Waist Circumference as an Indicator of Body Nutritional Status in Children Aged 3 to 6 Years

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The aim of present report is to assess the sexual and age-related differences of waist circumference in children from 3 till 6 years and to elaborate percentile curves for this age period. A sample of 640 3- to 6-year-old children (320 boys and 320 girls) living in Sofia City is used. The study is cross-sectional and carried out from June 2004 till May 2005 in 7 kindergartens. Boys have higher values for waist circumference as the sexual differences are significant in all ages excepting the 4th year. The waist circumference increase with age, but in a different manner for boys and girls. The elaborated by us curves represent the first waist circumference percentile values for Bulgarian children aged from 3 till 6 years. They could be used like auxiliary contrivance for the assessment and early identification of children who have underlined centralized distribution of fat.

Key words: waist circumference, children, percentile curves, sexual differences, age differences.

Introduction

The prevalence of obesity among children increases rapidly in the world according to data published by WHO [13]. The childhood obesity is linked with an increased risk of obesity in adulthood, and thenceforward with the connected important public diseases as hypertension, diabetes, early atherosclerosis, etc. [2, 3, 6, 11].

Many epidemiological studies in adults prove the high fat centrality as heightened risk for the individual, i.e. for those individuals with excessive body fat accumulation on abdomen and waist [9].

As basic criteria for the determination of fat distribution types serves the ratios of waist circumference to other body circumferences – abdomen, hip, thigh.

Results published in the 90s show that waist circumference like an independent feature is an objective and useful indicator of fat centrality as in adults, so in children [5, 10].

Waist circumferences cut off points are already available concerning adults from both sexes, and are used for identification of individuals in health risk. In children, how-

ever, such values had to be conformed not only with sex but to age, since during the growing up period waist circumference normally increases annually.

In the worldwide literature are published age- and sex-specific reference values for waist circumference in children having different nationalities (USA, Canada, Australia, Italy, Denmark, Cuba, Spain, Great Britain, etc.), and many authors emphasizing the need of national reference values for waist circumferences to be elaborated [1, 4].

In the Bulgarian scientific literature data from anthropological investigations concerning early childhood (3-6 years of age) could be found very rarely. We have not found yet data about waist circumference in the Bulgarian children, one fact that traced out the aim of the present work.

The aim of present report is to assess the sexual and age-related differences of waist circumference in children from 3 till 6 years of age and to elaborate percentile curves concerning this age period.

Material and Methods

A sample of 640 3- to 6-year-old children (320 boys and 320 girls) living in Sofia City is used. The study is cross-sectional and carried out from June 2004 till May 2005 in 7 kindergartens from several districts of the city.

The waist circumference measurements are taken on the level pointing the maximal hollowness of the lateral body contour, or so called in the international literature "natural waist". The measurements are taken on a naked body using non-elastic tape.

The statistical analysis is made by SPSS software for Windows, using the percentile analysis values for the 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles are computed concerning each sex and age group. The percentile curves are constructed and then smoothed by the Origin 7.0 software. The statistical significance of the established sexual and age differences are assessed by the t-test of Student at $P = 0,05$.

The sexual differences are evaluated in relative index units (IU) by the formula of Wolański for inter-group comparisons, named by us Index of Sexual Differences (ISD):

$$ISD = \frac{2 \times (\bar{x}_{\male} - \bar{x}_{\female}) \times 100}{(\bar{x}_{\male} + \bar{x}_{\female})}.$$

Results

In Table 1 are given the biostatistical characterizations of waist circumference for each sex and age group. The waist circumference means for both sexes are shown in Fig. 1, by which the comparative assessment in inter-sexual and inter-age aspect become possible.

The waist circumference in 3 years old boys is 507,9 mm and is significantly higher compared to the one in girls – 491,4 mm. Waist circumference is always higher in boys till 6 years, as the sexual differences are significant in all ages ($P \le 0,05$) excepting the 4th year. The assessment of sexual differences by the ISD shows that the differences are better underlined at the end of the studied period, i.e. in the 5 and 6 years old children (Fig. 2).

Between 3 and 6 years boys and girls have different increment of the waist circumference (Table 2). In boys the waist circumference increase most rapidly and significantly between 4 and 5 years, while in girls the increment is significant during the periods 3-4 and 5-6 years of age ($P \le 0,05$).

