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Discussion Paper 185/2007

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Sonya K. Huffman and Marian Rizov

Katholieke Universiteit Leuven

LICOS Centre for Institutions and Economic Performance
Huis De Dorlodot
Deberiotstraat 34 – postbus 3511
B-3000 Leuven
BELGIUM
TEL:+32-(0)16 32 65 98
FAX:+32-(0)16 32 65 99
http://www.econ.kuleuven.be/licos

The Rise of Obesity in Transition Economies:

Theory and Evidence from the Russian Longitudinal Monitoring Survey

Sonya K. Huffman*
Department of Economics, Iowa State University

Marian Rizov
Middlesex University Business School

March 23, 2007

Abstract:
This study integrates theoretical and empirical models to facilitate understanding of human obesity and the factors contributing to rising obesity in Russia during the transition from a planned to a market economy. Recent individual level data from the Russian Longitudinal Monitoring Survey for 1994 and 2004 show that diet/caloric intake, smoking, gender and education are important determinants of obesity in Russia. Empirical results strongly support our model for production of health and demand for inputs in the health production function. The analysis provides information on dietary patterns and other determinants of obesity which is essential for formulation and implementation of effective policies designed to improve overall nutritional wellbeing and reduce obesity and mortality of the population. Interventions, which enhance education toward healthy lifestyles and healthy diet, could play a vital role in preventing obesity in Russia.

JEL Classification: D10, I12, J01
Keywords: health, obesity, transition economies, Russia

* We thank Wally Huffman and the Human Resource Workshop participants at the Department of Economics, Iowa State University for helpful comments.

The Rise of Obesity in Transition Economies:

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1. Introduction

Since the early 1990s series of reforms have been implemented in transition economies. Economic reforms aiming at increase in efficiency comprised price liberalization, privatization and enterprise restructuring. However, the reforms also brought dramatic changes in all areas of the population's life. Important side effects were increase in unemployment and poverty, additional stress and uncertainty, rising crime, and fall in living standards, for certain groups of the population. As a result, the population in transition economies experienced dramatic changes in lifestyle and a significant decline in life expectancy.

The adverse effects of transition were most severe in the Former Soviet Union. Several studies examine the reasons for the mortality crisis in Russia and other former Soviet republics (Breinerd and Cutler, 2005; Cockerham, 2000; Shkolnikov et al., 2004). Breinerd and Cutler show that during the 1990s greater alcohol consumption was an important determinant of higher mortality rates in Russia. The increased stress from the transition to a market economy had dramatically affected the lifestyle and the diet of the population as well. Furthermore, the authors find that across households rising human obesity has important health consequences and is a significant predictor of mortality, however, the magnitude of the effect is small. Stillman (2006) reviews the literature examining health outcomes in Eastern Europe and the Former Soviet Union during the transition period and also points out to the link between obesity and health outcomes.

Obesity has reached epidemic proportions globally, with more than 1 billion adults overweight, and at least 300 million of them clinically obese (WHO, 2006). Obesity has become a major contributor to the global burden of chronic diseases and disability. The health consequences range from increased risk of premature death to serious chronic conditions that reduce the overall quality of life. The emerging and transition economies, including Russia, had the highest number of diabetics in 1995 (WHO, 2006). Therefore, a greater understanding of the rise in obesity and its determinants in transition economies could lead to important policy recommendations for reducing the problem and improving the health of the population.

The risk of obesity is strongly influenced by diet and lifestyle which have been changing dramatically as a result of economic and nutritional transitions. However, very few studies have examined the determinants of obesity in transition economies in contrast to the large literature on high-income countries such as the USA (Chou et al., 2004; Huffman et al., 2006; Komlos and Baur, 2004; Lakdawalla et al., 2005; Lakdawalla and Philipson, 2002; Rashad, 2006; Rashad et al., 2005). Mendez and Popkin (2004) find that the population of low-income countries has also become susceptible to obesity in the process of economic development. An interesting study by Liefert (2004) examines food security in Russia and points that a serious health problem is overweight and obesity "which have increased during transition and currently affect over half of the adult population." Zohoori et al. (1998) find that the prevalence of obesity, as well as the alcohol consumption, has risen significantly in Russia during 1992-1996.

The goal of this paper is to develop theoretical and empirical models to examine human obesity and its determinants in Russia, the largest transition economy. The analysis contributes to better understanding of how rationale economic agents respond to external factors that are expected to influence food consumption and weight. Russia is also one of the transition economies facing the most severe obesity and general health problems. Obesity has increased during transition, rising from 20.3 percent of the population in 1994 to 28.0 percent in 2004—a 38-percent increase, based on our weighted sample. Individual and household level data from the Russian Longitudinal Monitoring Survey (RLMS) for 1994 and 2004 is employed to study the factors contributing to rising obesity in the framework of the productive household models and to empirically test our hypotheses. The models are estimated for the pooled sample and for subsamples by gender and time period. Empirical results strongly support our models for production of health and demand for inputs in the health production function. The rest of the paper is organized as follows. First, a conceptual framework is developed, based on health productive household models. Next, the data and econometric techniques are described, followed by a discussion of the estimation results. Finally, conclusions and suggestions for further research are offered.

