal (on the level of navel) and hip circumferences. The aim of the present study is to characterize the age and sexual differences in the development of basic body circumferences throughout 9-15 years in schoolchildren from Sofia at the beginning of the 21st century, and to evaluate the information for the distribution of subcutaneous fat tissue given by Waist/Hip ratio during the growing up period. In boys all the investigated body circumferences consequently increase with age throughout the whole 9-15 ages period but in girls – only the abdominal and hip circumferences. The significant intersexual differences are mostly well expressed in the chest and waist circumferences between 11-15 years of age with priority for boys, and in the hip circumference at 10, 11 and 13 years of age – with priority for girls. In both sexes during the period 9-15 years, the hip circumference increases more intensively than the waist circumference more strongly expressed in girls. This determine significantly higher values of the Waist/Hip ratio (WHR) in boys from all age groups than in girls, and a decrease of WHR mean values with ages for both sexes. Nearly all obesity schoolchildren have android WHR type, and very few have mixed WHR type.

KEY WORDS. schoolchildren, body circumferences, Waist/Hip ratio (WHR), gynoid and android WHR type, Body nutritional status.

INTRODUCTION

The basic body circumferences and some relations among them are a group of anthropological traits that gives a total idea as for the massiveness of chest and pelvis, and so for the development of muscles and fat tissue. During the intensive growing up and developmental periods and also in the adult ages these features show specific

age and sexual differences reflecting the genetic and environmental factors, as well. This fact makes them important indicators tracing the changes in physical status and body constitution of man and in some cases for his health status [2, 3, 4, 7, 13, 14, 15, 18]. There are many papers in the scientific literature in Bulgaria and abroad in which the data of the circumferential measurements of human body are subject for analyses, as in connection with the peculiarities in human ontogenesis so with the secular changes [4, 7, 8, 10, 12, 13, 14, 15, 18]. In these papers many information can be found also for the practical evaluation of borderline between norm and pathology in different forms of overweight, obesity, cellulite and other dysfunctions. In adults the Waist/Hip ratio (WHR) is a common indicator of the fat distribution on waist-abdominal body area and thus being a marker of gynoid and android body constitution and in particular gynoid and android distribution of fat tissue [16, 17]. However there is a little information for the distribution of fat tissue on waist and abdominal body areas given by the WHR in children and adolescents abroad, and in Bulgaria we found only one report (in press) about this problem till now [2, 5, 6, 9].

The aim of the present study is to characterize the age and sexual differences in the development of basic body circumferences throughout 9-15 years in schoolchildren from Sofia at the beginning of the 21st century, and to evaluate the information for the distribution of subcutaneous fat tissue given by WHR during the growing up period.

MATERIAL AND METHODS

This is a part of a complex anthropometrical study of 569 boys and 573 girls aged from 9 to 15 carried out in 2001 – 2002 in three Sofia schools. The following anthropometrical features are taken by a standard millimetres' band: chest circumference in pause, waist, abdominal (on the level of navel) and hip circumferences.

The significance of age and sexual differences are evaluated by the t – test of Student at $P < 0.05$.

The type of waist-abdominal constitution is assessed on the base of the recommended by cut off WHO percentiles (P_5 and P_{95}) evaluated for every age and sexual group. The ratio values less than P_5 show gynoid type, between P_5 and P_{95} – mixed type, and more than P_{95} – android type (Table 1).

RESULTS

In Table 2 are presented the results of the descriptive statistic of chest, waist, abdominal and hip circumferences.

The investigated body circumferences increase regularly with age in both sexes parallel with the intensive growth and development in adolescence. The date obtained are illustrated graphically in Figure 1-4.

Age differences

In boys the most intensive and statistically significant increase for all circumferences is found between 10 and 11 years (5.0 - 5.5 cm). Statistically significant is also the

increase: in chest circumference – between 13-14 and 14-15 years of age (3,5 and 2,5 cm); in hip circumference – between 12-13 and 13-14 years (approximately 3.5 cm); in waist circumference – between 13-14 years; and in abdominal circumference – between 14-15 years (approximately 2.5 cm).

In girls the statistically significant increase begins earlier (connected with their earlier coming of puberty) just between 9-10 years of age (about 2.0-3.0 cm for all circumferences). It continues between the ages 10-11 (5.0 cm in hip circumferences and 2.0 – 3.0 cm in other circumferences). The next significant increase in girls is also one year earlier than in boys – between 12-13 years (5.5 cm in hip and 2.5 cm in other circumferences). Such increase commensurable with the size in boys (with 5.0 – 5.5 cm) is found only for the hip circumference in girls. A continuous increasing tendency during the entire investigated period in girls could be traced only in hip and abdominal circumferences. These measurements still increase between 13 and 15 years (although insignificantly). The increase of chest and waist circumferences in girls ends at 13-14 years but at 15 – these features even decrease with about 0.5 cm.

