Daily Calorie Intake, Level of Physical Activity and Morphological Status of Children and Adolescents in Three Cities of Russian Federation

Ekaterina Yu. Permiakova, Olga A. Gilyarova, Elena Z. Godina

Anuchin Institute and Museum of Anthropology, Moscow State University, Moscow, Russian Federation.

A B S T R A C T

The study is devoted to identifying the intergroup variability of morphological characteristics, body composition, indicators of physical activity and nutritional status in modern adolescents of the cities of Elista, Arkhangelsk and Moscow. The increased body weight of Arkhangelsk adolescents of both sexes determines the high values of basal metabolic rates in this group. At the same time, a low level of physical activity has a negative effect on the development of the musculoskeletal component, that is, increased body weight values are associated in this group to a greater extent with its fat component. Residents of Moscow have intermediate values among the three groups surveyed for most morphological indicators and minimum indicators of exchange. However, it is this group that is characterized by the maximum amount of time allocated to physical activity. The results obtained indirectly indicate the presence of a certain level of socio-economic differences in the surveyed cities.

Key words: anthropology, modern children and adolescents, physical activity, calorie intake, body composition, anthropometry

Introduction

The study of the relationship between the body composition and lifestyle is of a great interest for a number of scientific disciplines. Most of the works on this topic[1, 2] are devoted to determining the relationship between the calorie intake and the level (and quality) of physical activity with indicators of body composition and body mass index (BMI). This is of a certain value in the context of the term "obesogenic" environment, which has been frequently used in recent years[3], as a complex of factors leading to a decrease in the level of physical activity (up to hypodynamia) and a steady increase in the calorie intake (it has been proved that BMI is negatively related to the distance to the nearest fast food restaurant[4]).

The aim of this study was to identify intergroup variability in morphological characteristics, as well as indicators of physical activity and nutritional status in modern adolescents living in different locations of Russian Federation.

Materials and Methods

The results of comprehensive anthropological examinations of 15–17-year-old schoolchildren in the cities of Elista,

Arkhangelsk and Moscow, were taken for this study. In Arkhangelsk and Moscow the investigated children were of Russian origin, in Elista – Kalmyck children and adolescents were investigated. All measurements were carried out according to the standard method at the same season of the year (September–October). Arkhangelsk is the biggest city in the North of European part of Russia (population 355,476), located at 64º54'n.l. and 40º53'e.l., with mean annual temperature +1.3ºC. Elista is the capital of Kalmyk Republic (population 271,135), located at 46º31'n.l. and 44º26'e.l., with mean annual temperature +9.8ºC. Moscow is the capital of Russian Federation, megapolis (population 12mln. 678,079), located at 55º33'n.l. and 44º26'e.l., with mean annual temperature +6.8ºC.

Calorie intake and level of physical activity were assessed using a questionnaire; body composition indices and metabolic rate (basal and specific) were determined by bioimpedance analyzer according to the standard method[5].

The collection of data was carried out with the signing of consent protocols, subsequently the data were depersonalized.

Statistics

All calculations were performed with the Statistica 12.0 software package. The choice of data processing methods was determined after checking the normality test for the number of indicators, therefore, to compare the means in the case of metabolic parameters, as well as indicators of the caloric content of the diet and the level of physical activity, the Kruskall-Wallis test was used (the non-normal distribution was confirmed by the Kolmogorov–Smirnov test). In other cases, the assessment of intergroup differences was carried out using the methods of one-way ANOVA.

Results

Morphological characteristics

The larger values of the considered traits were characteristic of adolescents in Arkhangelsk; the minimum values were recorded among the residents of Elista (Table 1).

At the same time, intergroup differences in body height for both sexes are statistically significant (but not for the schoolchildren in Moscow (M) and Elista). For body weight and BMI, the significance of the obtained differences was confirmed only when comparing girls from Elista and Arkhangelsk. For boys, statistically confirmed differences were demonstrated for Kalmyks who had the lowest values of the studied traits.