2. Theoretical model

The productive household models of health developed by Rosenzweig and Schultz (1982) and Grossman (2000), and the agricultural household models developed by Huffman (1991) provide a useful framework for analyzing overweight and obesity. An important proposition in the framework is that the health status of each household member is determined by the degree of overweight and obesity of that member. The household has a utility function

$$U = U(H, D, C, L; O) . \tag{1}$$

Utility is determined by health status, H; consumption of food (diet), D, consumption of other goods (excluding food) and services (other than health inputs), C, and leisure, L. Furthermore, utility is affected by a vector O of fixed (observable) characteristics, such as education, age, gender, place of residence, etc.

The household has a health production function

$$H = H(D, M, L; O, \mu), \tag{2}$$

where M denotes a vector of purchased health inputs such as medical drugs and health care services, and μ is the unobservable individual and household characteristics that affect the individual's health; such characteristics may include genetic factors. Food consumption/diet affects utility directly and indirectly through health production, providing energy, protein, vitamins and minerals.

We assume that the household has a budget constraint

$$P_D D + P_M M + P_C C = W(T - L) + N, \tag{3}$$

where P_D, P_M and P_C denote the prices of food (D), medical drugs and health care services (M), and other goods and services (C), respectively. Further, W is the wage rate, T is the fixed time endowment (T-L=work), and N is the household's nonlabor income.

For an interior solution of the model, substitute equation (2) into (1) and use the budget constraint (3). Then, the household chooses D, L, M, and C by maximizing its utility subject to its budget constrain. The utility maximization problem can be written as

$$L = U[H(D, M, L; O, \mu), D, C, L; O] + \lambda(WT + N - P_D D - P_M M - P_C C - WL), \tag{4}$$

where λ is the Lagrange multiplier representing the marginal utility of household full income. The first order conditions for an optimal solution are:

$$U_H H_D + U_D = \lambda P_D, \tag{5}$$

$$U_H H_M = \lambda P_M, \tag{6}$$

$$U_H H_L + U_L = \lambda W, \tag{7}$$

$$U_C = \lambda P_C, \tag{8}$$

$$WT + N = P_D D + P_M M + P_C C + WL, \tag{9}$$

where $U_H = \partial U / \partial H$, $H_D = \partial H / \partial D$, $U_D = \partial U / \partial D$, $H_M = \partial H / \partial M$, $H_L = \partial H / \partial L$, $U_L = \partial U / \partial L$ and $U_C = \partial U / \partial C$. For an interior solution, equations (5)-(9) yield the household optimal demand functions for D, M, L and C:

$$\Phi^* = f_\Phi(P_D, P_M, P_C, W, N, O, \mu), \qquad \Phi = D, M, L, C. \tag{10}$$

Therefore, the demand for inputs into the health production function depends on the prices of the purchased inputs (P_D, P_M, P_C), the wage rate (W), nonlabor income (N), fixed factors (O) and unobserved factors (μ), which are assumed to have zero expected mean. After substituting the optimal demand functions D^*, M^* and L^* from equation (10) into the health production function (2), we obtain the household's health supply function:[1]

$$H^* = S_H(P_D, P_M, P_C, W, N, O, \mu). \tag{11}$$

To clarify, the household's health production function (equation 2) is a technology relationship, while the health supply function (equation 11) is the behavior relationship based on the optimal household's decisions.

3. Data and econometric specification

Data from the Russian Longitudinal Monitoring Survey (RLMS) for 1994 and 2004 is employed to investigate the factors contributing to the rising obesity in Russia. The RLMS is a nationally representative household survey that annually samples the population of dwelling units.[2] The RLMS is designed to monitor the effects of Russian reforms on the health and welfare of the Russian individuals and households and is coordinated by the Carolina Population Center at the University of North Carolina (http://www.cpc.unc.edu/projects/rlms). The survey is based on multi-stage probability samples of the Russian population. The collected data include a wide range of information concerning household characteristics such as demographic composition, income, and expenditures. Data on individuals includes employment, anthropometric measures, health status, nutrition, alcohol consumption, and medical problems. We use round 5 (1994) and round 13 (2004) of the RLMS. Table 1 presents the definitions, means and standard deviations for all variables used in the econometric analysis for the weighted data. The variables are based on the estimated sample of 6,424 individuals (age 18 and over) and 3,710 households that remain after observations with missing values are deleted.

