

## Risk Factors for Obesity in Adolescents Living in Rural Areas of Buryatia: A Case-Control Study

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### Abstract

**The aim** of the present study was to evaluate the association between early life factors, sociodemographic influences, behavioral characteristics and obesity in adolescents living in rural areas of Buryatia (Russia).

**Methods:** A case-control study was performed. A total of 158 adolescents aged between 11 and 17 years of age (79 adolescents with normal weight and 79 adolescents with obesity) were included in the study. All the adolescents had their weight and linear growth measured, and BMI was calculated. Height and weight parameters were based on the reference values accepted by the WHO. Obesity was diagnosed at BMI  $\geq$ 95th percentile. The data on the variables of interest were obtained from questionnaires filled in by parents and adolescents and their medical records from local outpatient clinics.

**Results:** The results showed that the adjusted ORs and 95% CIs for obesity were 1.15 (1.05–1.26), 4.87 (1.82–13.02), 3.08 (1.19–7.99) for maternal BMI, growth in infancy and unhealthy eating patterns, respectively. Breastfeeding longer than 12 months showed to play a protective role for the development of obesity in adolescence as compared to a shorter period of breastfeeding (OR=0.05, 95% CI: 0.006–0.40).

**Conclusion:** Maternal BMI, rapid growth in infancy and unhealthy eating patterns are associated with increased risk of obesity in adolescents in rural areas of Buryatia, while long-term breastfeeding is a protective factor against obesity. (**International Journal of Biomedicine. 2019;9(2):190-195.**)

**Key Words:** adolescents • breastfeeding • growth in infancy • obesity • parental body mass index

### Introduction

Obesity is a multifactorial disease that develops from complicated interactions among genetic, environmental, socioeconomic and behavioral factors that lead to an imbalance between energy intake and consumption.<sup>(1)</sup> Childhood obesity tracks into adulthood, contributing to the early development of *type 2 diabetes*, cardiovascular diseases, musculoskeletal diseases, obstructive sleep apnea, and some types of cancer.<sup>(2)</sup>

Such a situation provokes concern about the high rate of obesity, not only in adults but also in children and adolescents. According to the research data, about 20% of children and adolescents in Russia are overweight and 5.7% suffer from obesity.<sup>(3,4)</sup> Thus, it is necessary to search for effective strategies to prevent obesity and associated complications that

influence the modifiable risk factors. It should be noted that the role and character of the risk factors can vary not only among different countries<sup>(5)</sup> but also among urban and rural areas within the same country.<sup>(6)</sup> Until now, there have been no studies on the risk factors for obesity among adolescents in rural Russian communities.

It has been proved that the period from conception to 2 years of age is very important for the induction of those pathophysiological disorders that lead to the development of obesity in older age.<sup>(7)</sup> Any reasonable early childhood intervention will reduce the risk of this imprinting disorder, even when it comes to behavioral and environmental factors that have an impact in later life. Not much success has been achieved in the treatment of obesity, which makes the preventive approach especially relevant.

The aim of the present study was to evaluate the association between early life factors, sociodemographic influences, behavioral characteristics and obesity in adolescents living in rural areas of Buryatia.

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## Methods

The present study was a part of another study focused on the investigation of obesity in adolescent indigenous inhabitants of the Republic of Buryatia. Buryatia is a multinational republic located in the southern part of Eastern Siberia. Its population is 971.8 thousand people of more than a hundred of nationalities, the majority of which are Russians and Buryats. The Buryats belong to the Central Asia type of northern-Asian major mongoloid race.<sup>(8)</sup>

This study was conducted between January 2015 and April 2016. The sampling frame included 1,456 students that had annual screening examinations and were inhabitants of 6 rural municipal regions. The adolescents and their legally authorized representatives were provided the detailed information about the study in written and verbal form. The informed consent form was signed by the legal representatives of 269 adolescents that met the criteria for entry into the study: 11-17 years of age; at least two generations of parents of the same ethnicity; continuous residence of an adolescent in the territory of the specified settlement since birth.

Obesity was diagnosed in 81 adolescents included in the main study; 2 adolescents were later withdrawn from the study due to the coexisting retardation of growth (weight-for-height *z*-score <-2). A control group included 79 adolescents compatible by sex, age, ethnicity, and area of living, with normal height and body weight (BMI *Z*-score >5th and <85th percentile for the distribution for the specified age, height and sex).

