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Body Fat Distribution in Bulgarian Children and Adolescents Estimated by the Conicity Index

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The aim of our study is to present data for Conicity Index (CI) in newborns, children and adolescents aged 3 to 17 years, and to assess its relation with other anthropometric indexes of body fatness and body fat distribution.

For newborns the values of CI are higher in girls but sexual differences are not statistically significant. However in all investigated age groups from 3 to 17 years boys have higher values of CI, which is indicative of a more central distribution of body fat. Sexual differences in all age groups are well defined and statistically significant ($P<0.05$), marking the sex specificity of the feature. The correlation between CI and both body weight and BMI is slightly expressed. The positive correlation with the indicators of body fat distribution – waist circumference and trunk-to-extremities skinfold ratio shows that CI is a good measure of central fat distribution during the growth period.

Key words: body fat distribution, conicity index, children.

Introduction

Over the last few years, many epidemiological studies show that the risk of developing various metabolic complications (hypertension, hyperlipidemia, coronary heart disease, type 2 diabetes) depends not so much on the amount of body fat, but being mostly associated with the distribution of fats in the body. Individuals with high central fatness – i.e. these in which the accumulation of excess adipose tissue is concentrated in the abdominal area are at an increased health risk [1, 5, 6].

There are many anthropological approaches for determining body fat distribution and one of them determines it through the Conicity Index (CI). CI evaluates waist circumference in relation to body height and weight, quantifying the deviation from the circumference of an imaginary cylindrical shape modelled from the height and weight of the individual [2, 7]. Theoretically its values vary between 1.0 (perfect cylinder) and 1.73 (perfect double cone) and the higher index values are associated with more central fat distribution [8].

It is well established that most disturbances related with high central fatness have their onset during early childhood [3, 4] and in this sense the results of such studies in children and adolescents are extremely important for pediatric practice. Data of body distribution for Bulgarian children are less available in the literature, which led us to the choice of paper's topic.

The aim of our study is to present data for CI in children and adolescents and to assess its relation with other anthropometric indexes of body fatness and body fat distribution.

Material and Methods

Object of the study are 219 newborns (investigated through 2001), 640 preschool children – 3-6 years of age (investigated through 2004-2005) and 2291 children and adolescents between 7 and 17 years of age (investigated through 1993-2002), or totally of 3150 boys and girls relatively evenly distributed into 16 age groups for both sexes separately. The actual number of the groups is shown on Table 1.

Table 1. Investigated contingent

Age	**n ♂**	**n ♀**	**Total ♂ and ♀**
0	110	109	219
3	80	80	160
4	80	80	160
5	80	80	160
6	80	80	160
7	110	110	220
8	100	101	201
9	100	101	201
10	100	98	198
11	99	100	199
12	97	100	197
13	101	99	200
14	99	101	200
15	100	100	200
16	119	120	239
17	118	118	236
Total	**1573**	**1577**	**3150**

Anthropometry

Height is measured to the nearest millimeter with anthropometer and weight is measured with scales to the nearest 0.1 kg. Body mass index (BMI; in kg/m^2) is calculated.

The thickness of 8 skinfolds – 4 on the trunk (subscapular, X-th rib, suprailiac, abdominal skinfols) and 4 on the extremities (triceps, biceps, thigh and calf skinfolds) are measured triplicate on the right side of the body with Holtain skinfold caliper to the nearest 0.2 mm. The trunk-to-extremity skinfold ratio is calculated.

Waist circumference is measured in duplicate with an anthropometric tape at the minimum circumference between the iliac crest and the rib cage.

The conicity index is calculated as follows:

Conicity index = waist circumference / (0.109 × square root of weight/height) where waist circumference and height are measured in meters and weight is measured in kg.

Statistical analyses

Mathematical and statistical data processing are performed with Statistical Package for Social Science – SPSS 13.0, using the following analyses:

Descriptive statistics – mean (x), standard deviation (SD) and the minimum (min) and maximum (max) values are calculated.

One-way ANOVA – to establish statistically significant age differences. The analysis is applied separately for both sexes.

Student's *t*-test – to establish statistically significant sexual differences ($P<0.05$).

Correlation analysis – to determine the linear relationship between the CI and other anthropometric indexes using the Pearson's correlation coefficient ($P<0.05$ and $P<0.01$).

Results

Mean values about CI by sex and age in newborns and in children and adolescents aged 3 to 17 years are presented in Fig.1.