Based on the theoretical model, we add empirical content by providing empirical definitions of the variables and imposing a specific algebraic form of equations (2) and (11). We focus our efforts on two dependent variables: individual's weight and body-mass-index (BMI). A standard measure of obesity is based on the BMI—individual weight in kilograms divided by height in meters squared (kg/m^2). According to the WHO, an individual with a BMI over 25 kg/m^2 is defined as overweight, and with a BMI of over 30 kg/m^2 as obese. However, the BMI may overestimate body fat in athletes who have a muscular build, and may underestimate body fat in older people who have lost muscle mass (NIDDKD, 1996). Hence, we choose both an individual's weight and BMI as the measure of obesity. The BMI index is constructed for each respondent from data collected by trained personnel on weight and height. The average individual weight was 71.9kg in 1994 and it increased to 74.4kg in 2004, while the average BMI was 26.2 in 1994 and increased to 27.4 in 2004.

Tables 2a-2c present the descriptive characteristic of the Russian population by categories of normal weight, overweight and obese based on the definitions discussed above for the whole sample and by gender for each round (1994 and 2004) as well as for the pooled sample. The overweight and obese are on average older (50 and 54 years respectively) as compared to individuals with normal weight (43 years), shorter (165 cm and 162 cm as compared to 167 cm), with less education, smoke significantly less, drink alcohol less than the individuals with normal weight. The total income for the overweight is higher (9153 rubles/month) while for the obese is lower (8589 rubles/month) than the normal-weight individual's income (8880 rubles/month). Controlling for tree levels of education the overweight and obese males are more likely to have higher education compared to individuals with normal weight (15% and 18% as compared to 12%). While the opposite is true for the overweight and obese females that are less likely to have higher education than normal-weight females (17% and 11% as compared to 22%). Overweight men are more likely to be employed (68%) compared to the obese (60%) and normal weight men (64%) but obese men are less likely to have a job compared to the normal-weight men. Furthermore, overweight and obese men live in households with higher real income than the normal-weight men. They are slightly less likely to drink alcohol than the normal-weight men (69 % versus 72%) and they are significantly less likely to smoke (52% of overweight, 39% of obese as compared to 72% of normal-weight individuals). Similar characteristics for the females point that the overweight and obese females smoke and drink less, and are less likely to work.

Our (weighted) data reveal that the share of the population that is overweight and obese has increased in Russia between 1994 and 2004. Overweight people accounted for 34.25 percent of the total in 1994 and for 36.07 percent in 2004. In 1994 the overweight rate of males was higher than that of females—35.81 percent versus 33.16 percent. The increase in obesity was much more dramatic during the transition period, from 20.28 percent in 1994 to 28.00 percent in 2004. In 1994, the obesity rate was much higher for females, at 27.82 percent, compared to only 9.49 percent for males. Based on our data, women are more likely to be obese in Russia, which is a trend similar to western countries. Importantly, the overweight and obesity rates have increased for both genders over 1994 to 2004. For women, the overweight rate increased slightly from 33.16 to 34.59 percent, and for men from 35.81 to 38.07 percent. However, the increases in obesity rates were more significant in magnitude, from 27.82 percent to 36.62 percent for women, and from 9.49 percent to 16.34 percent for men. Therefore, it is important to identify and understand the factors that could have contributed to this dramatic increase in obesity in Russia during the economic transition.

Following our theoretical model, we first establish the technical relationship between weight (and BMI, in an alternative specification) and its determinants, including diet as measured by caloric intake and composition, and control for selective economic and socio-demographic factors. The individual's health production function (2) or the technical relationship is specified as

$$\begin{aligned} \ln H_i &= \gamma_1 + \gamma_2 \ln \text{Height}_i + \gamma_3 \ln \text{Calories}_i + \gamma_4 \text{Fat}_i + \gamma_5 \text{Protein}_i + \gamma_6 \text{Smoker}_i \\ &+ \gamma_7 \text{Male}_i + \gamma_8 \text{Education}_i + \gamma_9 \text{Work}_i + \gamma_{10} \text{Age}_i + \gamma_{11} (\text{Age}_i)^2 + \gamma_{12} \text{Year}_i + \varepsilon_{i1} \end{aligned} ,(12)$$

where subscript *i* refers to an individual, H_i is defined as the individual's weight in kg (or BMI).[3] Height is the individual's height measured in cm; Calories is the total individual calories consumed per day; Fat is the share of fat intake in the total calorie intake; Protein is the share of protein in the total calorie intake; Smoker is a dummy variable equal to one if the individual smokes and zero otherwise; Male is a dummy variable equal to one if the individual is male and zero otherwise (i.e. female); Education is a set of dummy variables for three levels of education (basic, high, and higher); Work is the labor force participation (employment) indicator equal to one if the individual works and zero otherwise; and Year is a dummy variable equal to one if the year is 2004 and 0 for year 1994.[4] γ_1- γ_{12} are parameters of the individual's health production function to be estimated. We include the individual's mature height in this equation as a summary indicator of an individual's genetic potential and early investments in good health. The year dummy variable controls for changes over time related to public health and the organization of the health care system as transition progresses. The random disturbance term ε represents the impact of all other factors and has a zero mean.

