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The declining prevalence of overweight among Russian children: Income, diet, and physical activity behavior changes

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Abstract

The aim of this study is to examine the relationships among income, diet, physical activity behaviors and overweight among Russian children during a period of economic upheaval. Subjects include 2151 schoolchildren aged 7-13 derived from cross-sectional waves of the Russia Longitudinal Monitoring Surveys in 1995 and in 2002. Diet was assessed by 24-h recall and physical activity (hrs/week) and household income by parental questionnaire. Hours spent in vigorous activities were low (1.0-1.5 hrs/week), and time spent in sedentary behaviors increased from 31 to 37 hrs/week between 1995 and 2002. In 1995 there was a direct relationship of income to energy and fat intake, and time spent in vigorous activity, and an inverse relationship of income to hrs/wk spent in moderate activities (such as walking to school). The effect of having low income parents was less in 2002 than in 1995. Overweight prevalence did not differ significantly by income in either year, but there was a significant decline in overweight among high income children. Only hours spent in moderate physical activity was moderately protective against overweight. Income disparities do not explain trends in overweight among Russian children.

Keywords

RLMS; children; physical activity; dietary intake Russia; overweight

1. Introduction

The obesity epidemic among children has been described for developed and developing countries, along with adverse health and social consequences associated with excess adiposity (de Onis and Blossner, 2000; Martorell et al., 2000; Seidell, 2000; Wang et al., 2002; Ogden et al., 2003; Bhargava et al., 2004; Muntner et al., 2004; Popkin et al., 2006; Vignerova et al., 2007; Komlos et al., 2009; Murasko, 2009). Economic development, leading to cheaper food prices and higher standards of living that include motorized transport, labour-saving devices, and increased sedentary leisure and occupational pursuits are the proximal results of development implicated in the obesity epidemic, and are consistent with the nutrition transition of economic development described elsewhere (Popkin, 1998; Popkin, 2003; Powell & Bao, 2009; Lakadawalla & Philipson, 2009).

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Within countries at different levels of development, socioeconomic factors may have differential effects, but overall the relationship is the same; low socioeconomic status (SES) is associated with poorer health, whether ill health takes the form of infectious disease related to undernutrition or nutrition-related noncommunicable disease associated with overnutrition. SES is often characterized by education; however income has been shown to have strong predictive power for health behaviors (Monteiro et al., 2001; Duncan et al., 2002). SES is associated with diet (Watt et al., 2001; Darmon et al., 2003; Worsley et al., 2003; Darmon et al., 2004; Drewnowski and Specter, 2004) and physical activity (Shapo et al., 2004). Income is also associated with overweight (Sobal and Stunkard, 1989; Monteiro et al., 2001; Strauss & Pollack, 2001; Storey et al., 2003; Drewnowski & Specter, 2004; Monteiro et al., 2004; Romon et al., 2005). Income may affect overweight through diet and activity, or serve as a proxy for other, unmeasured determinants.

Studies of energy intake in children find small or no effects on overweight (Maffeis et al., 1998; Bogaert et al., 2003; Lin et al., 2004; Patrick et al., 2004). High dietary fat intake and sedentary behaviors have been linked to overweight among children (Bray and Popkin, 1998; Berkey et al., 2000; McGloin et al., 2002; Utter et al., 2003); the association of weight with physical activity is inconsistent (Moussa et al., 1994; Goran and Sun, 1998; Storey et al., 2003). In addition, transitional societies, such as Russia, may have seemingly inconsistent patterns of overweight associated with rapid economic transition, such as the coexistence of overweight and underweight individuals in the same household (Doak et al., 2000; Jehn & Brewis, 2009).

Russia experienced a sort of “reverse transition” beginning in 1992 with a period of massive economic upheaval. Food, especially from animal sources, previously was subsidized by the State, and these subsidies were reduced or restructured after the dissolution of the USSR (Mroz and Popkin, 1995; Huffman and Rizov, 2007; Ulijaszek and Koziel, 2007). The economy improved in the early 1990s but collapsed in 1996-1998. Inflation exceeded 150% in 1998 and unemployment increased. Since post-1998, Russia has shown consistent economic growth and a narrowing of income inequality (Stillman and Thomas, 2008).

