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INFLUENCE OF NUTRITION ON GROWTH PROCESSES IN RUSSIANS AND TATARS ADOLESCENT BOYS

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Introduction

Growth is a complex process. There are different factors affecting growth and development during all life cycle. All these factors could be united in two main groups: hereditary and environmental factors. Nutrition is one of environmental factors. Together with other environmental factors, such as climate, altitude, migration and urbanization, nutrition influences on retardation or acceleration of hereditary potentials of individuals (Mlyńska, 2002).

Growth and nutrition are closely correlated. The process of the multiplication of cells and their enlargement in size requires an adequate supply of energy, amino acids, water, lipids, vitamins and minerals. With food people receive about 50 essential nutrients for growth. To define the types and amounts of nutrients essential for human growth nutritionists cannot use direct experiment because of ethical reasons. Scientists have to use indirect ways of investigation instead, such as experimentation with non-human animals. Humans also are studied. Naturally occurring human malnutrition and the response to nutrient supplementation of people suffering from malnutrition are analysed (Bogin, 1999).

Accordance of the total quantity of food consumed is a major determinant of growth. In populations where food shortages are present, growth delays occur, and children are shorter and lighter than in populations with adequate or abundant supplies of food. The famines of the World Wars are good models for studying retardation of growth in children and adolescents. During the World War II and some years after the mean stature of children decreased. More affected were children between the age of birth and 12 years. The post-war recovery in height and weight occurred after the improvement in diet (Markowitz, 1955; Murata, Hibi, 1992).

Agricultural populations experience periodic food shortages due to variation in rainfall, temperature, crop diseases and inadequate food storage. Longitudinal measurements of height and weight in two Gambian villages were performed (Billewicz and McGregor, 1982). There were a dry season and a rainy season. Food supplies were lowest during the rainy season. Children grew faster in height and weight during the dry season. Retardation in growth during the rainy season was not overcome during dry season. The Gambian children had a longer total growth period, but as a result of undernutrition their final height and weight were less in comparison with better nourished populations.

The cultural behaviour related to infant and child feeding may determine differences between populations in nutritional status and growth. An example is the change in dietary practices in post-war Japan (Murata, Hibi, 1992). Contact with Western cultures and economic development result in alteration of the traditional diet. Rice consumption decreased. At the other hand the consumption of meat and milk rose. Dietary changes with other factors (lower rates of childhood diseases, reduced family size) contributed to the average height increase.

Shortage of some necessary for growth nutrients can be filled by means of food supplement. The appearance of animal food, vegetable/fruit and milk in complementary feeding improve the child growth in the past decade in China (Chang S. at al., 2007). Milk consumption is associated with increased growth in height. It contains several essential nutrients, protein and calcium. The deficiency of any essential nutrient will result in growth retardation. Inadequate amounts of food or too low caloric food is the primary cause for growth failure, especially when the growth velocity is high. On the other hand, when the total amount of the diet is in excess of their needs, overnutrition can result in body fat storage.

At different stages of human development environmental factors in a different degree influence growth. First of all, the nutrition status of mother influences growth of the fetus. In early intra-uterine life, undernutrition tends to produce small but normally proportioned baby, whereas at later stages of development it leads to selective organ damage. Malnutrition in pregnancy leads to low birth weight infants who are at risk of neonatal mortality (Scott and Duncan, 2002).

The mother's milk is the source of infant nutrition, but breast feeding in some cases appears insufficient. Milk powder formulas, because of high proteins and calcium, induce a faster growth compared to breast – fed infants (Susanne at al., 2000).

Anthropometry is a common method of nutritional assessment. For monitoring different tissues and systems different measurements are used (body height and weight, diameters, circumferences and skinfolds). Soft tissues and fat more rapidly react to food changes. In field researches anthropometry could be useful to diagnostics malnutrition or obesity. A traditional method for the assessment of fat component is the use of empiric formulas based on skinfolds and body measurements. Estimated fat mass is greater in females than in males from late childhood through adolescence into young adulthood. Fat mass increases gradually through adolescence in females. In males it seems to reach a plateau near the time of adolescent growth spurt. Then, in contrast with fat mass, fat percentage of body mass gradually declines until 16-17 years then again to increase (Malina, 2007). Bioelectric impedance (BIA) analysis is one of the new methods for estimating body composition and is one of the most widely used techniques in the study of body composition (Baumgartner, 1996).

Materials and Methods

The data for the present study were collected in 2006 in schools of Naberezhnye Chelny (Tatarstan) and Moscow. Two groups of adolescent boys from 13 to 15 years old of Russian and Tatar ethnicity (about 60 each) has been observed

The investigation included anthropometric program and BIA analysis. Anthropometric program was taken according to the standard techniques (Bounak, 1941). For BIA analysis a system “ABC-1 Medass” was used (Nikolaev et al., 2004). It is a single-frequency tetrapolar system. It operates at a frequency of 50 kHz and a current strength of 800 μA and uses four electrodes attached to the right wrist and ankle. The body components (fat mass – FM, lean body mass – LBM) were estimated by original software. The percentages of FM and LBM in body mass were calculated (%FM and %LBM).

