

BIOELECTRICAL IMPEDANCE ANALYSIS ASSESSMENT OF BODY COMPOSITION OF CHILDREN AND ADOLESCENTS FROM PLOVDIV (BULGARIA)

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Emilia Andreenko, Mima Nikolova

Faculty of Biology, Paisii Hilendarski University of Plovdiv, Bulgaria
Department of Human Anatomy and Physiology

Summary: The purpose of this study is to analyze the age and gender variability of body composition in children and adolescents by using bioelectrical impedance-metric method. We transversally examined 738 boys and 753 girls, aged 10-17 years, from different schools in Plovdiv (Bulgaria) in 2008. Using the apparatus ABC-01 Medas, we measured the features of body composition of each child. The data were statistically processed. The results show an increase in the absolute amounts of adipose and fat-free tissue in both sexes with age advancing. After the age of 11, fat mass was significantly more in body composition of girls, while the fat-free one - in body composition of boys. In the period from 10 to 14 years, the differences between the sexes in the active cell mass are insignificant, and then the values of this feature begin to rise in boys. At the age 12-13 there were significant intersexual differences in respect with the active resistance and phase angle. In both sexes, reactance varies in weak borders and irregularly.

Key words: body composition, bio-impedance, children, adolescents.

Introduction

One of the most debated issues in the scientific literature is the search for an adequate solution to the problems associated with accurate assessment of body composition and of the human body nutritional status. Fractioning of the body in adipose and fat-free component allows to analyze the trends in body development, and also to assess the nutritional status and risk of obesity.

The quantitative ratio between the components of body mass, nutritional status and obesity in particular are issues that are important both for medicine and for the general biological characteristic of individuals. In connection with the need to monitor indicators of physical development of a growing organism, a question of special interest is the control of the dynamics of body composition in children and adolescents. For this purpose in most cases using the popular method for anthropometric assessment. Today the most modern, objective and accurate way to estimate the composition of a body and the basic exchange is the bio-impedance-metric analysis. From anthropological point of view it is a very accessible, easily applicable and non-invasive

method for estimating body composition. Its essence consists in determining the electrical resistance of the tissues in the body.

Bioelectrical impedance analysis is very modern and suitable method for mass population studies.

Purpose and objectives: The purpose of this study is to analyze the age and gender variability of body composition in children and adolescents, using the bio-impedance-metric analysis method.