While the prevalence of childhood overweight is increasing globally, this is not true in Russia (Lobstein et al., 2004; Popkin et al., 2006). Since 1998 Russia has experienced economic development such that we do not believe that inadequate resources are barriers to obtaining satisfactory foods (Dore et al., 2003; Stillman, 2006, Stillman and Thomas, 2007), although the distribution of wealth is skewed and there are still many people below the poverty level. The proportion of children living below the poverty line decreased and energy intake has risen (Zohoori et al., 2004), yet the observed prevalence of child overweight has decreased, from 15.6 to 9.0 percent in 1992 and 1998, respectively (Wang, 2002). What is it about Russia that makes it so different from other countries? We propose that lower income children consume less energy and fat and spend fewer hours in sedentary pursuits than higher income children, thereby lowering their risk of obesity. We believe that this income effect will decrease over time as the effect of being “poor” decreases as the economy improves, potentially leading to an increase in overweight prevalence.

In this study we investigate the relationship of income to diet and physical activity behaviors in Russian children. We examine the effect of income and diet and activity on overweight prevalence. Finally, we examine how the relationship of income to diet, physical activity and overweight prevalence changed over time.

2. Material and methods

The Russia Longitudinal Monitoring Survey (RLMS) is an ongoing survey of health and economic well-being in Russia. Although the survey contains a longitudinal component, the present study focuses on two cross-sectional samples collected in 1995 and 2002. The RLMS was designed to be a self-weighting, nationally representative sample. The pooled samples were identified with a year indicator (1995 = referent year). Details of the study design are provided elsewhere (Zohoori et al., 1998; Dore et al., 2003; Jahns et al., 2003; Zohoori et al., 2004). The Institutional Review Boards of the University of North Carolina and the Russian Institutes of Sociology and Nutrition approved the procedures for protection of human subjects.

2.1 Subjects

The sample consisted of 2315 children aged 7.0-13.0 years old who attended school (1215 in 1995 and 1100 in 2002). [1]One hundred-sixty-four children were excluded hundred-sixty-four children were excluded because of missing data on income (n = 94), weight or height (n = 4), or physical activity variables (n = 15). Nine children were excluded because they had extreme BMI values (z-scores more than 5 or less than -5), and 42 children were excluded as reported time spent in physical activity was impossibly high (e.g. 39 hrs/day). One-way ANOVA showed that excluded children did not differ from included children by BMI (p= 0.32), income (p = 0.09), or energy intake (p = 0.84). χ^2 analysis showed that excluded children did not differ from included children by year (χ^2 = 0.44; p = 0.51), overweight prevalence (χ^2 = 0.12; p = 0.73), or sex (χ^2 = 0.11; p = 0.74). The final analysis consisted of 2151 children.

2.2 Outcome variable: Child overweight

Weight (kg) and height (cm) were measured in subject's homes by trained interviewers using standard protocols and equipment. Subjects wore light clothing and no shoes. Overweight was defined using age- and sex-specific cutoff points for BMI (kg/m^2) adopted by the International Obesity Task Force (IOTF) (Cole et al., 2000). Obesity prevalence was low in this sample; therefore we combined overweight (8.79%) and obese (2.51%) categories and refer to this combination as “overweight”.

2.3 Primary exposure: Income

We created a three-level variable corresponding to income as a % of regional poverty level for each year (1995 and 2002). These were low (<=100%), middle (100-200%), and high (>200%), approximating thirds of the income distribution in 1995. A full description of the creation of regional poverty lines may be found elsewhere (Mroz and Popkin, 1995; Dore et al., 2003; Jahns et al., 2003).

2.4 Dietary intake

Diet was assessed by a single, interviewer-administered, 24-h recall, self-reported by children aged ≥10 years; intake of children aged <10 years was reported by the person responsible for the child's care. If the 24-h recall referred to a school day, the interviewer went to the school to collect information from the child's teacher, after school provider, and/or cafeteria workers. Failing these, the interviewer obtained a copy of the menu offered for that day. Interviewers utilized multiple-pass methodology pioneered by The U.S. Department of Agriculture. Variables were created to represent daily energy intake and % energy from fat, protein, and carbohydrates, total energy, energy/cm of child height. The

[1]Nineteen children in 1995 and 3 in 2002 did not attend school.

latter specification was used in the past to account for differences in energy needs of children based on body size, and can therefore be interpreted in the context of adequacy. As both total energy and energy/cm specifications gave similar results, energy/cm was chosen as the most parsimonious representation of diet.