Parents of the adolescents from both groups filled in the questionnaires that contained questions on sociodemographic characteristics of their families (age and professional occupation of the parents during pregnancy and presently, parents' education and income level, number of family members living together, number of children in the family), and smoking status of parents.

The information on early development (weight and height at birth, weight gain during the first year of life, feeding patterns and time of solids introduction, and type of solid foods) was obtained from the adolescents' medical records from the outpatient clinics. Duration of breastfeeding was taken as the time during which the subject received any breast milk. The period of exclusive breastfeeding was taken as the period when children were fed only breast milk.

The information on maternal health status during pregnancy, peculiarities of pregnancy development, and child delivery was obtained from the medical records provided by maternity hospitals to outpatient clinics, where these women were managed.

The information on the peculiarities in eating behavior, physical activity, time spent looking at a screen (TV, PC, tablet computer) was obtained from the questionnaires. Routine physical activity of the adolescents was ranged by four levels: 1) adolescents that attended PE (physical education) classes, but had low physical activity outside school and did not attend extracurricular sport activities; 2) adolescents that attended PE classes and were physically active outside school (routine household chores like looking after the livestock, working in the vegetable garden, and splitting firewood); 3) adolescents

that attended PE classes and extracurricular sports activities, but did not have sufficient physical activity outside school; 4) adolescents that attended PE classes and extracurricular sports activities, and were physically active outside school.

The questions on eating habits included the number of meals per day (wholesome meals at a dinner table, excluding snacks), time of the last meal in the evening, meals or snacks at night. The data on the regularity of breakfast meals was not presented because of lack of answers. The data on the height and weight of all the parents was obtained from the medical records of annual screening examinations. Excessive weight in parents was diagnosed at BMI from 25.0 kg/m<sup>2</sup> to 29.9 kg/m<sup>2</sup>, obesity –  $\geq 30$  kg/m<sup>2</sup>.

All the adolescents had their weight and linear growth measured, and BMI was calculated. Height and weight parameters were based on the reference values accepted by the WHO, with an AnthroPlus calculator. Obesity was diagnosed at BMI  $\geq 95$ th percentile.<sup>(1)</sup>

The study was conducted in accordance with ethical principles of the Declaration of Helsinki and approved by the Scientific Centre for Family Health and Human Reproduction Problems Ethics Committee. Written informed consent was obtained from all participants.

Statistical analysis was performed using statistical software package SPSS version 21.0 (SPSS Inc, Chicago, IL) For descriptive analysis, results are presented as mean  $\pm$  standard deviation (SD), median, interquartile range (IQR; 25th to 75th percentiles). The Mann-Whitney U test was used to compare continuous variables. Group comparisons with respect to categorical variables are performed using chi-square tests with Yates correction or, alternatively, Fisher's exact test when expected cell counts were less than 5. Binary logistic regression analyses were used to assess the early life, behavioral, and sociodemographic factors associated with adolescent obesity. First, univariate analyses were performed. Second, multivariate analyses (direct LR) were performed that included all variables that were significantly ( $P < 0.05$ ) or borderline significantly ( $P < 0.1$ ) associated with obesity in the univariate analyses. Odds ratios (ORs) and their 95% confidence intervals (CIs) were calculated by using logistic regression. A probability value of  $P < 0.05$  was considered statistically significant.

## Results

Clinical, sociodemographic, and behavioral characteristics of the adolescents at the time of their examination are presented in Table 1. Sociodemographic characteristics of the families at the time of assessment were similar in both groups. There was no significant difference in the physical activity and screen time.

However, unhealthy eating habits were observed significantly more often in the group of adolescents with obesity. Mothers of obese adolescents had a higher median BMI and suffered from obesity more often as compared to the control group. BMI of fathers was similar in both groups. Fathers of the adolescents with normal body weight were more often current smokers, which formed a significant intergroup difference in the rate of passive smoking in the family.

The early life factors for the adolescents are presented in Table 2.