Material and methods

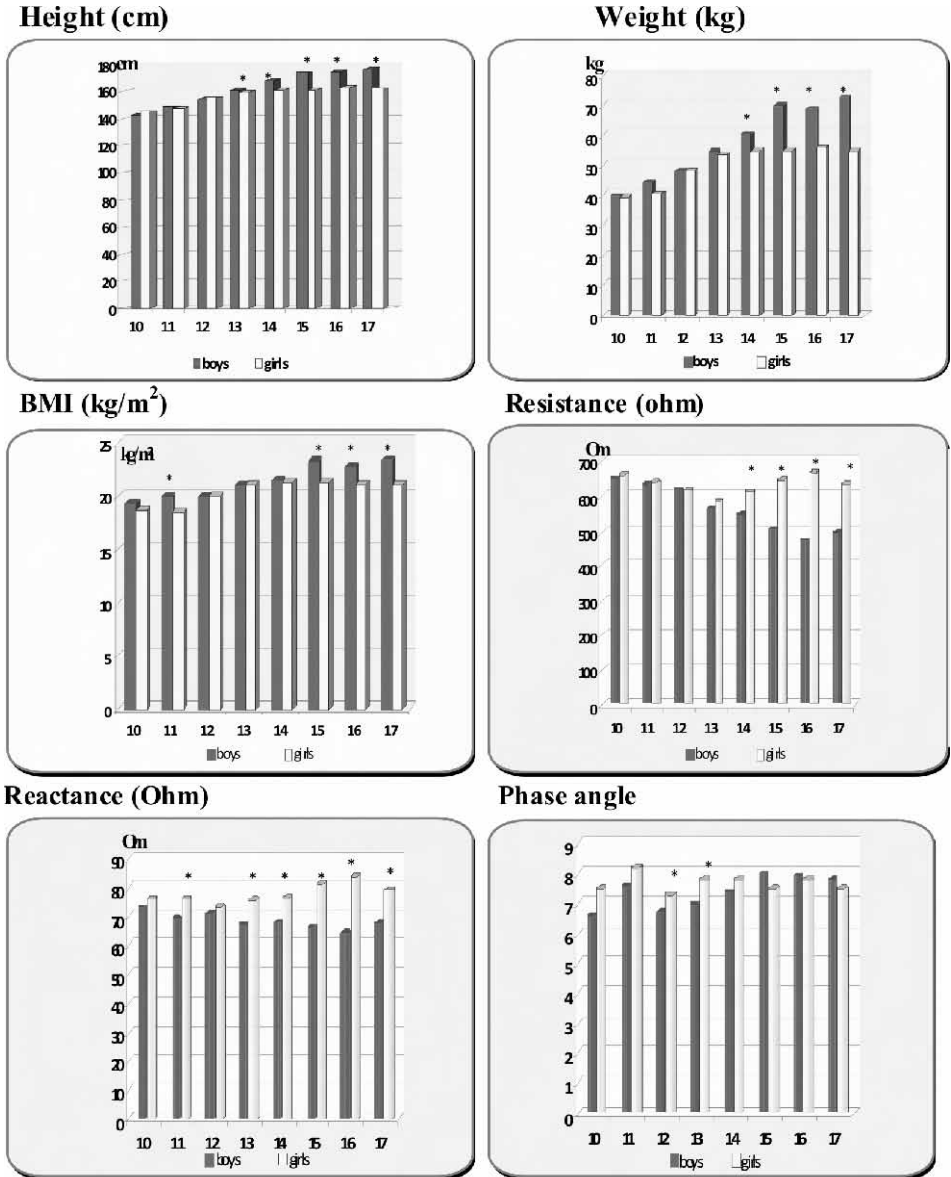
We transversally studied 738 girls and 753 boys, aged 10-17 years, from different schools in Plovdiv (Bulgaria), in 2008. We measured anthropometrically their heights and weights, on which to calculate the value of body mass index (BMI). Bio-impedance analysis was performed with apparatus ABC - 01 Medas (Nikolaev 2001), which operates at point frequency of 50 kHz. Individually we identified the levels of active resistance (R), reactance (Xc) and the phase angle on which we estimated the absolute and relative values of body components - fat mass, fat-free mass and active cell mass. The active resistance is positively connected with adipose tissue and negatively with fat-free tissue in the body. Reactance is positively connected with active cell mass (ACM) in the fat-free tissue (Nikolaev et al., 2004). The phase angle reflects the balance of intracellular and extracellular fluid. The obtained data were statistically processed.

Results and discussion

Table 1. Basic anthropometric and electrometric indicators of the surveyed children and adolescents according to age.

Age years	n	Height (cm)	Weight (kg)	BMI kg/m ²	Resistance Ohm	Reactance Ohm	Phase angle
Boys							
10	79	143,0 ± 6,4	39,9 ± 10,0	19,3 ± 3,7	655 ± 88	73,0 ± 10,6	6,6 ± 1,5
11	115	148,6 ± 8,1	44,5 ± 13,3	19,9 ± 4,6	636 ± 88	68,9 ± 9,4	7,6 ± 0,1
12	93	154,3 ± 8,0	48,2 ± 11,9	20,0 ± 3,7	618 ± 89	71,1 ± 10,9	6,7 ± 1,0
13	103	160,7 ± 8,2	54,6 ± 11,0	21,0 ± 3,9	564 ± 86	67,2 ± 9,5	7,0 ± 1,2
14	112	167,6 ± 8,3	60,5 ± 15,5	21,4 ± 4,3	548 ± 68	67,9 ± 8,9	7,4 ± 2,4
15	90	173,4 ± 6,5	70,3 ± 5,1	23,3 ± 4,5	506 ± 62	66,3 ± 9,4	8,0 ± 2,5
16	74	174,4 ± 7,7	69,2 ± 11,2	22,8 ± 3,5	473 ± 65	64,3 ± 8,6	7,9 ± 1,5
17	72	176,4 ± 7,1	72,8 ± 12,8	23,4 ± 3,9	496 ± 59	67,5 ± 9,2	7,8 ± 0,7
Girls							
10	87	144,2 ± 7,5	39,2 ± 9,3	18,7 ± 3,6	663 ± 131	76,0 ± 12,4	7,5 ± 2,5
11	81	147,4 ± 8,6	40,4 ± 9,6	18,4 ± 3,3	640 ± 116	76,0 ± 12,8	8,6 ± 6,3
12	110	154,5 ± 7,8	48,3 ± 12,2	20,0 ± 3,9	617 ± 109	73,1 ± 12,2	7,3 ± 2,3
13	113	159,2 ± 5,6	53,8 ± 12,2	21,1 ± 4,3	587 ± 116	75,4 ± 12,2	7,8 ± 2,0
14	105	160,3 ± 5,4	54,6 ± 10,1	21,2 ± 3,7	612 ± 109	76,5 ± 13,9	7,8 ± 2,6
15	104	161,0 ± 5,8	55,1 ± 8,0	21,2 ± 3,0	648 ± 64	81,0 ± 14,9	7,5 ± 2,0
16	80	162,8 ± 5,9	55,7 ± 9,8	21,0 ± 3,2	669 ± 78	83,7 ± 15,0	7,8 ± 2,3
17	73	161,1 ± 6,4	54,9 ± 9,3	21,1 ± 3,3	635 ± 111	79,1 ± 13,8	7,5 ± 1,5