2.5 Physical activity

Parents reported children's participation in in-school physical activity, before-and-after school sports, commuting mode and distance to school, and time spent in sedentary activities. Responses were coded as metabolic equivalent level (MET) values based upon the “Compendium of Physical Activities” (Ainsworth et al., 1993) classified as hrs/wk spent in moderate (3-6 METs, e.g. walking to school) or vigorous (> 6 METs, e.g. track and field) activities. Hours spent in sedentary activities (reading, watching television, computer time) were calculated separately. Representative survey questions and coding details are published elsewhere (Levin et al., 1999).

2.6 Statistical analysis

Mean (SD) estimates of reported diet and activity by income level and year were calculated and compared using one-way analysis of variance (ANOVA) with the Bonferroni correction for multiple tests within groups. Differences in prevalence of overweight by year and income level were assessed by χ^2. Significant differences were reported at $p < 0.05$. The proportion of sex did not differ by age. To measure the association between income (low or medium vs. high) and proximal predictors of overweight (kcals/cm, fat (% of energy), hrs/week in moderate, vigorous, or sedentary activities), and year effect, we developed multivariate regression models controlling for age and sex. To test whether the *effects* of income differed in 1995 or 2002, interactions among year and income levels (low or medium income level compared to highest were examined for each model. In order to interpret the coefficients of the models, we simulated the predicted level of each diet and physical activity outcome by income group by year.

Next, we used logistic regression to predict overweight as a function of 1) income and time (2002 vs. 1995), 2) income, diet and time, 3) income, diet, physical activity and time, and 4) a combination of moderate and vigorous activity in order to interpret any additional benefit of vigorous over moderate activity. Finally, to interpret the odds ratios (OR), we simulated the predicted prevalence of overweight if all children had the diet and activity profiles of the low, medium, or high income children in 1995 and in 2002.

Data management was performed using SAS software (SAS, 1999-2001). Data analysis was performed using Stata (StataCorp, 2003).

3. Results

Age, sex distribution, and mean height, weight and BMI were not different between the two samples (Tables 1 and 2). The proportion of children in the middle income group did not change, but the % of low income children decreased, and the % of high income children increased from 1995 to 2002. Average household income increased from 174% (95% CI 159, 189) of the regional poverty line in 1995 to 260% (95% CI 240, 279) in 2002. Reported energy intake increased by about 3%, from 1760 to 1817 kcal/day. The prevalence of overweight declined by one-fourth, from 12.7 to 9.7%.

Overweight prevalence did not differ significantly by income in either year, but there was a significant decline in overweight among high income children between 1995 and 2002. Energy intake differed significantly across groups for both years, especially for the proportion of energy consumed from fat (Table 3). Between years, low, medium, and high income groups all increased moderate and sedentary behavior. The medium income group reported fewer hours spent in vigorous activity in 2002 than in 1995. Low income children in 2002 reported consuming more energy (about 135 kcal, 7.5%) than in 1995.

A model was developed to predict the effect of income on diet and activity (Table 4). A significant year effect indicates how the effect of being high income differs in 2002 from 1995. The interaction term of (low income × year) tells us how low income individuals changed over time relative to the high income group. Linear combinations of coefficients tests the combined main effect and interaction effect of income with year. Compared to high income children, being low income in 2002 was associated with a significantly lower % of energy from fat, and fewer hours/week spent in vigorous activity. To interpret the coefficients in Table 4, Figure 1 shows the predicted value for each diet and physical activity variable based upon the regression coefficients. The predicted values are similar to those found in Table 3 as the model is linear with a continuous outcome measure. Age and sex, although they have independent effects in most of the models, are neither confounders nor modifiers of the association of income with diet and activity. Low income children consumed about 10 % fewer kcal/cm than high income in 1995, and about 2% fewer in 2002. Low income children consumed 3.64% percentage points less energy from fat than high income children in both time periods. Predicted hrs/wk spent in moderate activity increased by 20, 21, and 23% in the low, medium and high income groups respectively; hrs/wk spent in sedentary behaviors increased considerably, by 6.6, 3.3, and 5.5 hrs/week in the low, medium, and high income groups, respectively. Low and medium income children both decreased vigorous activity by less than 30 minutes/week. Predicted vigorous activity among high income children did not change over the 7-year period, and was higher in 2002 than among low and medium income children.