Larger caloric intake, other things equal, is expected to lead to weight gain and eventually to obesity ($\gamma_3>0$). Likewise, an increase in fat in the diet, beyond a certain threshold, is expected to accelerate obesity ($\gamma_4>0$), and increase in protein - possibly to accelerate obesity ($\gamma_5><0$). Smokers consume fewer calories than non-smokers. Specifically, cigarette smoking is associated with lower weight because smoking tends to increase metabolism and suppress appetite, thus having a negative effect on weight (BMI) ($\gamma_6<0$). For other variables the *a priori* hypotheses are more complex and outcomes less clear; therefore, we do not state prior expectations about the signs of coefficients for these variables.

Next, we estimate demand equations (eq. 10) for calories, meat and fish, fruits and vegetables, and dairy products. The empirical specification for these demand equations is

$$\ln Q_I^{i/h} = \alpha_1 + \alpha_2 \ln \text{Eqnum}_i + \alpha_3 \ln \text{Height}_i + \alpha_4 \text{Smoker}_i + \alpha_5 \text{Male}_i + \alpha_6 \text{Education}_i$$
$$+ \alpha_7 \ln \text{Income}_i + \alpha_8 \ln(\text{Income}_i)^2 + \alpha_9 \text{Age}_i + \alpha_{10} (\text{Age}_i)^2 + \alpha_{11} \text{Year}_i + \sum_{r=12}^{18} \alpha_r \text{Region}_i + \varepsilon_{i2}, \quad (13)$$

where $Q_I^{i/h}$ is the individual's (i) demand for (I=) a) calories, or the household's (h) demand for (I=) b) meat and fish, c) fruits and vegetables, and d) dairy products. The variable adult equivalent number (Eqnum) of household members is excluded from the individual's demand for calories equation 13a. Regional dummy variables are used to capture the differences in real prices. In equations 13(b, c, and d) height, gender, age, education, and smoking habits are proxied by the characteristics of the household head who is assumed to be the main decision maker in the household. Equation 13a is estimated by ordinary least squares (OLS), while for equations 13(b, c, and d) we use the interval regression estimation in STATA to deal with the censoring of dependent variables.

The probability of an individual consuming alcohol (A_i) is estimated as a function of exogenous demographic and socio-economic variables (O), including Height, Calories, Smoker, Male, Education, Income, Income^2, Age, Age^2 and Region, using a probit model:

$A_i^* = \delta_i' O_i + \varepsilon_{i3}$ where A_i=1 if $A_i^* > 0$ and 0 otherwise. (14)

Alcohol consumption can affect obesity through caloric intake in our analysis, as well as through mortality caused by accidents, cardiovascular disease, etc.

The individual's health supply function (11) is specified as

$$\ln H_i = \beta_1 + \beta_2 \ln \text{Height}_i + \beta_3 \text{Smoker}_i + \beta_4 \text{Male}_i + \beta_5 \text{Education}_i + \beta_6 \ln \text{Income}_i$$
$$+ \beta_7 \ln(\text{Income}_i)^2 + \beta_8 \text{Age}_i + \beta_9 (\text{Age}_i)^2 + \beta_{10} \text{Year}_i + \sum_{r=12}^{18} \alpha_r \text{Region}_i + \varepsilon_{i4}, \quad (15)$$

where Income is the total real household income per month, and Region is a dummy variable for each of eight regions of the country that represent, largely, the regional differences in real food prices. Regional fixed effects will control for relative prices of food and other omitted variables that differ by region. Studies on transition economies by Gardner and Brooks (1994) and Huffman and Johnson (2004) have found geographical price differences. Household income is expected to have a positive effect on the supply of good health, but we permit it to be non linear by adding a squared term. We expect individual weight (or BMI) to increase with age, at least up to middle age, but eventually the digestive system starts to lose its efficiency and capacity and the effects of finite life set in. Therefore, we expect $\beta_8>0$ and $\beta_9<0$.

The econometric specifications in equation (12) and (15) are estimated by OLS, both for the whole sample and by gender subgroups (male/female). We also test for homogeneity of the health production and supply functions across genders, (male/female) and expect to reject homogeneity.

4. Estimation results

We estimate the health production function, individual demand functions for calories and alcohol, and the household demand functions for other food types, and then the health supply function as specified in equations (12), (13), (14) and (15). The individual's health production function (equation 12), demand function for calories (equation 13a) and health supply (equation 15) function are fitted by OLS.[5] The household's demand functions for meat and fish (equation 13b), fruits and vegetables (equation 13c) and dairy products (equation 13d) are estimated by interval regression to account for censoring of the dependent variable. The parameters of the alcohol consumption equation (14) are estimated using the probit estimator. We have a balanced panel for individuals and households from 1994 and 2004. We report the robust standard errors that have been corrected for individual clustering.