Energy expenditure and food intake data have been received by means of a questionnaire. The questionnaire contained questions on a diet and physical activity. A residual (difference between food intake and energy expenditure) was calculated.

Correlations between values were calculated. T-tests were used to compare the significance of differences between values obtained. Statistical analysis was performed with STATISTICA 6.0.

Results and Discussion

The main aim of the present study was to compare the somatic status of two different groups of adolescents. Main parameters for the groups studied are presented in Table 1. We see that through all years Russians boys have greater body height, body weight, BMI and LBM in comparison with Tatars boys. But FM component has a different pattern. In the age of 13 years and 14 years Tatars boys have greater mean FM.

Table1. Main statistical parameters of the boys in the groups studied.

	Tatars			Russians			t	p
	N	Mean	SD	N	Mean	SD		
				13 years				
Height (cm)	16	152.4	7.3	14	156.9	10.8	-1.37	0.18
Weight (kg)	16	40.2	6.2	14	48.2	10.1	-2.66	0.01*
BMI	16	17.3	1.9	14	19.5	2.8	-2.60	0.02*
FM (kg)	16	8.6	2.2	14	8.5	4.2	0.10	0.92
LBM (kg)	16	31.7	5.3	14	39.8	7.8	-3.40	0.00*
				14 years				
Height (cm)	25	158.9	7.8	21	166.6	8.1	-3.27	0.00*
Weight (kg)	25	48.3	9.7	21	55.2	10.1	-2.36	0.02*
BMI	25	19.0	2.7	21	19.7	2.3	-1.01	0.32
FM (kg)	24	10.4	4.0	21	7.8	3.4	2.26	0.03*
LBM (kg)	24	38.3	7.4	21	47.4	8.6	-3.84	0.00*
				15 years				
Height (cm)	18	168.0	9.3	23	171.3	8.9	-1.15	0.26
Weight (kg)	18	52.5	10.8	23	66.8	16.9	-3.10	0.00*
BMI	18	18.5	2.6	23	22.7	5.2	-3.15	0.00*
FM (kg)	18	9.7	4.2	22	11.5	7.2	-0.93	0.36
LBM (kg)	18	42.8	7.7	22	53.5	10.1	-3.69	0.00*

* - marked significant p level < 0.05

As a reason of such differences between somatic status of two groups the hypothesis about distinction in the nutritional status has been considered. Mean values of food intake and energy expenditure are presented in Table 2. Energy expenditure is greater in Tatars at all ages. Food intake is greater in Tatars at the age of 14 years, and in Russians at the age of 15 years. Thus, the residual energy is greater in Tatar boys at the age of 13 and 14 years. We consider the residual as a rest of energy, which can be stored in a quickly reacting fat tissue. Hence, greater residual gives more FM.

Also we have calculated correlations between food intake and energy expenditure on the one hand, and somatic parameters on the other (Table 3). And have obtained a paradoxical result. Energy expenditure has a small positive significant correlation, and the residual has a small negative significant correlation with body height, body weight, BMI, FM and LBM.

There can be different explanations of such a result. First, it could be connected with a small sample sizes. Second, there might be a case when a correlation does not mean cause-and-effect.

On the other hand, mean values do not illustrate the whole situation. Among Tatar boys there is a big proportion of those with negative residual (20% versus 9% among Russian boys). It could explain bigger body sizes in Russian boys.

Table 2. Food intake and energy expenditure (kcal).

Age	Tatars			Russians		
	N	Mean	SD	N	Mean	SD
food intake						
13 years	14	3312	849	14	3313	870
14 years	25	3718	1151	16	2907	555
15 years	18	3119	900	21	3444	1051
energy expenditure						
13 years	16	2095	288	14	2120	570
14 years	24	2202	445	15	2117	443
15 years	18	2417	424	21	2270	500
residual						
13 years	14	1211	1011	14	1193	893
14 years	24	1473	1280	15	757	867
15 years	18	702	990	21	1174	1152

Table 3. Correlations between energy expenses and body parameters in Tatar and Russian groups.

	Height	Weight	BMI	FM	LM
food intake	-0.13	-0.15	-0.13	-0.17	-0.11
energy expenditure	0.41*	0.36*	0.20*	0.20*	0.35*
residual	-0.29*	-0.29*	-0.20*	-0.24*	-0.25*

* - marked correlations are significant at $p < .05$

Conclusions

Tatar boys have less body height, body weight, BMI and LBM. One of the reasons could be a big percentage of negative energy balance cases in Tatar boys.

At the age of 13 and 14 years Tatars have a greater average FM because of the greater mean residual energy.

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