In Table 5 we present the simple model (model 1) consisting of the effects of income and year on the odds of overweight, excluding energy intake and activity. Model 2 adds energy intake, model 3 adds physical activity, and model 4 explores the effect of vigorous over moderate activity. Neither income, energy intake, vigorous nor sedentary activity levels were significant predictors of overweight, and there was no additional effect of vigorous activity over moderate observed. Hours per week of moderate physical activity had a significant inverse effect on overweight prevalence (adjusted odds ratio: 0.98 per hour of activity, 95% CI 0.95, 1.00), which was not modified by year. To interpret the odds ratios from the multivariate logistic model, Figure 2 simulates how overweight prevalence would change if all children had the diet and physical activity patterns of alternately, low, medium, or high income children in both time periods.

There is a u-shaped distribution of the predicted prevalence of overweight in 1995, and the shape of the distribution flattens in 2002. Medium income children's predicted prevalence of overweight does not change, but both the low and high income children decrease.

4. Discussion and Conclusion

The main findings of this study are as follows: overweight prevalence decreased by one-fourth between 1995 and 2002 and the effects of income on diet, activity, and overweight prevalence were attenuated in 2002 compared to 1995. Hours spent in moderate physical activity were significantly associated with a decrease in overweight prevalence, although the effect was small. The decrease in overweight is inconsistent with the increasing prevalence of overweight found in other transition countries and in both developed and developing countries (Wang, 2002; Lobstein et al., 2004; Vignerova, et al., 2007), and with concurrent increasing prevalence of overweight among Russian adults (Jahns et al., 2003; Huffman & Riziv, 2007). It is consistent, however, with other studies derived from RLMS showing a decreasing prevalence of overweight among Russian children (Wang, 2001; Wang, 2002). In a multicountry study of childhood obesity, Wang et al found an overall trend towards increasing overweight in the US, China, and Brazil; in contrast, childhood overweight in Russia decreased from 16.0 to 9.0% between 1992 and 1998, and the prevalence of underweight increased. Compared to middle-income groups, both low- and high-income children were at increased risk of overweight in other countries (Wang, 2001).

We found a direct relationship of income to energy and fat intake, and hours spent in sedentary behavior. Although measured differently, these results are consistent with other studies which have shown differences in food consumption by income (Worsley et al., 2003; Darmon et al., 2004; Drewnowski and Specter, 2004). Because the proportion of calories from fat was lower among the low income children, we might expect them to have experienced the largest decrease in prevalence of overweight. However, only among the high income group did overweight decline significantly. These seemingly contradictory results may be a function of the small size of our overweight sample, or changes in cultural norms. Monteiro et al found that in Brazil, higher income was a risk factor for obesity, while higher education tended to be protective. Similarly, Popkin et al (2003) found that education had a more significant protective effect among US adults. An examination of SES as a function of parental education may yield different results, because in Russia, income and education are not as directly related as in the United States.

Utter et al (2003) reported a direct association between sedentary behaviors and increased energy consumption in American children. In their study, low SES children spent more time watching television and less time studying or reading than high SES children, but SES was controlled in the final analysis, precluding SES comparisons with BMI. In the present study we did not examine the effect of physical activity on energy intake, nor did we examine the differential effects of television vs. other sedentary pursuits, which may account for some of the observed lack of association between sedentary behavior and overweight in this sample.