Table 3 presents the OLS estimates of the health production function where the dependent variable is the natural log of an individual's weight. It is fitted on pooled data and separately by gender. We test for equality across gender and reject the homogeneity.[6] We find strong econometric evidence for the health production function for both females and males. Weight increases with an individual's height. Age has a positive and significant effect on weight, but the age effect is diminishing at higher ages. Total calories consumed positively and significantly affect male's weight, while the protein intake leads to an increase in the weight of both men and women. A ten percent increase in caloric intake increases individual's weight by 0.6 percent for males. An increase in food fat content, holding protein content and calorie consumption constant, increases the weight for both females and males. Increasing protein content, holding fat content and calories consumed constant, increases an individual's weight, as well. Smoking decreases significantly the male's weight by 7.6 percent and the female's weight by 2.7 percent. Having a higher level of education has a strong and significant negative effect on woman's weight—a decrease of 3.8 percent compared to the basic education category, but there is no significant effect of a male's education on his weight. An individual being employed has a statistically significant positive effect (a 1.7 percent increase) on male's weight. However, there is no a significant effect for women. Being employed could possibly increase the opportunity costs of off-the-job physical exercise needed to maintain lower (optimal) weight. The estimated coefficients for the year dummy are statistically significant and positive, indicating that people are heavier in 2004 than 1994. During the transition, individual weights have increased by 1.2 percent, other things equal. This finding suggests that the standard mechanism driven by technological change is also at work, as is observed for other countries.

Table 4 presents the OLS estimates of the health production function where the dependent variable is the natural log of BMI. It is fitted to data pooled over men and women and separately by gender. The results from the BMI equation look similar to those from the weight equation. Age follows a nonlinear relationship with both weight and BMI. BMI and obesity appear to rise with age and then peak at 60, thereafter lowering again for those in their 60's and 70's. We tested for equality across genders and rejected this hypothesis at the 1 percent level. A male's age, total calories and the fat and protein content of his food consumption have statistically significant and positive effects on his BMI. A female's BMI increases with her dietary fat and protein consumption. Having higher education decreases her BMI. While being employed increases only the BMI for males, being a smoker significantly decreases their BMI. However, the BMI for both genders is higher in 2004 than in 1994.

Diet (food consumption) is an important determinant of an individual being overweight or obese. In Russia, the traditional diet is high in sugar and livestock products (meat and dairy) that contain fat, protein and cholesterol, but is low in consumption of healthier foods, such as vegetables and fruits, and has extremely low intake of citrus fruit (Ginter 1995). This is probably due to the difficulty of growing fruits and vegetables in the Russian climate, as well as to the state authorities' food recommendations during the Soviet era that heavily favored meat and dairy products. The original Recommended Daily intake in the Soviet Union specified that high protein intakes were necessary for maintaining good health. But high animal protein diets are likely to be high in saturated fat also.

How did consumption of meat and fish, fruits and vegetables, dairy, and alcohol change during the transition? Tables 2a-c present the changes in consumption of fruits and vegetables, meat and fish, and dairy products from 1994 to 2004 by population categories. Consumption of food products is measured by the household real (with reference to June 1992) monthly expenditures. There is a trend of declining consumption of food products for all groups, with the most dramatic decline in consumption of meat and fish, and fruits and vegetables. The consumption of fruits and vegetables declined the most for the overweight people (49 percent), followed by decline for the normal-weight people (45 percent) and for the obese (33 percent). The consumption of meat and fish declined the most for the normal-weight people, by 50 percent, followed by decline for the overweight people, 43 percent and for the obese, 36 percent. The dairy products consumption declined by 37 percent for normal-weight people and by 32 percent for the overweight and obese groups. The average Russian adult's calories consumption is about 1870 calories per day. Protein intake contributes around 13 percent of total calories, with a very small increase during the transition period. Caloric intake from fat declined from 34 percent for adult men and women, to 32 percent only for the normal-weight and overweight groups, possibly due to an overall improvement in nutritional status, while for the obese people it stayed the same at 33 percent. Tables 2a-c show also the changes in consumption of alcohol and cigarette smoking in Russia during the period 1994-2004. The general pattern during the transition period is that the number of people who consume alcohol has decreased, while there was a slight increase in the number of people who smoke.

Next, we estimated the individual demand for a) calories by OLS, the household demands for b) meat and fish, c) fruits and vegetables, and d) dairy products (equation 13) by interval regression, and the individual demand for alcohol (equation 14) by probit models.[7] First, we fitted the demand equation for individual's total calories. An increase in age and income significantly increases the demand for calories but the effect of income is diminishing at higher income levels, given the negative coefficient on the squared term of income. The income elasticity estimated at the sample mean is 0.035. Therefore, the estimated income effect is quite small. Being male increases the demand for calories by about 10 percent. During the transition, the demand for (consumption of) calories has increased by 2.3 percent. Being a smoker decreases the demand for calories by 3 percent. The results of the estimation of the demand for calories equation show significant regional effects, as well. Compared to the base Moscow-St. Petersburg metropolitan regions, the consumption of calories in all less urbanized regions is higher by between 10.8 and 23.9 percent.

