Institute of Experimental Morphology and Anthropology with Museum
Bulgarian Anatomical Society

Acta morphologica et anthropologica, 15
Sofia • 2010

Body Composition in Children and Its Relationship with Sexual Maturation Level

I. Khomyakova, E. Godina, L. Zadorozhnaya, A. Tretyak, E. Dorogova

Institute and Museum of Anthropology, Moscow State University, Russia

278 girls and 349 boys from 8 to 17 years old were investigated in 2004-2006 in different Moscow schools. The method of canonical correlations was used to determine interactions between indices of maturation, on the one hand, and two groups of characteristics, on the other: estimations of body mass components values received with the use of equations on the basis of skinfolds measurements and bioimpedance characteristics. To estimate the role of each body mass component the regression analysis was used. Age dynamics of body fat mass in boys and girls were studied. It has been shown that for calculations of body mass components in children and teenagers equations of Matiegka (FM-M, FFM-M) and Slaughter (FM-S, FFM-S) are equally applicable. The interrelation of the level of sexual maturation and fat-free mass both in boys, and in girls is revealed. Significant sexual dimorphism was detected at interrelation level. High level of inverse relationship between the rates of sexual maturation and components of impedance analysis was found in boys.

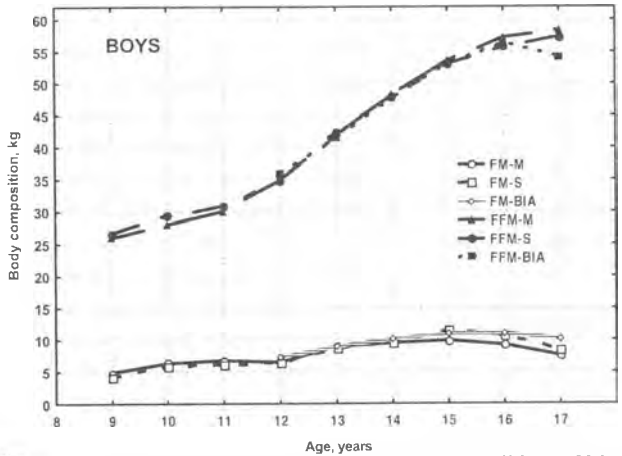
Key words: body composition, sexual maturation level, bioelectrical impedance analysis.

The interrelation of morphological characteristics and body mass components with puberty level in children and teenagers is discussed in many works. Various conclusions have been made [6] on the role of body mass components in morphophysiologycal reorganization of the organism during the pubertal period, and also about their direct influence on the starting rates of sexual maturation.

The purpose of the present paper is to study the relationship between body composition and sexual maturation level. The data were collected by the authors in 2004-2006 in different Moscow schools. 278 girls and 349 boys from 8 to 17 years old were investigated cross-sectionally. All children were measured by a standard anthropometrical technique [4]. For bioelectric impedance analysis a single-frequency system "ABC-01 Medass" [3] was used. It operates at a frequency of 50 kHz and a current strength of 800 μA. The estimation of body mass components was also conducted with the equations of Matiegka [1] and Slaughter et al. [2].

Age dynamics of body mass components in boys and girls are presented in Fig.1.

Evaluation of sexual maturation indices was conducted according to Soloviева [7]. Principal component analysis was applied to an estimation of the degree of sexual maturation in children and adolescents, secondary sexual characteristics presented in the form of general integrative indicator [5]. As a result, the 1st principal component is interpreted as an integrative indicator of sexual maturity.



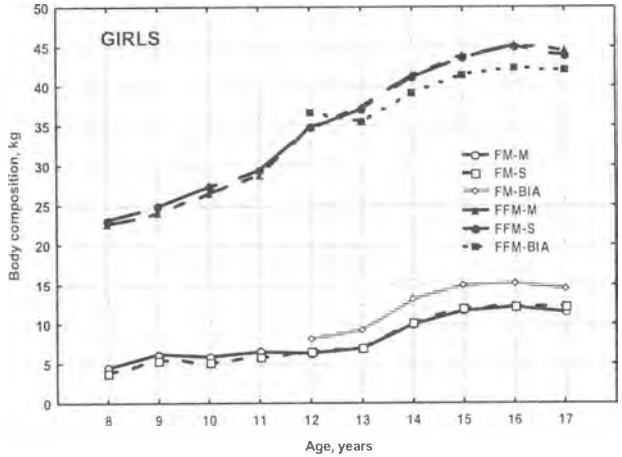
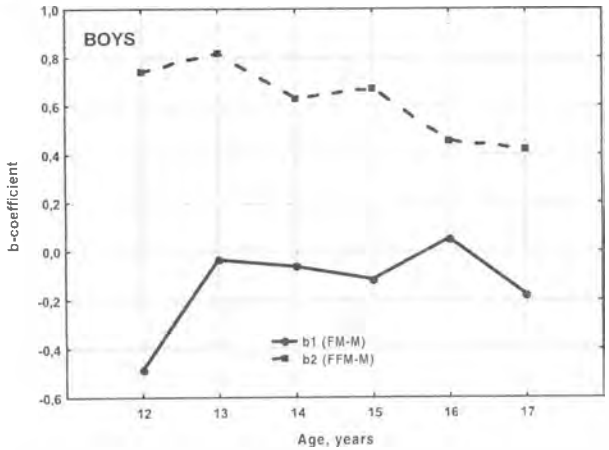