Table 1. Biostatistical data and sexual differences of waist circumference (mm)

Age	♂			♀			Sexual differences	
	n	$\bar{x}$	SD	n	$\bar{x}$	SD	Absolute differences	ISD
3	80	507.9	28.2	80	491.4	29.7	16.5*	3.3
4	80	519.4	41.1	80	510.4	29.3	9.0	1.8
5	80	540.4	54.4	80	515.9	32.1	24.5*	4.6
6	80	556.2	49.7	80	537.5	50.6	18.7*	3.4

* $P \leq 0.05$

Table 2. Year alteration

Age	♂				♀			
	n	AYA (mm)	RYA (%)	t-test AYA	n	AYA (mm)	RYA (%)	t-test AYA
3-4	80	11.5	2.2	2.1*	80	19.0	3.8	4.1**
4-5	80	21.0	4.0	2.8*	80	5.5	1.1	1.1
5-6	80	15.8	2.9	1.9	80	21.6	4.1	3.2*

* $P \leq 0.05$; AYA – Absolute Year Alteration; RYA – Relative Year Alteration
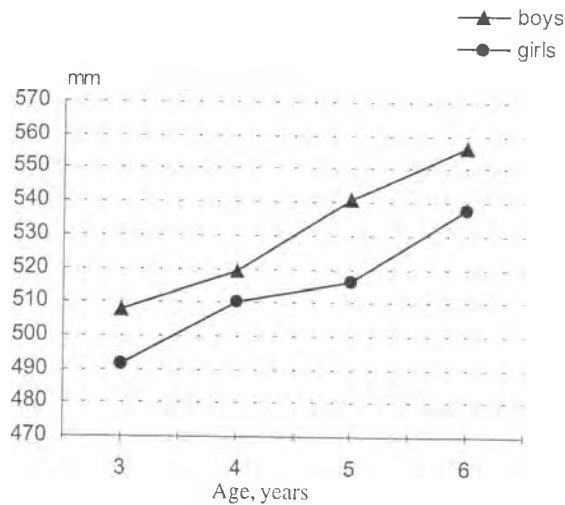

Fig. 1. Waist circumference (mm)

The presence of significant differences in waist circumference means between boys and girls, as well as the sexual differences concerning the intensity of growth during separate one-year periods determine the need of elaboration of cut off points connected with children's gender and age.

At table 3 are presented the values about 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles for waist circumference in children from Sofia - 3-6 years old boys and girls separately, and in Fig. 3 and Fig. 4 are shown the respective suggested percentile curves.

In both sexes the waist circumference percentile values increase with age, the boys having higher values during the entire period under study.
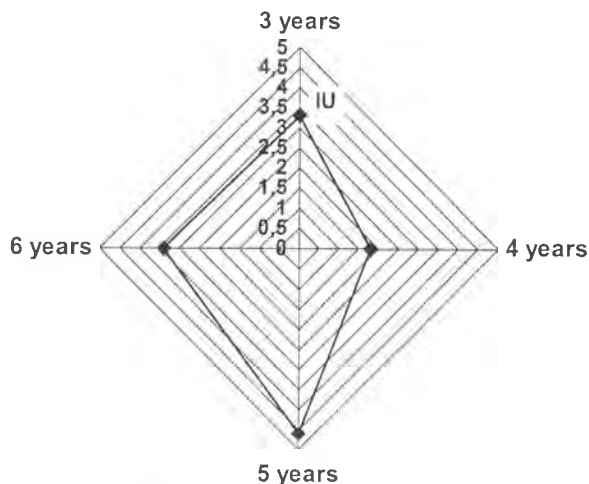
Fig. 2. Sexual differences for waist circumference after ISD data (IU)

T a b l e 3. Percentile values for waist circumference in 3-6 years old children (cm)

Age	♂						
	P₃	P₁₀	P₂₅	P₅₀	P₇₅	P₉₀	P₉₇
3	46.0	47.1	48.8	**50.5**	52.5	54.0	57.8
4	46.0	48.0	49.6	**51.5**	54.0	56.0	60.1
5	49.0	49.5	51.5	**53.0**	55.0	58.0	69.3
6	50.2	50.6	52.6	**54.5**	57.0	61.6	66.7
	♀						
3	43.0	45.1	47.5	**49.0**	51.2	53.4	55.0
4	45.4	47.5	48.6	**51.0**	53.0	55.2	56.5
5	46.4	47.6	49.5	**51.5**	53.0	55.0	61.9
6	47.7	48.5	50.5	**52.5**	56.0	60.1	67.9

Most data about waist circumference in the literature concerning children and adolescents are relevant mainly to children over 5 years. In the foreign literature available we didn't found data about the investigated by us age period (3-6 years old children). Comparison concerning one part of our data with such elaborated by authors from abroad is possible only with the data presented by M c C a r t h y et al. [7] for British children aged from 5,0 till 16. 9 years, as well as by Moreno et al. [8] for 6.0 - 14.9 years old Spanish children (Table 4).