Our results are similar to those found in a study by Patrick et al (2004), who examined diet and physical activity as risk factors for overweight in American adolescents, and found insufficient vigorous physical activity to be the only observable risk factor, despite the use of objective physical activity measures. Storey et al (2003) reported an inverse relationship between both family income and team sport participation with children's BMI. The lack of an observed effect between income and overweight, or diet and overweight in our sample is consistent with previous research (Maffeis et al., 1998; Rocandio et al., 2001; Bogaert et al., 2003; Lin et al., 2004; Patrick et al., 2004).

The inverse effect of moderate physical activity is consistent with previous RLMS research by Tudor-Locke et al. (2002), who found that active commuting to school was a crucial source of physical activity. Ninety-two percent of 7-13 yr old Russian children in 1998 walked to school, so if hrs/week spent in moderate activity is associated with a small (2%) decreased risk of overweight, and 92% of children walk to school, then the overall effect on overweight prevalence could be substantial. Although they did not examine effects of income, Tudor-Locke et al. (2008), described a decrease in overweight and at risk of overweight and an increase in moderate to vigorous physical activity among boys but not girls in the RLMS study population.

So why is the prevalence of childhood overweight decreasing in Russia? Between 1992 and 1995 a cross-section of children reported decreased energy intake but no corresponding decrease in height or weight (Martinchik et al., 1997). During the 1998 crisis low-income households were able to maintain dietary stability among children (Dore et al., 2003), and although diet composition changed in response to transitory income shocks, energy intake

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and body mass were maintained by adults and children (Stillman and Thomas, 2008). Popkin et al., (2006) propose that worldwide rates of increase in the prevalence of overweight among children may be slower than rates of increase in adults, especially in Russia. Within our study high income groups, despite comparable energy intake and physical activity in 1995 and 2002, had overweight prevalence lower in 2002. Longitudinal analyses are needed to create a more complete socioeconomic-biological model of the determinants of overweight, or perhaps more importantly, the determinants of *not* being overweight, among these Russian children (Cebu, 1991).

One reason for the observed lack of effect of diet and activity among children in epidemiologic studies may be the difficulty in measuring diet and activity in a sufficiently precise manner. However, in this study our data were sensitive enough to find effects of income on diet and physical activity. Another reason may be that growing children do not increase height and weight concurrently. Children often will “store up” energy prior to a burst in linear height, causing them to appear overweight, only to return to a healthy weight after the period of rapid growth. BMI cut-off points based upon age- related changes using reference percentiles addresses age-related changes (Cole et al., 2002), but individual height and weight growth patterns may vary, attenuating the observed effect of diet or activity on overweight in empirical studies.

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Highlights

>We study income and overweight in Russian children aged 7-13 in 1995 and 2002. >Overweight prevalence decreased by one-fourth between 1995 and 2002. >Obesity declined more among high income parents. >The effect of having low income parents was less in 2002 than 1995. <Moderate physical activity was associated with reduced child overweight.