**Table 1.**

**Comparison of sociodemographic, parental and life-style characteristics between adolescents with normal weight and obesity**

Variable	Normal Weight	n	Obesity	n	P-value
Age, years	13 (12;15)	79	13 (12;15)	79	1.00
Gender, male	51 (64.6)	79	51 (64.6)	79	1.00
Ethnicity:					
Asians	51 (64.6)	79	51 (64.6)	79	1.00
Russians	28 (35.4)		28 (35.4)		
Height, cm	160.3±10.1	79	162.8±11.6	79	0.158
Weight, kg	49 (43;55)	79	75 (68;92)	79	<0.0001
BMI	19.3 (18.1;20.2)	79	28.6 (27;31)	79	<0.0001
BMI z-score	0.08 (-0.5;0.51)	79	2.4 (2.15;2.7)	79	<0.0001
Maternal education level:					
high	26 (32.9)	79	23 (29.1)	79	0.334
middle	53 (67.1)		54 (68.3)		
low	0		2 (2.5)		
Maternal employment:					
housewife	21 (26.9)	78	26 (32.9)	79	0.304
work in public service	33 (42.3)		23 (29.1)		
manual worker	23 (29.5)		27 (34.2)		
self-employed entrepreneur	1 (1.3)		3 (3.8)		
Paternal education level:					
high	25 (37.9)	66	15 (24.6)	61	0.243
middle	40 (60.6)		44 (72.1)		
low	1 (1.5)		2 (3.3)		
Paternal employment:					
unemployed	14 (21.5)	65	13 (21)	62	0.610
work in public service	21 (32.3)		14 (22.6)		
manual worker	25 (38.5)		30 (48.4)		
self-employed entrepreneur	5 (7.7)		5 (8.1)		
Single motherhood	13 (16.5)		79		
Number of family members living together	4 (4;5)	79	4 (3;5)	78	0.261
Number of children in the family	2 (2; 2)	79	2 (2; 2)	78	0.360
Family income:					
low	7 (8.9)	79	14 (17.9)	78	0.109
average	65 (82.3)		53 (67.9)		
above average	7 (8.9)		11 (14.1)		
Maternal smoking	15 (19)	79	23 (29.1)	79	0.136
Paternal smoking	57 (72.1)	79	39 (49.4)	79	0.003
Smoking of any parent	64 (81)	79	50 (63.3)	79	0.013
Maternal BMI	23.8 (20.2;28.7)	79	28.3 (25.5;30.5)	79	<.0001
Paternal BMI	26.3 (24.4; 28.7)	66	26.7 (23.3;29.4)		0.893
Mother is obese	12 (15.2)	79	24 (30.8)	78	0.020
Father is obese	11 (16.7)	66	16 (26.2)	61	0.188
Both are obese	3 (3.8)	79	5 (6.4)	78	0.457
Meal frequency, times per day:					
3-4	50 (63.3)	79	37 (48)	77	0.159
< 3	5 (6.3)		7 (9.1)		
> 4	24 (30.4)		33 (42.9)		
Meal before bedtime	34 (43)	79	44 (55.7)	79	0.112
Eating at night	7 (8.9)	79	8 (10.1)	79	0.786
Unhealthy eating patterns	50 (63.3)	79	66 (83.5)	79	0.001
Extracurricular sports activities	26 (32.9)	79	23 (29.1)	79	0.606
Physical activity level:					
1	37 (46.8)	79	35 (44.3)	79	0.476
2	16 (20.2)		21 (26.6)		
3	4 (5.1)		7 (8.9)		
4	22 (27.8)		16 (20.2)		
Screen time, hours					
≤ 2	17 (21.5)	79	19 (25.3)	75	0.793
3-4	31 (39.2)		26 (34.7)		
> 4	31 (39.2)		30 (40)		