Intersexual differences

The intersexual differences are mostly well expressed between 11 and 15 years of age for the circumferences of upper body part, with predominance for boys. At 10 years the chest and waist circumferences are equal in both sexes. In the next age group they are significantly higher in boys than in girls (about 2.0 cm). Until the end of the period under examination, these two circumferences rise more intensively in boys. The 15 years old boys have chest circumference higher by 10.0 cm, and waist circumference – higher by 7.0 cm than girls. About abdominal circumference significant intersexual difference are found only at the 10 years old schoolchildren (about 3.0 cm in plus for girls). Girls predominate in hip circumference during the entire period under study, but significant are only the differences at 10, 11 and 13 years of age (about 1.5 – 3.8 cm). These are the ages in which a significant increase of hip circumference in girls are found.

Waist/Hip ratio (WHR).

The described specific changes of body circumferences with age in boys and girls depend on the particular intersexual differences of body constitution in the schoolchildren. They could be illustrated by the results of WHR through the investigated period (Fig. 5).

Throughout the entire period 9-15 years, the boys have bigger waist circumferences and smaller hip circumferences than the girls. This determined significantly higher values of the WHR in boys from all age groups (by 0,05 to 0,08) than in girls. From other side in boys and girls through the investigated period the hip circumferences rise more intensively than the waist circumferences. This determines the decrease in WHR mean values with age for both sexes (from 0,85 to 0,79 in boys and from 0,80 to 0,71 in girls). In boys the WHR decreases statistically significant only between 12 и 13 years of age (about 0,06), while in girls – almost throughout the entire investigated period (about 0,09). An exception is observed only at 10 and 14 years

old girls, by whom the decrease of WHR values are statistically insignificant, than the girls aged 9 and 13 years, respectively.

Distribution of the schoolchildren in categories according to the values of WHR (Fig. 6-8).

By the distribution of schoolchildren in the categories WHR, the mixed WHR type is observed most frequently through the entire 9-15 ages period (between 82.8% and 97.0%). In the gynoid type are classified 1.5 times more schoolchildren than in the android one. Highest is the frequency of gynoid type in boys at 9 and 10 years (8.9% – 11.4%), while in girls it is – at 9, 10 and 15 years (9.1%, 10.0% and 9.7% respectively). For the android type, however, the frequency is highest in the 15 years old boys (10.3%). The highest percent of android type in girls is established in the 14 years old ones (5.2%), and it is two times less than in boys.

From the results received could be summarized that during the period 9-14 years in boys the gynoid type (about 8.0%) is twice more frequent than the android one (about 4.0%). The frequency of these two WHR types changes at 15 years of age, and already the android type is 1.5 times more frequent (10.3%) than the gynoid one (6.9%). Between 9 and 14 years the mean frequency of both WHR types in girls have the same proportions as in boys (2:1 in favour of the gynoid type). Opposite the boys, in girls at 15 years of age the gynoid type still prevails (and is three times more frequent – 9.7%) compared to the android one (3.2%). This results suggest that only at the age of 15 the specific for both sexes peculiarities in WHR for adults could be traced.

Relationship between WHR type and the type of body nutritional status (Fig. 9 и 10).

It is interesting to follow out the relationship between WHR type in schoolchildren and their type of body nutritional status determined according the recommended by WHO cut off points for BMI in each sexual and age group [1].

The boys having gynoid type are mostly with normal BMI – 87.8% and the rest 12.2% are with overweight. In the mixed WHR type the boys with normal nutritional status are again more frequent (83.4%), with overweight are about 14.1% and with obesity – 2.5%. For the android WHR type the finding changes sharply – with normal nutritional status are only about 50%, with overweight are – 41,7% and with obesity – 8.3%. Thus half of the boys with android type have over normal and pathologically high values of BMI.

In the girls the results are similar to these in the boys. In the gynoid type the majority of girls are with normal BMI (92.5%), with overweight are only 7.5%, which is comparatively less than in boys. In girls with mixed WHR type also prevail those with normal nutritional status (86.7%), as it is in boys; with overweight are about 11.8% and with obesity only – 1.6%. In the android type, however, girls with overweight are most frequent (61.1%), with normal BMI they are only about 27.8% and with obesity – 11.1%. This results show that nearly all the girls with obesity have

an android type as it is in boys, and very few of them have a mixed WHR type, respectively.