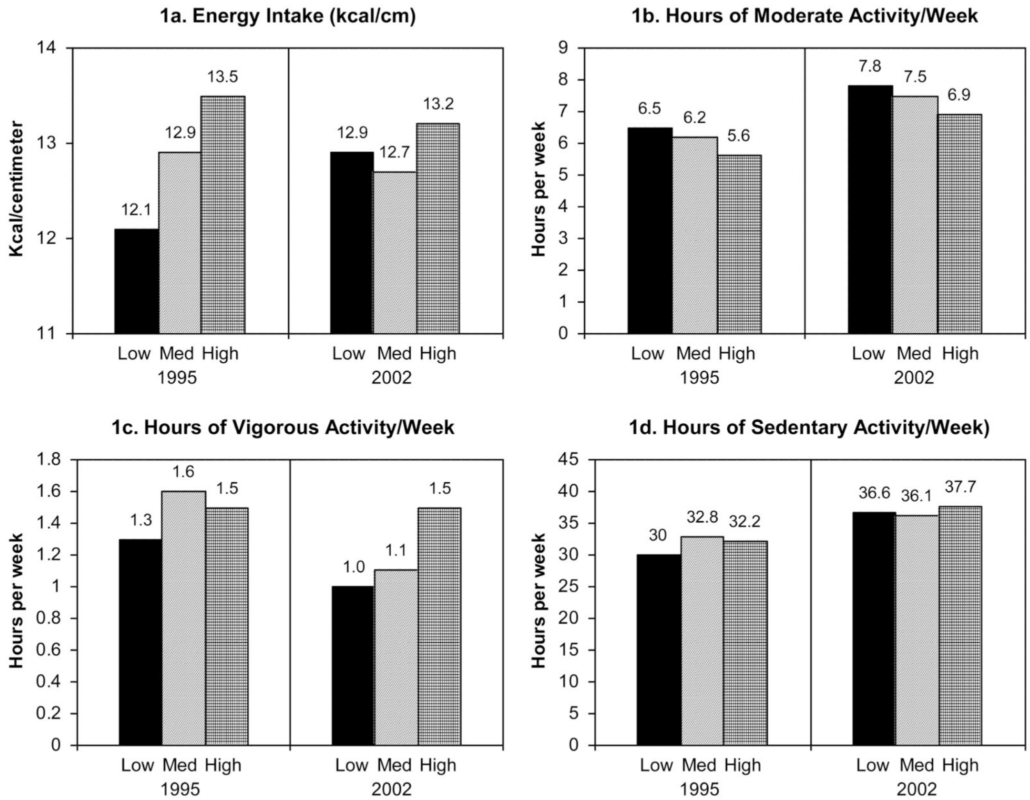

Figure 1.

(a) Energy intake (kcal/cm); (b) hours of moderate activity/week; (c) hours of vigorous activity/week; (d) hours of sedentary activity/week.

*adjusted for age, sex

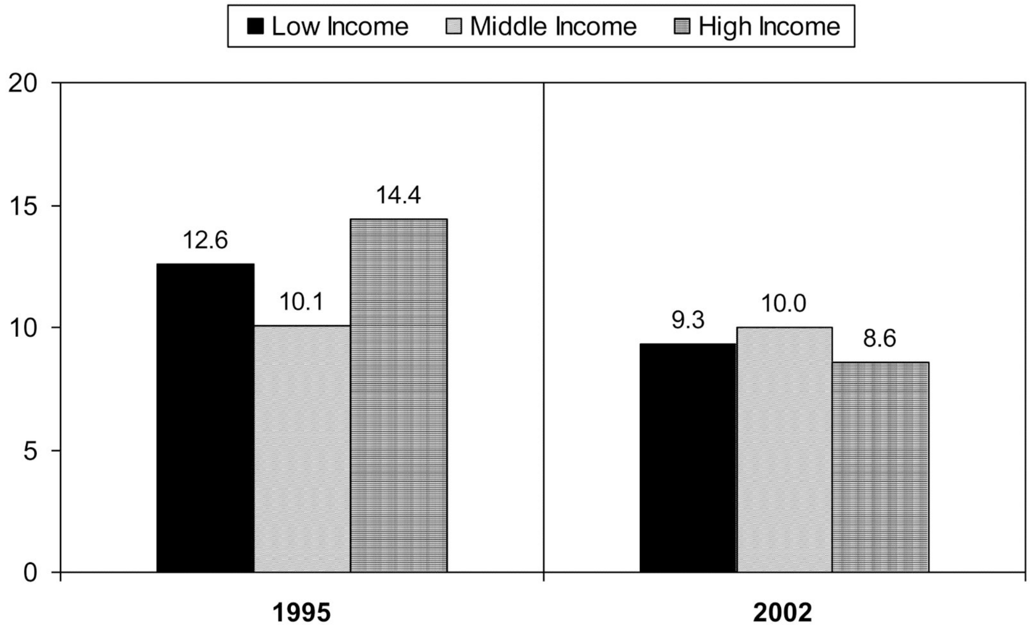

Figure 2. Simulated Prevalence of Overweight
*adjusted for age, sex

Table 1

Sample count by characteristics of 2151 7-13 year old Russian schoolchildren.