**Table 2.**

**Prenatal factors and early life factors for adolescents by weight status**

Variable	Normal Weight	n	Obesity	n	P-value
Socio-demographics					
Maternal age at the time of childbirth, yr	25 (22;28)	79	24 (20;28)	78	0.132
Maternal age at the time of childbirth, yr:					
< 19	2 (2.5)	79	3 (3.8)	78	0.743
19-34	71 (89.9)		67 (85.9)		
> 35	6 (7.6)		8 (10.3)		
Paternal age at the time of childbirth, yr	27 (25;31)	69	26 (23;31)	64	0.471
Paternal age at the time of childbirth, yr					
< 19	1 (1.4)	69	3 (4.7)	64	0.532
19-34	58 (84.1)		51 (79.7)		
> 35	10 (14.5)		10 (15.6)		
Maternal occupation during pregnancy:					
housewife	30 (38.5)	78	34 (44.2)	77	0.142
work in public service	42 (53.8)		29 (37.7)		
manual worker	2 (2.6)		2 (2.6)		
self-employed entrepreneur	2 (2.6)		4 (5.2)		
student	2 (2.6)		8 (10.4)		
Paternal occupation during pregnancy:					
unemployed	20 (28.2)	71	21 (37.5)	56	0.138
work in public service	25 (35.2)		10 (17.9)		
manual worker	21 (29.6)		18 (32.1)		
self-employed entrepreneur	4 (5.6)		3 (5.4)		
student	1 (1.4)		4 (7.1)		
Early life factors of children					
Anemia in pregnancy	36 (48)	75	32 (48.5)	66	0.954
Risk of preterm labour	13 (17.3)	75	6 (9.1)	66	0.153
Birth order:					
1	42 (53.2)	79	44 (55.7)	79	0.742
2	24 (30.4)		26 (32.9)		
3	9 (11.4)		6 (7.6)		
> 4	4 (5.1)		3 (3.9)		
Cesarean delivery	7 (9.3)		75		
Birth length, cm	51 (50;52)	79	52 (51;53)	79	0.079
Birth weight, gr	3110 (3190;3600)	79	3350 (3100;3600)	79	0.778
Birth weight, gr:					
< 2500	2 (2.5)	79	2 (2.5)	79	0.588
2500-3999	71 (89.9)		74 (93.7)		
> 4000	6 (7.6)		3 (3.8)		
Apgar scores, 1 min	7 (7; 8)	79	7 (7; 8)	79	0.812
Apgar scores, 5 min	8 (8; 8)	79	8 (8; 9)	79	0.490
Breastfeeding duration:					
never	2 (2.5)	79	0	79	0.0003
< 4 month	2 (2.5)		4 (5.1)		
4-6 month	15 (19)		20 (25.3)		
7-12 month	39 (49.4)		53 (67.1)		
> 12 month	21 (26.6)		2 (2.5)		
Exclusive breastfeeding, month	4.2 (4; 5)	79	4 (4; 5)	79	0.722
Additional formula before 4 months	9 (11.7)	77	14 (17.7)	79	0.288
Additional cow milk before 4 months	5 (6.3)	79	7 (8.9)	79	0.548
Time of solid foods initiation, months	5 (4; 5)	79	5 (4; 6)	79	0.722
First solid food:					
milk porridge	69 (88.5)	78	58 (74.4)	78	0.125
vegetables	6 (7.7)		12 (15.4)		
meat soup	2 (2.6)		4 (5.1)		
other	1 (1.3)		4 (5.1)		
Weight gain from birth to 12 month, gr	7170 (7087;7273)		79		
Weight at 1 year, gr	10520 (10304;10830)	79	10875 (10518;11230)	79	<0.0001

There were no significant peculiarities identified in the prenatal and perinatal period of adolescents with different weight. But the proportion of adolescents that were breastfed after the first year of life was higher among those with normal weight, while the duration of exclusive breastfeeding was similar in both groups. It should be noted that the adolescents with obesity had significant weight gain during the first year of life, which formed significant intergroup differences in the body weight of infants aged 1 year old.

The odds ratios (ORs) associated with obesity for variables were calculated individually in a univariate model (Table 3). Weight gain during the first year of life, bodyweight at the age of one, maternal BMI, obesity and unhealthy eating patterns were significantly associated with obesity. Breastfeeding for more than 12 months, introduction of porridges as first solid foods, smoking father and mother's occupation in public service during the pregnancy were shown to have a protective role in the univariate models of obesity.