CONCLUSION:

- In boys all the investigated body circumferences consequently increase with age throughout the whole 9-15 ages period but in girls – only the abdominal and hip circumferences. The increase of the chest and waist circumferences in girls stops after 13 years of age.
- The significant intersexual differences are mostly well expressed in the chest and waist circumferences between 11-15 years of age with priority for boys, and in the hip circumference at 10, 11 and 13 years of age – with priority for girls.
- The results show that in adolescents, as it is in adults, the WHR give a specific information for intersexual differences in the laying of body fat tissue on waist-abdominal body area.
- In both sexes during the period 9-15 years, the hip circumference increases more intensively than the waist circumference more strongly expressed in girls. This determine significantly higher values of the WHR in boys from all age groups than in girls, and a decrease of WHR mean values with ages for both sexes.
- The comparison of the WHR types and the types of nutritional status shows that the girls with gynoid WHR type have a normal nutritional status and only 7.5 percents are with overweight.
- In contrast to girls, in the gynoid WHR type relatively less are the boys with normal nutritional status and 12.2 percents are with overweight.
- In the android WHR type only half of the boys have a normal nutritional status and the rest are with overweight and obese. In the same WHR type the girls having normal nutritional status are only 27.8 percents, and the rest of them are over normal or with pathologically high values of BMI.

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Table1. Cut of points for the determination of different WHR types.

Age years	BOYS			GIRLS		
	Gynoid type ($<P_5$)	Mixed type ($P_5 - P_{95}$)	Android type ($>P_{95}$)	Gynoid type ($<P_5$)	Mixed type ($P_5 - P_{95}$)	Android type ($>P_{95}$)
9	0.80	0.81-0.91	0.92	0.75	0.76-0.88	0.89
10	0.79	0.80-0.90	0.91	0.74	0.75-0.88	0.89
11	0.78	0.79-0.95	0.96	0.72	0.73-0.87	0.88
12	0.76	0.77-0.89	0.90	0.70	0.71-0.84	0.85
13	0.75	0.76-0.86	0.87	0.67	0.68-0.83	0.84
14	0.74	0.75-0.86	0.87	0.67	0.68-0.79	0.80
15	0.73	0.74-0.83	0.84	0.66	0.67-0.77	0.78

Table 2. Statistical data of the investigated features.

Age	BOYS												GIRLS																						
	Chest circumference			Waist circumference			Abdominal circumference			Hip circumference			Waist/hip ratio (WHR)			Chest circumference			Waist circumference			Abdominal circumference			Hip circumference			Waist/hip ratio (WHR)							
	n	mean	SD	SEM	CV	n	mean	SD	SEM	CV	n	mean	SD	SEM	CV	n	mean	SD	SEM	CV	n	mean	SD	SEM	CV	n	mean	SD	SEM	CV	n	mean	SD	SEM	CV
9	81	65,7	6,1	0,7	9,3	81	60,7	6,2	0,7	10,3	81	64,7	7,8	0,9	12,1	79	71,9	6,9	0,8	9,6	79	0,85	0,03	0,00	3,53	77	73,4	7,8	0,9	10,6	77	0,80	0,04	0,00	5,00
10	79	66,4	5,6	0,6	8,5	79	61,0	6,1	0,7	10,1	79	65,4	7,1	0,8	10,9	79	73,0	6,6	0,7	9,1	79	0,84	0,04	0,00	4,76	79	73,0	6,6	0,7	9,1	79	0,84	0,04	0,00	4,76
11	82	71,4*	8,2	0,9	11,5	82	65,6*	8,2	0,9	12,5	82	70,9*	9,7	1,1	13,6	75	78,5*	8,6	1,0	11,0	75	0,84	0,04	0,01	4,76	79	78,5*	8,6	1,0	11,0	75	0,84	0,04	0,01	4,76
12	83	73,6	7,8	0,9	10,6	83	66,7	8,2	0,9	12,3	83	72,3	9,6	1,1	13,3	83	80,6	8,4	0,9	10,4	83	0,83	0,04	0,01	4,82	83	80,6	8,4	0,9	10,4	83	0,83	0,04	0,01	4,82
13	81	75,8	6,7	0,7	8,9	81	67,6	6,8	0,8	10,0	81	74,0	8,1	0,9	10,9	81	84,3*	8,1	0,9	9,6	81	0,8*	0,04	0,00	5,00	81	84,3*	8,1	0,9	9,6	81	0,8*	0,04	0,00	5,00
14	83	79,5*	6,8	0,8	8,6	83	70,0*	6,9	0,8	9,8	83	76,3	7,9	0,9	10,4	78	87,7*	9,0	1,0	10,2	78	0,80	0,07	0,01	8,75	78	87,7*	9,0	1,0	10,2	78	0,80	0,07	0,01	8,75
15	80	81,9*	7,0	0,8	8,5	80	71,9	7,5	0,8	10,5	80	78,9*	7,9	0,9	10,0	29	90,4	6,6	1,2	7,3	29	0,79	0,03	0,01	3,80	29	90,4	6,6	1,2	7,3	29	0,79	0,03	0,01	3,80

“**”Differences in the age, statistically significant at p<0.05 level.