The average values of basic anthropometric and electrometric indicators of the surveyed children and adolescents, of both sexes, in different age periods, are presented in Table 1 and illustrated in Figure 1.



* - Presence of statistical significance p < 0.05

Figure 1. Dependence of the basic anthropometric and electrometric indicators on age

The results show sustained growth in height and weight in both sexes from the beginning to end of the study. After 11 years of age, in boys the two features rise more rapidly, and at the 13th year they are already ahead of girls in body height, and at the 14th year – in weight.

Along with the increase in height and weight with age advancing, the values of BMI in both sexes increase, but by the end of the period the values remain within the standard (BMI <25.0). Boys have significantly higher BMI values than those of girls at the age of 11, as well as between 15-17 years of age.

The data obtained for active resistance show that in girls the average values of this feature change and tend to decrease between 11-13 years and there is a further increase in the period 14-17 years. In boys it can be seen a continued downward trend in average values of active resistance with age advancing, and this reduction is the most clear after 13 years of age. After this age and by the end of the study, the values in boys are statistically lower than those of girls.

The average values of reactance in both sexes change in low levels and irregularly. In all age groups, however, girls' values are higher than those of boys.

There was a similar trend with age advancing for the change of phase angle. The most distinct intersexual differences were observed between 12-13 years, where the average values of girls are significantly higher than those of boys.

Along with increasing body mass, an increase occurs in the absolute amounts of fat mass, fat-free mass and active cell mass - Table 2 and Figure 2.

Table 2. Body composition of the surveyed children and adolescents according to age by the data of bio-impedance analysis

Age (years)	n	Fat Mass (kg)	Fat-free Mass (kg)	Active Cell Mass (kg)
Boys				
10	79	9,1 ± 5,1	30,7 ± 6,0	17,4 ± 4,5
11	115	10,5 ± 7,5	34,0 ± 7,4	19,5 ± 5,8
12	93	10,4 ± 5,3	38,0 ± 8,9	21,6 ± 6,0
13	103	10,7 ± 7,1	43,9 ± 9,2	25,6 ± 6,5
14	112	12,1 ± 8,7	48,6 ± 8,9	29,0 ± 7,2
15	90	14,5 ± 9,0	55,6 ± 8,8	34,2 ± 6,8
16	74	11,6 ± 6,5	57,6 ± 8,0	35,7 ± 6,8
17	72	14,1 ± 7,7	58,8 ± 7,0	36,1 ± 4,6
Girls				
10	87	8,8 ± 4,7	30,1 ± 5,7	17,9 ± 4,9
11	81	8,7 ± 4,1	31,5 ± 6,6	19,1 ± 4,8
12	110	11,6 ± 6,3	36,8 ± 7,3	21,7 ± 6,0
13	113	13,1 ± 6,8	40,5 ± 7,6	24,8 ± 6,1
14	105	14,3 ± 5,9	40,5 ± 6,1	24,6 ± 4,7
15	104	15,5 ± 4,7	39,9 ± 5,2	23,8 ± 4,3
16	80	15,6 ± 5,2	40,1 ± 6,4	24,3 ± 5,5
17	73	14,4 ± 5,5	40,8 ± 6,8	24,5 ± 5,5

The results of intersexual comparisons show that 10 to 12 years old boys have significantly higher absolute amount of fat than 11-year-old girls only. After this age, fat mass in girls increases more rapidly and by the end of the study they are characterized with a bigger total fat amount than boys.

By the age of 13 the values of fat-free mass and active cell mass do not differ statistically significantly in both sexes, and the values increase gradually. After 13 years of age the values for girls stay at one level, but in boys they increase significantly and by the end of the study they remain permanently higher than those of girls.

The data from this study, derived on the basis of bio-impedance method for the two body components - fat mass and fat-free mass, are similar to the results for other populations of children and adolescents in Bulgaria, on the basis of anthropometric method (Mladenova S. 2003, S. Tineshev 2009, Z. Mitova 2009). This is an indirect evidence for the reliability of assessment of body composition in children, basing on the data of bio-impedance method.