The household demand equations for meat and fish, fruits and vegetables, and dairy products were fitted to the household data. The results are presented in Table 5. The adult equivalent number of household members is included to control for the size of the household, and the individual characteristics of the household head are used. The year dummy variable, household income and the head's education are among the important factors that significantly increase the household's demand for meat and fish, fruits and vegetables, and dairy products. The quantity demanded of these products is 7.0 to 8.9 percent higher in 2004 than in 1994. The demands for fruits and vegetables, meat and fish, and dairy products are also convex in age of the household head—the quantity demanded declines until middle age and increases later. However, the effects are statistically significant only for the fruits and vegetables and dairy demand equations. The positive coefficient on income and the negative coefficient on income squared indicate that the demands for calories, meat and fish, fruits and vegetables, and dairy products are concave with respect to income. The demands for meat and fish, fruits and vegetables, and dairy products peak at 44769, 44755 and 34007 rubles, respectively. The income elasticities computed at the mean values of expenditures are positive and higher than unity—1.97 for fruits and vegetables, 1.66 for meat and fish and 1.27 for dairy products, indicating that as real income fell there was a major reduction in the consumption of these products. The estimated elasticities are relatively high compared to those found in developed countries but comparable to those found in other transition economies (Hossain and Jensen, 2000). The regional differences in demands are interesting as the pattern of demand for all types of food is just the opposite of the pattern of demand for calories. In all regions, demands are lower compared to the base Moscow-St. Petersburg regions. The results suggest that dietary patterns differ substantially between metropolitan areas and rural provinces in Russia.

Table 6 presents the estimated coefficients and the marginal effects of the individual's probability of consuming alcohol. The marginal effects are evaluated at the sample means. Being a male, a smoker, and having a higher education, all increase the probability of consuming alcohol by 20.4, 12.8 and 11.0 percent, respectively. An increase in age has a positive but diminishing effect on the probability of alcohol consumption. The marginal effect of age evaluated at the sample mean is negative. Alcohol consumption also increases with income, although the effect is not statistically significant. However, the marginal effect of income at the mean is positive and statistically significant. The probability of alcohol consumption is significantly higher in the North and Northwest (by 8.1 percent), Central (by 7.0 percent) and Ural (by 12.4 percent) regions compared to the Moscow-St. Petersburg regions. The probability of consuming alcohol declined in 2004 compared to 1994, by 6.1 percent.

The results from the OLS estimation of the health supply function using lnWeight as the dependent variable are presented in Table 7. An increase in household income increases weight for males but not females, a similar finding with the study by Jahns et al. (2003). The observed income effect could be explained by the more sedentary nature of higher income jobs as well as higher opportunity cost of off-the-job exercising. Female weights were higher in 2004 than 1994, by 1.4 percent, and male weights were 1.1 percent higher. Most of the coefficients on the regional dummies are not statistically significant. Only the weight of males living in the North Caucasus and females living in the East Siberia regions are significantly higher relative to the weight of individuals residing in the base Moscow-St. Petersburg regions.

Table 8 presents the OLS estimates of the household's health supply function where the dependent variable is lnBMI. The results are very similar to the results of the specification where the dependent variable is lnWeight. We fitted the models separately for the 1994 and 2004 subsamples and also for each year by gender.[8] The effects of the factors affecting obesity are similar, with the only difference being the impact of income, which is larger in magnitude and more significant in 2004. This is an important result pointing to the fact that economic forces have begun to play an increasingly important role in individual choices with the unfolding transition to a market economy.

5. Conclusions

This paper develops both theoretical and empirical models to facilitate understanding of the increased human obesity, measured as weight and BMI, and its determinants in Russia during the transition from a planned to a market economy. During ten years of transition there was a significant rise in obesity in Russia - a 38 percent increase by 2004. Empirical results strongly support our models for production of health and demand for inputs in the health production function. Diet/caloric intake, smoking, gender and education are important determinants of obesity in Russia. The study finds a strong positive effect of caloric intake and a strong negative effect of smoking on weight and BMI - findings similar to those in developed market economies (Chou et al., 2004; Rashad, 2006; and Rashad et al., 2005).

We employ a balanced panel from the RLMS for 1994 and 2004 for both households and individuals in order to evaluate the changes in overweight and obesity during the transition and the effects of various factors. The individual health production and supply functions are the main focus of this analysis. Demographic and anthropometric characteristics such as height, gender, and age positively and significantly influence the degree of overweight and obesity in Russia, while age has a nonlinear effect, and better educated individuals are less overweight and obese. Economic and dietary factors such as caloric intake and composition of fat and protein also affect positively and significantly the individual's weight, and therefore contributes to obesity, but smoking deters overweight. These findings are similar to findings for developed economies, including the US (Chou et al., 2004; Lakdawalla and Philipson, 2002). Being employed increases individual's weight only for males, also. Income is associated with higher weight and BMI for males, a trend currently observed in developed countries. For example, in 1970s the obesity rate of the population in the United States was heavily concentrated in low income households, but over the past three decades obesity has spread throughout the middle and high income population groups as well (Maheshwari et al., 2005).