Table 3. Distribution of the schoolchildren in categories according to the values of WHR.

Age years	BOYS							GIRLS						
	N	Gynoid type		Mixed type		Android type		N	Gynoid type		Mixed type		Android type	
		n	%	n	%	n	%		n	%	n	%	n	%
9	79	7	8,9	69	87,3	3	3,8	77	7	9,1	67	87,0	3	3,9
10	79	9	11,4	66	83,5	4	5,1	79	6	7,6	71	89,9	2	2,5
11	75	5	6,7	66	88,0	4	5,3	80	8	10,0	70	87,5	2	2,5
12	83	6	7,2	73	88,0	4	4,8	83	6	7,2	74	89,2	3	3,6
13	81	7	8,6	71	87,7	3	3,7	81	5	6,2	73	90,1	3	3,7
14	78	5	6,4	70	89,7	3	3,8	77	5	6,5	68	88,3	4	5,2
15	29	2	6,9	24	82,8	3	10,3	31	3	9,7	27	87,1	1	3,2

Fig. 1. Chest circumference.

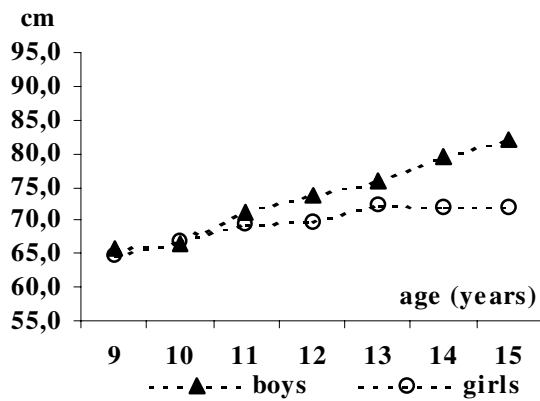


Fig. 2. Abdominal circumference

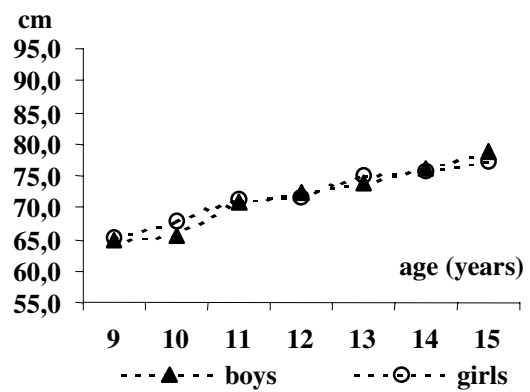


Fig. 3. Waist circumference.

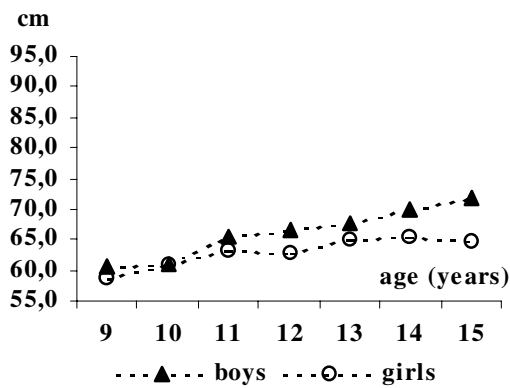


Fig. 4. Hip circumference.

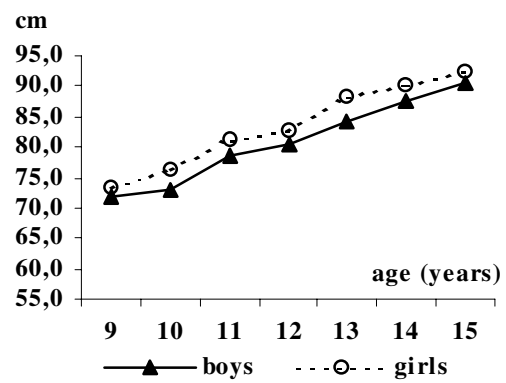


Fig. 5. Waist/Hip ratio (WHR).