For newborns the values of CI are higher in girls but the sexual differences are not statistically significant. However in all investigated age groups from 3 to 17 years, the boys have significantly higher values of CI than girls, which is indicative of a more central distribution of adiposity. Other words boys establish a preferential accumulation of body fat in and around the abdominal area (Table 2).

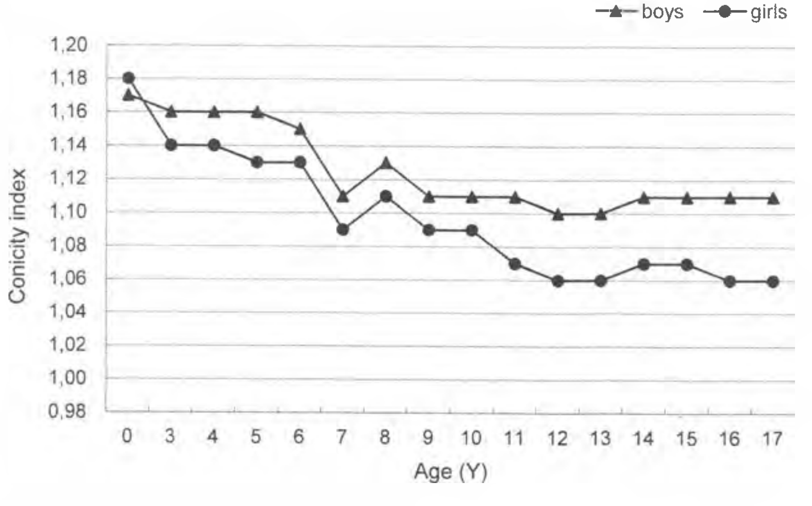

Fig. 1. Mean values of CI in boys and girls

Table 2. Biostatistical data about CI by age and sex

Age (Y)	Boys					Girls				
	n	mean	SD	min	max	n	mean	SD	min	max
0	110	1.17	0.03	1.10	1.25	109	1.18	0.04	1.10	1.29
3	80	1.16	0.03	1.11	1.28	80	1.14	0.04	1.07	1.26
4	80	1.16	0.03	1.07	1.27	80	1.14	0.03	1.07	1.23
5	80	1.16	0.05	1.07	1.39	80	1.13	0.03	1.06	1.28
6	80	1.15	0.04	1.09	1.32	80	1.13	0.04	1.05	1.30
7	110	1.11	0.04	1.03	1.24	110	1.09	0.05	0.96	1.25
8	100	1.13	0.05	0.99	1.28	101	1.11	0.05	1.00	1.25
9	100	1.11	0.05	0.99	1.22	101	1.09	0.05	0.98	1.22
10	100	1.11	0.05	1.02	1.27	98	1.09	0.05	0.94	1.22
11	99	1.11	0.05	0.94	1.24	100	1.07	0.05	0.97	1.22
12	97	1.10	0.04	1.00	1.22	100	1.06	0.04	0.95	1.15
13	101	1.10	0.05	0.92	1.30	99	1.06	0.05	0.96	1.18
14	99	1.11	0.04	0.99	1.22	101	1.07	0.04	0.98	1.20
15	100	1.11	0.05	1.01	1.30	100	1.07	0.04	0.97	1.20
16	119	1.11	0.05	1.00	1.26	120	1.06	0.04	0.96	1.18
17	118	1.11	0.04	1.02	1.21	118	1.06	0.04	0.96	1.18

The differences between boys and girls in the separate age groups are very well defined and statistically significant ($P < 0.05$), marking the sex specificity of the feature. (Fig. 1) Our results illustrate also the dependence of sexual differences on age. They are considerably more pronounced after 10 years of age, an expected result being due to the transformation of childish body type into those of a grown up individual with characteristic differences in male (*android*, or apple-shaped) and female (*gynoid*, or pear-shaped) body type (Fig. 2).

The values of CI decrease with age in both sexes, which is associated with a reduction in trunk fats and waist shaping. The reduction is grater in girls – CI value is 1.18 at birth and reaches 1.06 in the 17 year old girls (0.12 decrement). The index in boys decreases from 1.17 in newborns to 1.10 at the age of 17 (0.07 decrement). This reduction continues till 9 years of age in boys and till 11 years for girls, after which the index remains relatively constant till the end of the studied period (Fig. 1).