Data from the questionnaires

The results (Table 2) suggest that the schoolgirls of Elista when compared to the other groups spend more time to work in conditions of hypokinesia and less – for physical activity. At the same time, the maximum daily calorie intake has been confirmed for them. For the boys, the trend is somewhat different: for example, the increased energy value of food consumed in this group is combined with minimal time spent on physical activity and sedentary work. Arkhangelsk and Moscow schoolchildren were almost the same in calorie intake but demonstrated different patterns for the daily routine. Thus, female residents of the capital spent more time working in conditions of hypokinesia, and young men have the highest value of this indicator among all groups. As for the level of physical activity, Moscow schoolchildren are ahead of their peers from other cities, and the inhabitants of the Russian North take an intermediate position, according to the amount of time spent on it.

Intergroup pairwise comparisons recorded the differences in the amount of time spent on hypokinetic work for boys: schoolchildren in the capital of Russia paid more attention for this type of leisure, residents of Arkhangelsk were in second place, followed by those from Elista. The maximum number of statistically significant differences was also confirmed for physical activity: in the groups of girls – between Muscovites and those living in Elista, as well as between the former and the inhabitants of Arkhangelsk. In groups of boys – between the residents of the capital at one pole and the residents of Elista and the city of Arkhangelsk on the other (between the last two groups the differences are very small).

Metabolic indicators

As can be seen from Table 3, the maximum values of basal metabolic rate were found in girls and boys of Arkhangelsk, while the specific metabolic rate was highest in groups of Moscow schoolchildren of both sexes.

From Table 3 it can be concluded that schoolchildren in the Northern region as individuals with the highest values of body weight among the surveyed groups also have the highest values of basal metabolic rate. At the same time, the level of specific metabolic rate in this group is quite low, possibly because this indicator is calculated per unit of body surface, depending on height, which, in turn, reaches the highest values in this group. The hypothesis about the possible effect of high calorie intake on high body weight values in schoolchildren of Arkhangelsk was not confirmed (on the contrary, the maximum values

TABLE 1

DESCRIPTIVE STATISTICS (M±SD) OF THE FOLLOWING MORPHOLOGICAL TRAITS IN THE THREE GROUPS STUDIES

	N		Height, cm		Weight, kg		BMI, kg/m²	
	♀	♂	♀	♂	♀	♂	♀	♂
A	184	64	160.4±6.6 *	168.0±9.8 *	51.1±7.8 *	58.2±13.3 *	19.8±2.4 *	20.4±3.6 *
M	48	42	156.7±11.3	162.9±15.1	48.4±12.4	54.8±16.0 **	19.4±3.4	20.2±3.4 **
E	168	287	155.9±11.1 *	161.6 ±14.3 *	47.6±11.9 *	52.3±15.0 *, **	19.3±3.2 *	19.6±3.6 *, **

A – Arkhangelsk, M – Moscow, E – Elista

* differences are significant when comparing the values of the indicator among Arkhangelsk and Elista, ** differences are significant when comparing the values of the indicator among Moscow and Elista, *** differences are significant when comparing the values of the indicator among Arkhangelsk and Moscow

TABLE 2

DESCRIPTIVE STATISTICS (M±SD) OF CALORIE INTAKE, TIME SPENT ON HYPOKINETIC WORK AND PHYSICAL ACTIVITY IN THE THREE GROUPS STUDIED

	Kcal/day		Hypokinetic work. min/day		Physical activity, min/day	
	♀	♂	♀	♂	♀	♂
A	2312.4±1136.8	2630.2±790.4	754.1±124.7 *.***	754.9±146.0	12.3±12.9 ***	26.0±15.4 ***
M	2368.6±824.2	2629.5±1028.3	760.9±150.9 **.***	822.8±174.9	35.8±16.6 **.***	35.6±16.4 **.***
E	2681.8±697.6	2664.8±710.5	766.1±290.9 *.**	683.7±180.1	12.1±6.2 **	25.4±13.1 **

A – Arkhangelsk, M – Moscow, E – Elista

* differences are significant when comparing the values of the indicator among Arkhangelsk and Elista, ** differences are significant when comparing the values of the indicator among Moscow and Elista, *** differences are significant when comparing the values of the indicator among Arkhangelsk and Moscow