**Table 3.**

**ORs for obesity in univariate conditional logistic regression model**

Variable	B	Std. error	Wald test	OR	95% CI	P-level
Mother is currently working in the public service	-0.58	0.34	2.95	0.56	0.29–1.08	0.086
Family income:						
low	ref					
average	-0.9	0.5	3.24	0.41	0.15–1.08	0.072
above average	-0.24	0.67	0.13	0.79	0.21–2.92	0.719
Mother working in the public service during pregnancy	-0.66	0.33	4.05	0.52	0.27–0.98	0.044
Mother student during pregnancy	1.48	0.81	3.37	4.41	0.90–21.46	0.066
Smoking of any parent	-0.91	0.37	6.00	0.40	0.20–0.83	0.014
Maternal smoking	0.56	0.38	2.19	1.75	0.83–3.68	0.139
Paternal smoking	-0.98	0.34	8.4	0.38	0.19–0.73	0.004
Maternal BMI	0.15	0.04	16.81	1.16	1.08–1.25	<.0001
Mother is obese	0.91	0.40	5.21	2.48	1.14–5.41	0.022
Breastfeeding duration:						
< 4 month	ref					
4-6 month	-0.40	0.93	0.19	0.67	0.11–4.13	0.663
7-12 month	-0.39	0.89	0.19	0.68	0.12–3.90	0.665
> 12 month	-3.04	1.14	7.14	0.05	0.01–0.44	0.008
Milk porridge as first solid	-0.97	0.44	4.90	0.38	0.16–0.89	0.027
Weight at 1 year	1.41	0.36	15.67	4.10	2.04–8.26	0.0001
Weight gain from birth to 12 month	1.72	0.44	15.1	5.57	2.34–13.23	0.0001
3-4 meals per day	-0.62	0.33	3.64	0.54	0.28–1.02	0.056
Unhealthy eating patterns	1.25	0.40	9.69	3.48	1.59–7.63	0.002

Variables that were statistically significant, and close to statistically significant differences in OR for obesity, in the univariate analysis were introduced in a multivariate model (Table 4). Since the variables “weight gain during the first year of life” and “body weight at the age of 1”, as well as the variables “maternal BMI” and “maternal obesity” are highly correlated, the authors used only those that demonstrated higher significance in the primary models. The analysis showed

that the weight gain during the first year of life, maternal BMI and unhealthy eating patterns of adolescents significantly increased the risk of obesity, while breastfeeding for longer than 1 year, passive smoking and mother's occupation in public service were found to be protective factors against obesity. The regression model as a whole explained between 38.5% (Cox&Snell R square) and 51.4% (Nagelkerke R square) of the variance in the obesity status and correctly classified 79.6% of cases.

**Table 4.**

**Multivariate conditional logistic regression model of risk factors for obesity**

Variable	B	Std. error	Wald test	OR	95% CI	P-level
Breastfeeding > 12 month	-3.04	1.09	7.81	0.05	0.006–0.40	0.005
Maternal BMI	0.14	0.05	9.63	1.15	1.05–1.26	0.002
Unhealthy eating patterns	1.12	0.49	5.36	3.08	1.19–7.99	0.02
Mother working in the public service during pregnancy	-0.87	0.43	4.07	0.42	0.18–0.97	0.04
Weight gain from birth to 12 month	1.58	0.50	9.98	4.87	1.82–13.02	0.002
Smoking of any parent	-1.34	0.49	7.38	0.26	0.1–0.69	0.007

## Discussion

In the present study, significant factors associated with obesity in adolescents from rural areas were maternal BMI, rapid growth in infancy and current unhealthy patterns. The association of obesity in adolescents with maternal, but not paternal, BMI was a peculiar finding of the present study, because in the majority of other works, obesity was associated with overweight in both parents.<sup>(9,10)</sup> It can be suggested that the identified association is realized via the primary role of a mother in the formation of family ambience in rural communities, which, in its turn, determines the eating patterns and lifestyle of a child.

Currently, there is some evidence that the postnatal growth during the first 1–2 years of life may be positively associated with subsequent obesity in childhood, adolescence, and adulthood. A recent systematic review of 18 studies showed that the rapid postnatal growth was linearly associated with obesity in children and adolescents of all sizes at birth.<sup>(11)</sup> These associations are preserved when both the BMI and features of body composition are used as an outcome variable. In the present study, the authors showed significant direct correlation between rapid growth during the first year of life and obesity in adolescents.<sup>(12)</sup> This correlation did not depend on many sociodemographic, family and behavioral characteristics, which, however, did not exclude its mediation by other confounders (e.g. composition of diet for an infant during the first year of life and further) that were not taken into account in the present study.

The association between obesity and unhealthy eating patterns has been described in many other studies.<sup>(13,14)</sup> The obtained results prove the importance of measures on the formation of healthy eating habits of children in families and organized social groups.

When it comes to other risk factors for obesity associated with lifestyle, the results of the present study showed that these factors in adolescents who permanently lived in rural areas differed from the ones in adolescents that lived in urban areas. At least two studies showed that obesity in urban children and adolescents in Russia were associated with low physical activity and a significant increase of time spent in front of a screen.<sup>(14,15)</sup> In the present study, the level of physical activity in adolescents with obesity was similar to that in adolescents with normal body weight. The percentage of adolescents who spent more than 3 hours per day on screens was rather high in both groups. Probably, the increase of screen time can be considered as a tendency that involves rural communities as well.