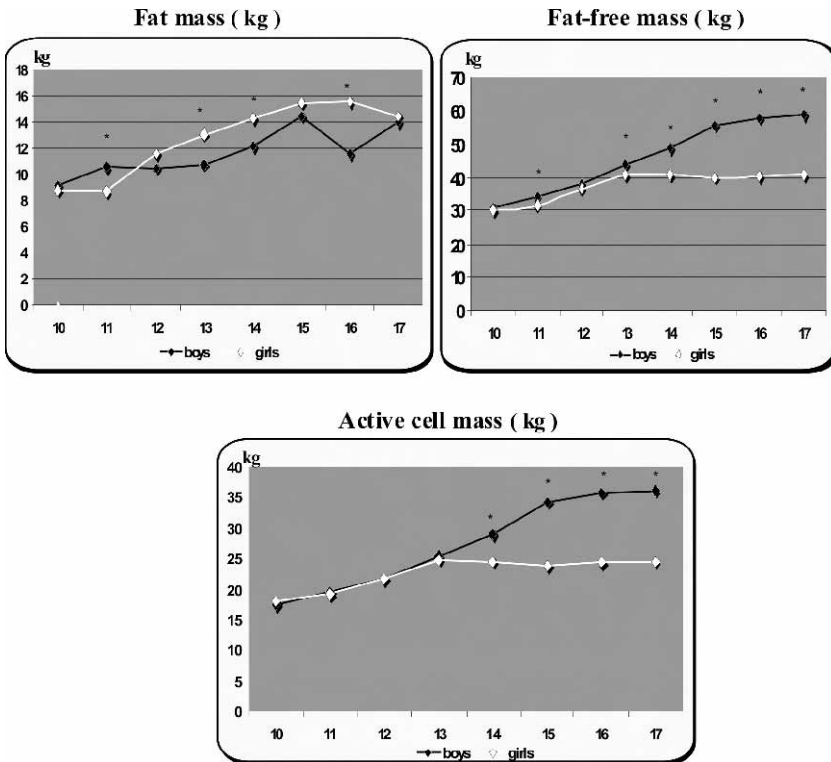


Figure 2. Dependence of the basic components of body composition on age

Conclusions

1. With the data from bio-impedance analysis we estimated the body composition of children and adolescents from Plovdiv (Bulgaria), aged 10-17 years.

2. The absolute amounts of adipose and fat-free tissue in both sexes increase with age. After 13 years of age fat mass is significantly more in girls' body composition, while fat-free mass – in body composition of boys.

3. Between 10-13 years of age, the differences between genders in the active cell mass are insignificant. After this age the values in boys increase significantly, which is determined by the stronger development of fat-free tissues in their body.

4. Between 14-17 years, in boys there is a sustained downtrend in the values of active resistance, while in girls – an increase, due to the positive relation of active resistance to the adipose tissue.

5. In both sexes reactance and phase angle change in low levels and irregular.

6. The data obtained from applications bio-impedance method for evaluating changes in body composition of children and adolescents reflect a general trend of age increasing the role of the skeleton and the muscularity in boys, typical of male-type physique, and increasing the role of fat component in girls, typical of somatic features in women.

Acknowledgements

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ANALIZA TELESNE KOMPOZICIJE KOD DECE I ADOLESCENATA IZ PLOVDIVA (BUGARSKA) METODOM BIOELEKTRIČNE IMPEDANCE

Izvod

Cilj ovog rada je bio da se metodom bioelektrične impedance analizira uzrasna i polna varijabilnost telesne kompozicije dece i adolescenata. Transverzalnim istraživanjem koje je sprovedeno 2008. godine u Plovdivu (Bugarska), ispitano je 738 dečaka i 753 devojčica, uzrasta od 10-17 godina. Upotrebom aparata ABC-01 Medas, merena je telesna kompozicija kod svakog deteta. Podaci su statistički obrađeni. Rezultati su ukazali da sa starenjem dolazi do povećanja adipoznog i bezmasnog tkiva kod oba pola. Posle 11. godine masna masa je značajno više zastupljena u telesnoj

kompoziciji kod devojčica, dok je bezmasna komponenta više zastupljena kod dečaka. U periodu između 10 i 14 godina, razlike između polova u aktivnoj ćelijskoj masi nisu značajne, a nakon toga vrednosti ove karakteristike počinju da se povećavaju kod dečaka. U uzrastu od 12 do 13 godina postoje značajne polne razlike u pogledu aktivnog otpora i faznog ugla.

Ključne reči: telesna kompozicija, bio-impedanca, deca, adolescent