Year	**1995**	**2002**
	n (%)	**n (%)**
	Total (n = 1133)	**Total (n =1018)**
Age (years)		
7	149 (13.4)	127 (12.5)
8	151 (13.9)	141 (13.8)
9	172 (14.8)	141 (13.8)
10	169 (14.7)	140 (13.8)
11	169 (14.8)	148 (14.5)
12	165 (14.5)	171 (16.8)
13	158 (13.8)	150 (14.7)
Girls	567 (50.0)	480 (47.2)
Income (% of poverty line)		
<100 (Low)	509 (44.9)	256 (25.2)*
100-200 (Middle)	381 (33.6)	367 (36.0)
>200 (High)	243 (21.4)	395 (38.8)*
BMI category[a]		
Normal	989 (87.3)	919 (90.3)*
Overweight	144 (12.7)	99 (9.7)*

BMI = body mass index.

[a]Overweight refers to the combined overweight/obese categories based upon International Obesity Task Force (IOTF) age-and-sex specific BMI cutpoints.

*Differs from 1995, <0.05.

Table 2

Physical characteristics of 7-13 year old Russian schoolchildren. Data are shown as mean (S.D.)

Year	**1995**	**2002**
	Total (n = 1133)	**Total (n =1018)**
Age (years)	10.0 (2.0)	10.1 (2.0)
Height, (cm)	140.0 (13.8)	140.8 (13.5)
Weight (kg)	34.8 (10.4)	34.9 (9.8)
BMI (kg/m^2)	17.4 (3.0)	17.3 (3.0)
Energy (kcal/day)	1760.0 (660.7)	1817.2 (630.0)*
fat (% energy)	31.0 (9.1)	31.4 (9.1)
Energy/cm (kcal/cm)	12.6 (4.8)	13.0 (4.5)
Hrs/week spent in		
Moderate activity	6.2 (6.1)	7.3 (6.5)*
Vigorous activity	1.4 (2.8)	1.2 (2.1)*
Sedentary activity	31.4 (14.5)	36.8 (13.2)*

BMI = body mass index.

*Differs from 1995, <0.05.

Table 3

Distribution of overweight, diet and physical activity of children by income group (1995 and 2002)*. Data are presented as mean (S.D.) unless otherwise indicated.

Year	**1995**			**2002**		
	Income level			**Income level**		
	Low	**Med**	**High**	**Low**	**Med**	**High**
Variable						
Overweight (%)	13.2	10.8	14.8	9.8	10.6	9.7[d]
Hrs/week spent in						
Moderate activity	6.4 (6.3)	6.2 (6.2)	5.6 (5.6)	7.8 (6.6) [d]	7.6 (6.8) [d]	6.8 (6.1)[d]
Vigorous activity	1.3 (2.4)[c]	1.5 (3.2)	1.4 (2.8)[c]	1.0 (1.9)	1.2 (1.9)[d]	1.5 (2.5)
Sedentary activity	30.0 (9.2)[a]	32.8 (14.0)[a]	32.2 (13.7)	36.6 (13.0)[d]	36.0 (12.7)[d]	37.8 (13.7)[d]
energy (kcal/day)	1666.1 (629.4)[ac]	1801.7 (646.0)[a]	1891.8 (718.3)[c]	1801.4 (592.8) [d]	1765.0 (592.0)[b]	1875.8 (682.2)[b]
Energy/cm (kcal/cm)	12.1 (4.7) [ac]	12.9 (4.7)[a]	13.4 (5.1)[c]	13.0 (4.3)[d]	12.8 (4.3)	13.2 (4.7)
Fat (% energy)	29.9 (9.2)[c]	31.0 (8.9)[b]	33.5 (8.7)[bc]	29.0 (9.1)[ac]	31.7 (9.4)[a]	32.8 (8.7)[c]
protein (% energy)	11.6 (2.8)	11.8 (2.9)	12.1 (3.1)	11.6 (2.6)	11.9 (2.9)	11.9 (2.9)

*Overweight refers to the combined overweight/obese categories based upon International Obesity Task Force (IOTF) age-and-sex specific BMI cutpoints.

[a]Significant difference between low and middle income groups within the same year, <0.05.

[c]Significant difference between middle and high income groups within the same year, <0.05.

[c]Significant difference between low and high income groups within the same year, <0.05.

[d]Significant difference from 1995 for the same income group, <0.05.

Table 4

Coefficients and intercepts from multiple regression models used to predict diet and activity within income groups. (n = 2151).