Fig. 1. Age changes of fat mass and fat-free mass in children of Moscow



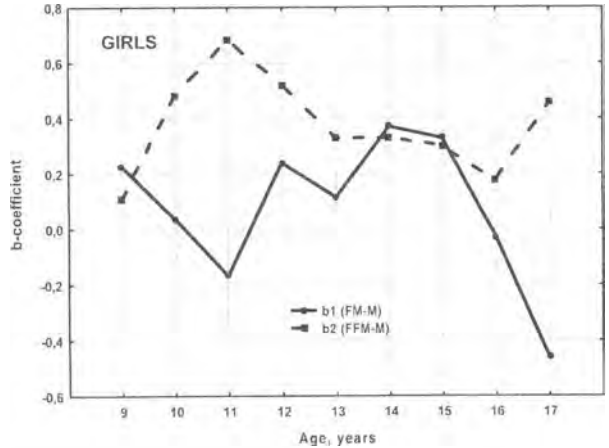


Fig. 2. Age changes of regression equation's b-coefficient: dependence of the sexual maturation level from the fat mass and fat-free mass

To reveal the presence of interrelation between the degree of sexual maturity and body mass components, and also some indicators of bioelectric resistance of the body, the method of canonical correlations was used. To estimate the role of each body mass component in the course of puberty regression analysis was used. Statistical analysis was performed with STATISTICA 6.0 software.

One of the aims of the present work was to define the degree of interdependence between characteristics of sexual maturity with two sets of traits: values of body mass components, received by different methods, and the electric resistance (impedance) characteristics, including active resistance (Rz) and reactance (Zc). The values of canonical correlations in boys and girls are shown in table 1. It has been shown that between the above-mentioned groups of characteristics there is a significant connection.

Table 1. Estimates of canonical correlations between factors of sexual maturation indices and the BIA characteristics, body composition

Age	Factors of sexual maturation indices (PC1, PC2)	Rz, Zc, Phase angle φ			FM-M, FM-S, FFM-M		
		R	*p*	*Chi²*	*R*	*p*	*Chi²*
Boys							
12	PC1, PC2	0.93	**0.024**	14.538	0.72	0.164	9.1747
13	PC1, PC2	0.72	**0.000**	28.34	0.85	**0.000**	68.815
14	PC1, PC2	0.55	**0.001**	23.237	0.62	**0.000**	38.412
15	PC1, PC2	0.49	**0.013**	16.116	0.65	**0.000**	28.475
16	PC1, PC2	0.32	0.250	7.839	0.51	**0.017**	15.395
17	PC1, PC2	0.53	0.568	4.815	0.48	0.107	10.443
All ages	PC1, PC2	0.46	**0.000**	59.323	0.28	**0.000**	30.009
Girls							
9	PC1, PC2				0.53	**0.045**	12.886
10	PC1, PC2				0.58	**0.013**	16.066
11	PC1, PC2				0.70	**0.003**	19.988
12	PC1, PC2	0.82	**0.014**	15.921	0.73	**0.006**	18.277
13	PC1, PC2	0.54	0.393	6.278	0.54	0.292	7.325
14	PC1, PC2	0.74	0.116	10.209	0.73	**0.0001**	29.602
15	PC1, PC2	0.41	0.798	3.084	0.65	**0.002**	20.505
16	PC1, PC2	0.49	0.087	11.047	0.36	**0.524**	5.153
17	PC1, PC2	0.53	0.434	5.901	0.63	**0.049**	12.643
All ages	PC1, PC2	0.10	0.968	1.348	0.30	**0.000**	35.285

To find out the character of existing connection between the level of sexual maturity and body mass components, regression analysis was performed. The following regression models were considered:

1. The 1st principal component was taken as a dependent variable (PC1), the independent variables being values of fat and fat-free mass (FM-M and FFM-M). Association between the general level of sexual maturity and body mass components was checked.