These results correspond to the results obtained for other community-based samples of rural and urban children and adolescents. These studies showed that rural children and adolescents were more physically active than urban ones, and the median of their physical activity in the rural sampling was not associated with overweight and obesity, as compared to the urban sampling.<sup>(6,16)</sup>

The factor that showed to have a protective effect against the development of obesity in children was the duration of breastfeeding. The adolescents that were breastfed longer than 12 months had a significantly lower risk of developing obesity as compared to those who were breastfed for a shorter period.

Currently, there are many studies on the association between breastfeeding and obesity in childhood, and more seldom in adolescence. The results of these studies are controversial. A number of studies have shown that there was no association between breastfeeding and obesity in children<sup>(17,18)</sup> and adolescents.<sup>(19)</sup> Other studies, as well as the present study, show that there was a dose-dependent influence of breastfeeding on body weight during life. Portela et al.,<sup>(20)</sup> as well as the present study, showed that the children who were breastfed for more than 12 months significantly decreased the risk of obesity as compared to those who were breastfed for a shorter period. Other two studies,<sup>(21,22)</sup> as well as the present study, showed that the protective effect of longer breastfeeding remains until adolescence.

The inconsistency in the results obtained in different studies can be explained by the peculiarities of the study design, different power, and the influence of socioeconomic, behavioral and other confounders that were not included in all the studies. Jwa et al.<sup>(23)</sup> showed that the relationship between breastfeeding and obesity became clear with growth, suggesting that breastfeeding has a latent protective effect against childhood obesity. Their results suggest that the studies investigating the effect of breastfeeding in early childhood might be unable to show a significantly slower increase of BMI with age or a protective effect against overweight and obesity because the data were collected too early. Probably, this latent effect of breastfeeding can be associated with the activity of bioactive factors (leptin, adiponectin, insulin, ghrelin, resistin, obestatin, peptide YY, glucagon-like peptide 1) contained in breast milk that can exert a long-term effect on the metabolism and the regulation of appetite in the future, determining the future patterns of body weight.<sup>(24)</sup>

It should be highlighted that smoking by any of the parents had a negative correlation with obesity in adolescents. This contradicts the results of the previous studies on this aspect of obesity,<sup>(25)</sup> and the results of the studies that focused on the biological effects of passive smoking, and showed that it was independently associated with the degree of inflammation, oxidative stress and endocrine disorders.<sup>(26,27)</sup> It should be noted that the authors did not find any significant association between obesity in adolescents and current smoking of the mothers. The negative correlation was associated only with fathers' smoking. The authors have no convincing explanation but speculate that these unusual results can be observed for the following reasons: First, the authors did not consider the fact that adolescents' passive smoking could come from nonpaternal sources. Second, due to a great amount of the missed data, the authors could not take into account the fact of smoking by adolescents themselves. Thirdly, it was unknown if fathers smoked outside or inside the house. Fourth, we did not assess the composition of the diet of adolescents. The last factor can be significant because it was shown that dietary fibers and omega-3-polyunsaturated fatty acids can weaken the association between passive smoking and obesity in children.<sup>(28)</sup> Finally, the information on parents' smoking was obtained from their self-reports, and we did not check for biological markers, like cotinine, that could have characterized quantitatively the level of impact. All the above-mentioned facts indicate that the obtained results should be interpreted with caution.

#### Study limitations

It was the first comprehensive study on obesity conducted within the rural community-based sample of adolescents in Russia. However, this study has some limitations. First, this is a cross-sectional analysis. Therefore, assumptions about causality cannot be made. Second, the authors did not use specialized questionnaires and special devices to evaluate routine physical activity of adolescents. Instead, the authors used the participants' self-reports. Third, because of a great number of missed answers, the authors could not present the complete information on eating patterns (e.g. regularity of breakfast meals), or on the details of passive smoking.

We conclude that maternal BMI, rapid growth in infancy and unhealthy eating patterns are associated with increased risk of obesity in adolescents in rural areas of Buryatia, while long-term breastfeeding is a protective factor against obesity. The obtained results provide evidence that the first year of a child's life is a unique "period of possibilities" for the prevention of diseases and confirm the importance of family as a complex factor that affects the development of obesity in childhood and the necessity to implement family-oriented disease prevention programs.

### **Competing Interests**

The authors declare that they have no competing interests.

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