Table 3 and Table 4 illustrate the relationship between CI and some generally accepted indicators of body fatness and body fat distribution: body weight, BMI, waist circumference and the trunk-to-extremities skinfold ratio.

The correlation between CI and both body weight and BMI is slightly expressed, in some age groups even a negative correlation is observed. This is probably related to the normal growth of body and waist shaping. Positive significant correlation, higher in boys, is observed at the end of the investigated period – between 15 and 17 years when the body and its parts increase in smaller rate and weight gain is already associated with the massiveness of the body. However, our results show very well expressed relation-

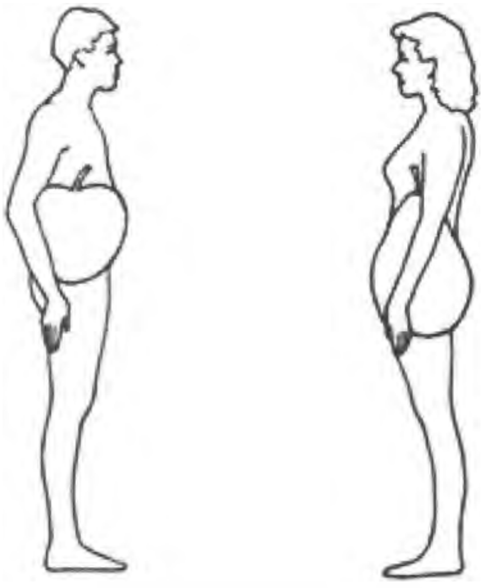

Fig. 2. Android (apple) and gynoid (pear) fat deposition patterns in men and women

Table 3. Corelation between CI and body weight, BMI, waist circumference and trunk-to-extremities skinfold ratio by age groups in boys

Age (Y)	Body weight	BMI	Trunk-to-extremities skinfold ratio	Waist circumference
0	–0.17	–0.23*	–	0.41**
3	–0.11	0.03	0.11	0.42**
4	0.22	0.16	0.18	0.54**
5	0.48**	0.47**	0.54**	0.77**
6	0.28*	0.37**	0.29**	0.62**
7	0.13	0.05	0.26**	0.54**
8	–0.06	–0.03	0.14	0.49**
9	0.00	–0.01	0.39**	0.45**
10	0.20*	0.24*	0.42**	0.55**
11	0.31**	0.42**	0.53**	0.70**
12	0.17	0.21*	0.35**	0.57**
13	0.09	0.21*	0.34**	0.56**
14	0.18	0.28*	0.42**	0.55**
15	0.38**	0.36**	0.22*	0.68**
16	0.35**	0.32**	0.28**	0.66**
17	0.33**	0.39**	0.21*	0.63**

*P <0.05
**P <0.01

T a b l e 4. Corelation between CI and body weight, BMI, waist circumference and trunk-to-extremities skinfold ratio by age groups in girls

Age (Y)	Body weight	BMI	Trunk-to-extremities skinfold ratio	Waist circumference
0	–0.22*	–0.32**	–	0.38**
3	0.15	0.24*	0.47**	0.69**
4	–0.23*	–0.19	0.38**	0.27*
5	0.02	0.17	0.15	0.53**
6	0.34	0.49**	0.56**	0.71**
7	0.21	0.09	0.24*	0.62**
8	–0.04*	–0.02	0.36**	0.52**
9	0.03	0.03	0.27**	0.43**
10	0.21*	0.23*	0.50**	0.59**
11	0.25*	0.29**	0.47**	0.59**
12	0.12	0.19	0.59**	0.50**
13	0.08	0.13	0.32**	0.43**
14	0.03	0.07	0.42**	0.50**
15	0.24*	0.27**	0.38**	0.63**
16	0.27**	0.24**	0.45**	0.61**
17	0.21*	0.21*	0.42**	0.60**

*$P < 0.05$
**$P < 0.01$

ship between CI and the indicators of body fat distribution (waist circumference and trunk-to-extremities skinfold ratio) indicating that CI is a good measure of the central fat distribution in children and adolescents.

Conclusions

1. Our results confirmed the dependence of body fat distribution on sex and age.
2. The preferential accumulation of body fat on the trunk, typical for adult men, begins early in life (established even in 3-year-old boys).
3. The CI adequately reflects the changes in body shape during childhood and adolescence. Its positive correlation with other indicators of body fat distribution, especially with waist circumference shows the ability of this index to assess the central fatness during growth period.

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