TABLE 3

DESCRIPTIVE STATISTICS (M±SD) OF METABOLIC INDICATORS IN THE THREE GROUPS STUDIED

	Basal metabolic rate, kcal (BMR)		Specific metabolic rate, kcal/m² (BMR/m²)	
	♀	♂	♀	♂
A	1269.4±154.71 *.***	1391.1±191.36 *.***	837.6±78.36 ***	860.3±51.41 ***
M	1145.1±179.59 ***	1244.4±240.89 ***	927.2±110.42 **.***	934.4±84.06 **.***
E	1157.2±134.98 *	1298.6±230.50 *	856.7±77.21 **	887.6±70.40 **

A – Arkhangelsk, M – Moscow, E – Elista

* differences are significant when comparing the values of the indicator among Arkhangelsk and Elista, ** differences are significant when comparing the values of the indicator among Moscow and Elista, *** differences are significant when comparing the values of the indicator among Arkhangelsk and Moscow

TABLE 4

DESCRIPTIVE STATISTICS (M±SD) OF BODY MASS COMPONENTS IN THE THREE GROUPS STUDIED

	Skeletal-muscle mass, kg		Skeletal-muscle mass, %		Fat mass, kg		Fat mass, %	
	♀	♂	♀	♂	♀	♂	♀	♂
A	16.6±4.3 *.***	27.8±5.1	33.2±9.9 *.***	48.4±6.8	14.0±5.1	12.2±6.4	27.4±10.0 *.***	20.6±6.8 *.***
M	20.9±2.8 ***	28.3±4.8	38.1±4.5 ***	46.8±5.3	13.8±5.1	10.9±6.4	24.6±5.5 ***	17.4±7.5 ***
E	19.0±2.1 *	26.7±4.5	37.8±4.0 *	48.3±5.6	13.3±5.3	10.4±6.0	25.3±5.5 *	17.8±6.9 *

A – Arkhangelsk, M – Moscow, E – Elista

* differences are significant when comparing the values of the indicator among Arkhangelsk and Elista, ** differences are significant when comparing the values of the indicator among Moscow and Elista, *** differences are significant when comparing the values of the indicator among Arkhangelsk and Moscow

of daily calorie intake were recorded in the residents of Elista). This fact, combined with a relatively low level of physical activity, can cause elevated body weight values.

To support this hypothesis, the amount of skeletal-muscle and fat mass in the groups surveyed was also compared (Table 4). According to the results, the girls of

Arkhangelsk are characterized by the minimum values of skeletal-muscle mass, both in absolute and relative expression. At the same time, a high proportion of the fat component allows to conclude that it is it that contributes more to the maximum body weight observed in this group. As for the Arkhangelsk boys, the percentage of skeletal-muscle mass in this group is maximal (and close to the corresponding values in the Elista sample), but in its absolute amount they occupy an intermediate position. The fat component in this group is higher than in the other two. Moscow schoolchildren are characterized by a greater amount of skeletal-muscle component and the minimum values of fat mass for the three groups studied. Teenagers from Elista are characterized by intermediate values of skeletal-muscle mass in the case of girls and minimal in the case of boys. The fat component shows a slightly different picture: its absolute value is minimal in teenagers of both sexes, and the relative one has intermediate values among the groups.

Discussion and Conclusion

The increased body weight of the Arkhangelsk adolescents also determines the high values of the basal metabolic rate in this group. At the same time, the low level of physical activity has a negative impact on the development of the skeletal-muscle component, that is, the increased weight values are associated in this group more with fat component. Residents of the Russian capital have intermediate values among the three groups studied in the values of most morphological characteristics and minimum metabolic rates. However, this group is character-ized by the maximum amount of time allotted to physical activity. This does not contradict previous data showing that there are more leisure opportunities for residents of larger cities[6,7]. In the case of Elista schoolchildren, with minimal or intermediate values of the most studied char-acteristics, it is also important to consider the impact of the traditional way of life (primarily, diet habits) of the indigenous population of the region (Kalmyks) on their physique.