2. The fat-free mass was taken as a dependent variable, the independent variable being the 1st principal component. Association between fat-free mass component and level of sexual maturity was checked.

3. The fat mass was taken as a dependent variable, the independent variable being the 1st principal component. Association between fat mass component and level of a sexual maturity was checked.

The results are as follows:

In boys **the level of sexual maturity** have a high degree of dependency on fat-free body mass from 12 to 17 years, and low – on indicators of fat mass at all ages. Before the age of 12 years such a dependency is absent, which probably indicates that in the majority of boys at this age period secondary sexual characteristics only start to appear. The dependency of the level of sexual maturity on indicators of fat-free body mass increases during the period from 12 to 14 years, and, further, gradually decreases (Fig. 2). This may be due to the fact that during the specified period of 12-14 years the peak of longitudinal growth and the increase in fat-free body mass are observed.

An increase in fat component in the course of puberty in boys, compared to fat-free body mass is not so evident at all ages. This can explain the absence of high connection between maturation and fat component in boys. **Fat-free body mass** has high degree of dependency on the level of sexual maturity at the age from 12 to 17, which is possible to explain by greater accumulation of fat-free mass in boys during this age period. **Body fat mass** is significantly dependent on the level of sexual maturity at the age of 13 and 16 years, but estimations of R^2 in the regression equation are 18 and 11 % correspondingly, which indicates that the degree of this dependency is rather low.

In girls the **level of sexual maturity** has high degree of dependency on fat-free body mass in 10, 11 and 12 years, and low degree of dependency on indicators of fat mass at all ages (Fig. 2). In this case high correlation with fat-free body mass is caused by the factor that before 12 years intensive longitudinal growth and a gain of fat-free body mass is observed in girls. The values are high because in girls puberty characteristics are already expressed starting from 10 years. **Fat-free body mass** in girls has high degree of dependency on the level of sexual maturation from 10 to 12 years, and also at 14 and 15 years. **Fat body mass** in girls has high degree of dependency on the level of sexual maturation at 12, 14 and 15 years because after the achievement of puberty (approximately 12 years) in girls' organism active fat deposits start to occur.

On the basis of these results it is possible to conclude of the existence of sexual dimorphism in the level of relationships between indicators of sexual maturation and body mass composition in boys and girls. In boys no connections is revealed between sexual development and indicators of fat mass, whereas in girls the interrelation of increase in fat component and sexual maturity is traced. Differences between sexes are revealed also with the regression models. They show the connection between values of bioelectric impedance and the level of sexual maturity. In boys Rz has high degree of negative relationship with the degree of sexual maturity at 13-15 years, in girls this dependency is low at all ages.

Conclusions

1. Age changes of the fat mass in boys and girls have different trends, which could be explained in terms of different roles of fat mass in the origin of male and female body build.

2. Differences between Matiegka's and Slaughter's methods are not significant. Thus we can use both equations for the estimation of body composition.

3. Sexual maturation level is significantly correlated with body mass components in children of both sexes at all ages. The regression analysis shows correlations between sexual maturation level and fat-free mass in boys and girls.

4. Sexual dimorphism in the level of correlation between sexual maturity and body mass components can be seen. In boys there are no correlations between sexual maturation level and fat mass. But in girls these correlations exist: fat component increases with sexual maturation.

5. The analysis of correlation between bioimpedance characteristics (Rz and Zc) with sexual maturation level shows high negative correlations in boys and smaller ones in girls.

Acknowledgements. This work was supported by the Russian Foundation of Basic Research, grants No 07-06-00410-a.

References

1. Matiegka, J. The testing of physical efficiency. – Am. J. Phys. Anthrop., 1921, 223-230.
2. Slaughter, M. H., T.G. Lohman, R.A. Boileau, et al. Skinfold equations for estimation of body fatness in children and youth. – Hum. Biol. – S. l., **60**, 1988, 709-723.
3. АВС-01 «Медасс»: руководство пользователя. Москва, 2006.
4. Бунак, В. В. Антропометрия. Москва, Учпедгиз, 1941.
5. Дерябин, В. Е. Биометрическая обработка антропологических данных с применением компьютерных программ. Москва, 2004.
6. Пуруиджан, А. Л., Е. З., Година, И. А. Хомякова и др. Возрастные изменения состава тела у московских детей и подростков. – В: Сборник трудов учёных РГУФК. М., 2006, 8-15.
7. Соловьёва, В. С. Морфологические особенности подростков в период полового созревания (в этно-территориальном разрезе) (диссертация кандидата биологических наук). Москва, 1966. 176 с.