	Energy/cm (kcal)	Fat (% energy)	Low	Hrs/week activity Moderate	Vigorous
	Coefficient (95% Confidence Interval)				
Low income	-1.37* (-2.07, -0.68)	-3.64** (-5.02, -2.26)	0.95 (-0.004, 1.90)	-0.20 (-0.59, 0.18)	-2.12** (-4.23, -0.01)
Medium income	-0.52 (-1.25, 0.21)	-2.50** (-3.95, -1.05)	0.61 (-0.40, 1.61)	0.11 (-0.30, 0.51)	0.64 (-1.58, 2.86)
Year	-0.24 (-0.97, 0.49)	-0.78 (-2.22, 0.66)	1.28** (0.29, 2.28)	-0.004 (-0.40, 0.40)	5.54* (3.33, 7.75)
Low[a]year	1.10** (0.97, 2.10)	-0.06 (-2.04, 1.92)	-0.83 (-1.45, 1.28)	-0.28 (-0.82, 0.27)	1.07 (-1.96, 4.09)
Med[a]year	-0.002 (-0.98, 0.98)	1.49 -0.45, 3.42)	0.05 (-1.29, 1.38)	-0.42 (-0.96, 0.12)	-2.28 (-5.24, 0.69)
Age	-0.23* (-0.33, -0.14)	0.15 (-0.04, 0.35)	-0.14** (-0.27,-0.002)	0.03 (-0.02, 0.09)	0.47** (0.17, 0.76)
Sex (male)	1.58* (1.19-1.96)	-0.14 (-0.90, 0.62)	1.53* (1.00, 2.05)	0.54* (0.33, 0.75)	-1.08 (-2.25, 0.92)
intercept	15. 00 (13.84, 16.16)	32.02 (29.72, 34.32)	6.18 (4.59, 7.77)	0.85 (0.21, 1.49)	28.02 (24.50, 31.54)
Tests of linear combination of income effects plus the difference in income effects in 2002 vs 1995					
Low + low[a]year	-0.28 (-0.99, 0.44)	-3.70** (-5.11, -2.28)	0.86 (-0.11, 1.85)	-0.48** (-0.87, -0.09)	-1.05 (-3.23, 1.12)
Medium + medium[a]year	-0.52 (-1.17, 0.12)	-1.01 (-2.30, 0.27)	0.65 (-0.24, 1.54)	-0.31 (-0.67, 0.04)	-1.64 (-3.60, 0.33)

[a] Interaction between income level and years.

* $P<0.001$. Reference group = high income.

** $P<0.05$. Reference group = high income.

Table 5

Results of logistic regression models of predictors of overweight in children (n = 2 151). All models were adjusted for age and sex.

	Model 1	Model 2	Model 3	Model 4
Variable	**Adjusted odds ratio (95% Confidence Interval)**			
Income				
Low	0.85 (0.55, 1.33)	0.88 (0.56, 1.36)	0.89 (0.57, 1.38)	0.89 (0.57, 1.38)
Medium	0.69 (0.43, 1.12)	0.70 (0.43, 1.13)	0.71 (0.44, 1.16)	0.71 (0.44, 1.16)
Year	0.56* (0.34, 0.92)	0.56* (0.34, 0.93)	0.60* (0.36, 0.99)	0.60* (0.36, 0.99)
Low income[a]year	1.27 (0.63, 2.55)	1.24 (0.62, 2.50)	1.23 (0.61, 2.49)	1.23 (0.61, 2.49
Medium income[a]year	1.71 (0.86, 3.38)	1.70 (0.86, 3.37)	1.68 (0.85, 3.32)	1.68 (0.85, 3.32)
Diet				
Kcal/cm		1.02 (0.99, 1.05)	1.02 (0.99, 1.05)	1.02 (0.99, 1.05)
Physical Activity (hrs/week)				
Moderate			0.98* (0.95, 1.00)	
Vigorous			0.98 (0.93, 1.04)	1.00 (0.95, 1.07)
Sedentary			1.00 (0.99, 1.01)	1.00 (0.99, 1.01)
Moderate+Vigorous				0.98* (0.95, 1.00)

[a] Indicates interaction between the two variables.

* *P*<0.05. Reference group = high income.