For Moscow adolescents, body height, body weight, BMI and daily calorie intake per kg indicate intermediate position between the North and the South, on the other hand, daily physical activity shows the highest values, which might cause the highest value of specific BMR.

It is also shown, that physical body dimensions (height and weight) are significantly greater in the North (Arkhangelsk region) than in the South (Elista). While daily calorie intake per body weight (when calculated by mean values) may be smaller in the North, but BMR and daily physical activity show the same values, BMI and body fat (%) are significantly smaller in the South. However, the value of BMI may be within standard range. These trends of physical characteristics of Northern subjects could be interpreted according to Bergmann's rule, which would demonstrate adaptability to cold climate in children and adolescents of Arkhangelsk.

Acknowledgement

REFERENCES

1. DAYAN CM, KORAH M, TATOVIC D, BUNDY BN, HEROLD KC Lancet, 394 (2019) 1286. doi: 10.1016/S0140-6736(19)32127-0. — 2. MER-HOUT F, DOYLE JJ Nutr Educ Behav, 51 (2019) 1107. doi: 10.1016/j.jneb.2019.06.021. — 3. RENDINA D, CAMPANOZZI A, DE FILIPPO G, NMCD, 29 (2019) 561. doi: 10.1016/j.numecd.2019.02.009. — 4. WILKINS EL, MORRIS M, RADLEY D, GRIFFITHS C, Methods of measuring associations between the Retail Food Environment and weight status: importance of classifications and metrics (Elsevier Publ., Leeds Beckett University, 2019). — 5. SMIRNOV AV, KOLESNIKOV VA, NIKOLAEV DV, ERUKOVA TA, Rukovodstvo pol'zovatelya programmnogo obespech-eniya (basovaya versiya ot 18.08.09 (User's Manual of ABC01-036 «ME-DASS» (basic version from 18.08.09) (Scientific-technical center «Me-dass», Moscow, 2009). (In Russ.). — 6. BOGIN B, AZCORRA H, ÁVILA-ESCALANTE ML, CASTILLO-BURGUETE MT, VARELA-SILVA MI, DICKINSON F, Globalization and Children's Diets: The Case of Yucatan, Mexico. In: AZCORRA H., DICKINSON F. (Eds) Culture, Environment and Health in the Yucatan Peninsula (Springer Nature, Switzerland, 2020). doi: 10.1007/978-3-030-27001-8_3. — 7. GODINA E, GUNDEGMAA L, PERMIAKOVA E. Moscow University Anthropology Bulletin, 1 (2019) 35. doi: 10.32521/2074-8132.2019.1.035-048. (In Russ.).

E. Permiakova

Anuchin Institute and Museum of Anthropology, Moscow State University, Mokhovaya str., 11, Moscow, Russian Federation, 125009.

e-mail: ekaterinapermyakova@gmail.com

DNEVNI UNOS KALORIJA; RAZINA FIZIČKE AKTIVNOSTI I MORFOLOŠKI STATUS DJECE I ADOLESCENATA U TRI GRADA RUSKE FEDERACIJE

S A Ž E TA K

Prikazano istraživanje usmjereno je na određivanje varijabilnosti u morfološkim obilježjima, sastavu tijela, fizičkoj aktivnosti i prehrambenom statusu među skupinama današnjih adolescenata iz gradova Elista, Arhangelsk i Moskva. Povećana težina tijela uvjetuje visoke vrijednosti bazalnog metabolizma adolescenata u Arhangelsku. Istodobno, niska razina fizičke aktivnosti negativno utječe na razvoj mišića i kostiju u toj skupini, tj. povećana tjelesna težina povezana je kod njih s s većim postotkom masnog tkiva. Adolescenti iz Moskve pokazuju srednje vrijednosti u odnosu na druge dvije ispitivane skupine za većinu ispitivanih morfoloških obilježja. Međutim, upravo ta skupina posvećuje najviše vremena fizičkoj aktivnosti. Dobiveni rezultati neizravno ukazuju na postojanje određenih socio-ekonomskih razlika među ispitivanim skupinama adolescenata.