Unbalanced diet and unfavorable health behavior such as large increases in alcohol and tobacco consumption amongst certain groups of the population are important determinants of health. Since diet is an essential factor affecting obesity, we fitted demand equations for several food groups, including meat and fish, fruits and vegetables and dairy products. Among the factors significantly and positively affecting consumption are household income, and the education and age of the household head. Although the total calories consumed did not change over the ten-year period, obesity has increased. Change in the composition of the diet such as shifting away form healthy food as fruits and vegetables toward fatty and sugary products, or unhealthy lifestyle such as increased alcohol consumption, as well as the change in lifestyle with the technological progress, are among the possible explanations.

Understanding the determinants of obesity in Russia is important in order to define what strategies are most likely to be effective in preventing and reducing obesity. This study indicates that higher education has a significant and negative effect on obesity. Education not only provides economic returns such as increasing earnings and employment, but also improves health and well being. Therefore, interventions which enhance education could play a vital role in preventing obesity in Russia. People should be educated about healthy lifestyles and healthy diet.

Notes

1. This is analogous to the derivation of the supply function for farm output in an agricultural household model (see Huffman, 1991).
2. This is not a true panel survey where sample households and individuals are followed and interviewed in each round. However, after 1999 the original design was modified and some households and individuals who moved were surveyed at their new locations. Most importantly, the analyses of the RLMS data for attrition, carried out by the Institute for Social Research at the University of Michigan, show that the exits can be characterized as random and that the sample distributions remain unchanged (Heeringa, 1997)
3. In the alternative estimation, where the dependent variable is BMI, Height is not included as an explanatory variable.
4. All of the variables are defined in Table 1.
5. We are aware of the fixed and random effects models for panel data but we have only two time points (1994 and 2004) of the cross section sample. In the estimations we have included a year dummy to capture the average year effects and also allow for clustering of individuals and households.
6. We applied Wald tests for coefficient differences between the male and female subsamples. The results are available from the authors upon request.
7. Due to data limitations, we estimated demands for meat and fish, fruits and vegetables, and dairy at the household rather than the individual level.
8. The results are available from the authors upon request.

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Table 1
Variable names, definitions, means and standard deviations (weighted data)

Symbol	Mean (SD)	Definition
lnWeight	4.272(0.003)	Individual weight (kg) in logarithm
lnHeight	5.106(0.001)	Individual height (cm) in logarithm
lnBMI	3.270(0.002)	Individual weight divided by height (m) squared (kg/m2) in logarithm
lnCalories*	7.493(0.004)	Total calories consumed per day in logarithm
Fat	32.994(0.138)	Percent of daily calories from fat
Protein	12.885 (0.048)	Percent of daily calories from protein
lnMeat&fish	5.307(0.051)	Real total household expenditure per month on meat and fish (rubles) in logarithm
lnFruits&veggies	3.574(0.052)	Real total household expenditure per month on vegetables and fruit (rubles) in logarithm
lnDairy	4.097(0.046)	Real total household expenditure per month on dairy products (rubles) in logarithm
Alcohol	0.547 (0.007)	Dummy variable equal to 1 if the individual consumes alcohol and 0 otherwise
Smoker	0.289(0.006)	Dummy variable equal to 1 if the individual smokes currently and 0 otherwise
Male	0.417(0.007)	Dummy variable equal to 1 if the individual is a male and 0 otherwise
Education1	0.378(0.006)	Dummy variable equal to 1 if the individual has education level below grade 8 and 0 otherwise
Education2	0.465(0.007)	Dummy variable equal to 1 if the individual has completed high school and 0 otherwise
Education3	0.157(0.005)	Dummy variable equal to 1 if the individual has completed higher education and 0 otherwise
Age	48.00(0.208)	Age in years
Age2	2550.34(20.72)	Square of age
Work	0.569(0.007)	Dummy variable equal to 1 if the individual is employed and 0 otherwise
lnIncome	8.833(0.010)	Total real household income per month (rubles) in logarithm
lnIncome_sq	78.569(0.172)	Square of total real household income per month in logarithm
lnEqnum	1.014(0.006)	Adult equivalent number of household members in logarithm
Moscow-St Peterburg	0.017(0.002)	Dummy variable equal to 1 if the individual resides in Moscow-St. Petersburg region and 0 otherwise
North and Northwest	0.059(0.003)	Dummy variable equal to 1 if the individual resides in North and Northwest region and 0 otherwise

* Since the data for year 1994 was not available, we calculated it by extrapolation of previous years, 2000-2004.