The data show that at 5 years of age British and Bulgarian girls have close means of waist circumference, while the Bulgarian boys have higher waist circumference compared to the British ones. In the 6 years old children, however, the Bulgarian boys and girls have higher values for waist circumference compared to their British coevals.
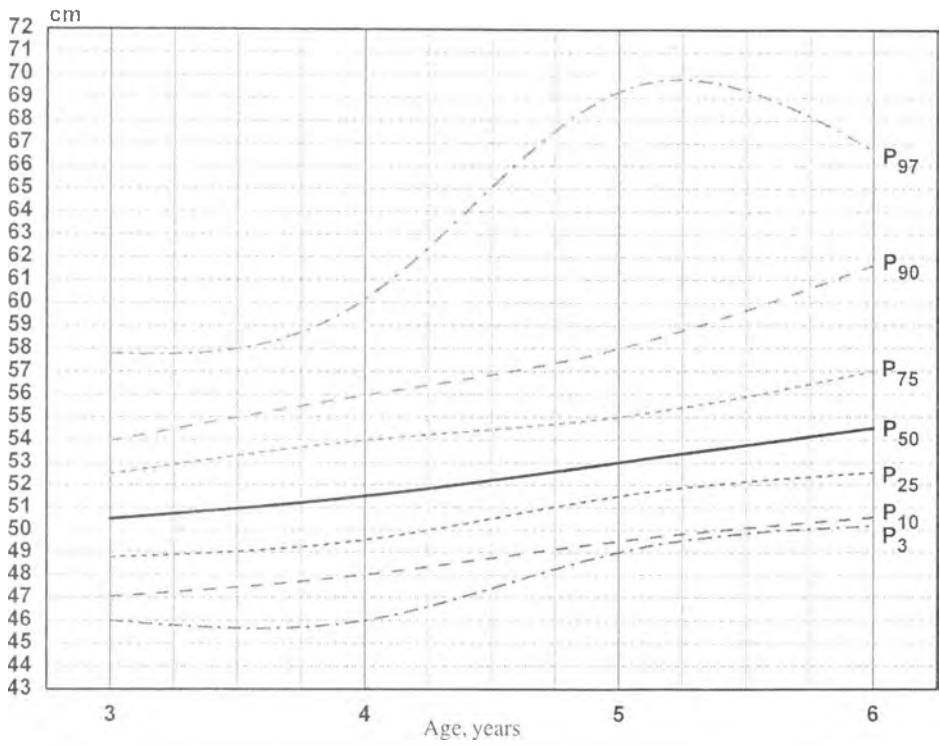
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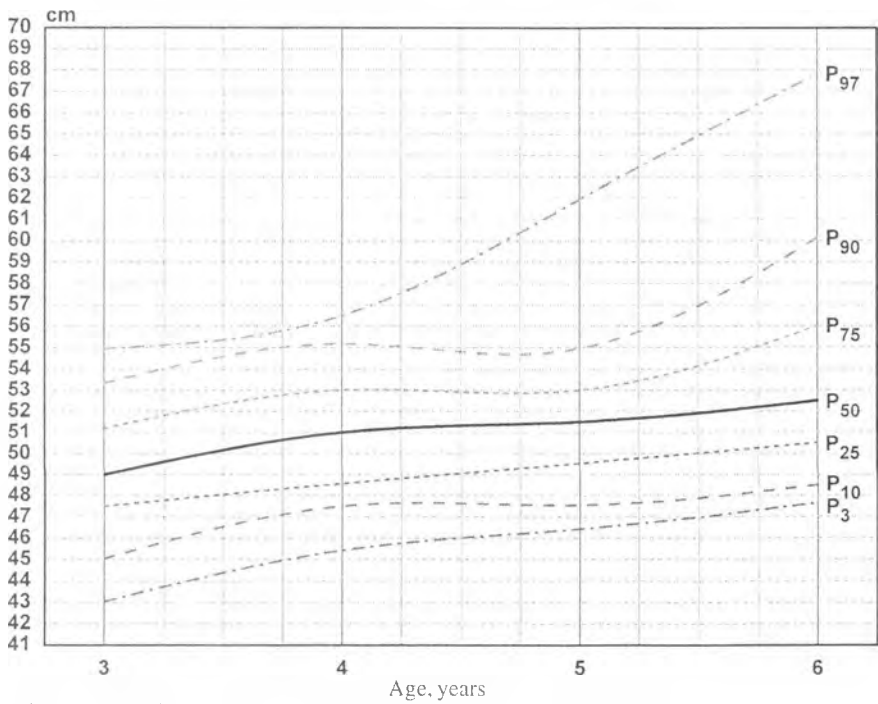Fig. 3. Percentile curves for waist circumference in 3-6 years old boys

Fig. 4. Percentile curves for waist circumference in 3-6 years old girls

T a b l e 4. Comparative data for waist circumference

Country	5 years old children		6 years old children	
	$\overline{X}$ boys (cm)	$\overline{X}$ girls (cm)	$\overline{X}$ boys (cm)	$\overline{X}$ girls (cm)
Bulgaria	54.0	51.6	55.6	53.8
Great Britain	52.3	51.3	52.8	52.2
Spain	–	–	56.0	54.9

Comparing the data about 6 years old Spanish children, the Bulgarian ones have greater waist circumference, and the differences are better underlined in girls.

Conclusion

The elaborated by us curves represent the first waist circumference percentile values for Bulgarian children aged from 3 till 6 years. They could be used like auxiliary contrivance for the assessment and early identification of children who have underlined centralized distribution of fat. And the subsequently require appropriate intervention could help the risk reduction of forthcoming health complications.

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