Table 1
Continued

Symbol	Mean (SD)	Definition
Central	0.214(0.005)	Dummy variable equal to 1 if the individual resides in Central region and 0 otherwise
Volga region	0.225(0.006)	Dummy variable equal to 1 if the individual resides in Volga region and 0 otherwise
North Caucasus	0.156(0.005)	Dummy variable equal to 1 if the individual resides in North Caucasus region and 0 otherwise
Ural region	0.161(0.005)	Dummy variable equal to 1 if the individual resides in Ural region and 0 otherwise
West Siberia	0.085(0.004)	Dummy variable equal to 1 if the individual resides in West Siberia region and 0 otherwise
East Siberia	0.082(0.004)	Dummy variable equal to 1 if the individual resides in East Siberia region and 0 otherwise
Year	0.432(0.007)	Dummy variable equal to 1 if year is 2004 and 0 if the year is 1994

Note: Number of observations is 6424 individuals and 3, 710 households

Table 2a
Characteristics of obese and overweight and their consumption, polled sample (weighted data)

Variables	Round 1994			Round 2004			All rounds		
	normal	overweight	obese	normal	overweight	Obese	normal	overweight	obese
Age	38(0.38)	46(0.41)	50(0.48)	51(0.52)	56(0.48)	57(0.50)	43(0.33)	50(0.33)	54(0.36)
Height	168(0.24)	166(0.28)	162(0.31)	167(0.31)	165(0.31)	162(0.33)	167(0.19)	165(0.21)	162(0.23)
Male	0.49(0.01)	0.43(0.02)	0.19(0.02)	0.54(0.02)	0.45(0.02)	0.25(0.02)	0.51(0.01)	0.44(0.01)	0.22(0.01)
Education1	0.34(0.01)	0.37(0.01)	0.45(0.02)	0.37(0.02)	0.39(0.02)	0.40(0.02)	0.35(0.01)	0.38(0.01)	0.42(0.01)
Education2	0.49(0.01)	0.47(0.02)	0.44(0.02)	0.47(0.02)	0.44(0.02)	0.46(0.02)	0.48(0.01)	0.46(0.01)	0.45(0.01)
Education3	0.17(0.01)	0.16(0.01)	0.12(0.01)	0.16(0.01)	0.17(0.01)	0.14(0.01)	0.17(0.01)	0.16(0.01)	0.13(0.01)
Work	0.65(0.01)	0.66(0.01)	0.58(0.02)	0.51(0.02)	0.48(0.02)	0.43(0.02)	0.59(0.01)	0.58(0.01)	0.50(0.01)
Income	9431(196.55)	10039(304.32)	9048(245.08)	7961(230.47)	8046(204.27)	8150(263.39)	8880(150.88)	9153(193.05)	8589(180.57)
Smoker	0.39(0.01)	0.25(0.01)	0.11(0.01)	0.46(0.02)	0.25(0.01)	0.13(0.01)	0.42(0.01)	0.25(0.01)	0.12(0.01)
Drinker	0.64(0.01)	0.59(0.01)	0.51(0.02)	0.54(0.02)	0.46(0.02)	0.43(0.02)	0.60(0.01)	0.53(0.01)	0.47(0.01)
Calories	1879(13.90)	1883(16.27)	1822(22.22)	1860(18.26)	1902(18.29)	1843(19.09)	1872(11.07)	1892(12.15)	1833(14.59)
Fat	34(0.29)	34(0.31)	33(0.45)	32(0.34)	32(0.31)	33(0.35)	33(0.05)	33(0.22)	33(0.28)
Protein	13(0.09)	13(0.10)	13(0.14)	13(0.12)	13(0.12)	13(0.14)	13(0.07)	13(0.08)	13(0.10)
Fruits&veggies	488(22.64)	514(26.02)	443(37.99)	269(20.76)	260(13.29)	298(26.32)	406(16.30)	401(15.85)	369(22.99)
Meat&fish	1507(77.60)	1632(69.10)	1448(87.20)	757(32.77)	929(35.59)	929(43.67)	1226(50.56)	1320(42.18)	1182(48.49)
Dairy	383(13.99)	391(15.27)	383(20.11)	243(10.46)	266(9.71)	261(10.59)	331(9.68)	336(9.59)	320(11.31)
Percentage	45.47	34.25	20.28	35.93	36.07	28.00	41.36	35.03	23.61
Number of observations	1432	1111	669	1155	1154	903	2587	2265	1572

Table 2b
Characteristics of obese and overweight and their consumption, males only (weighted data)

Variables	Round 1994			Round 2004			All rounds		
	normal	overweight	obese	normal	overweight	Obese	normal	overweight	obese
Age	38(0.51)	43(0.58)	48(1.04)	50(0.04)	54(0.70)	55(0.98)	43(0.44)	48(0.49)	52(0.74)
Height	173(0.27)	173(0.33)	171(0.68)	172(0.34)	172(0.36)	172(0.63)	173(0.21)	172(0.24)	172(0.46)
Education1	0.36(0.02)	0.35(0.02)	0.39(0.04)	0.39(0.02)	0.39(0.03)	0.35(0.04)	0.37(0.01)	0.37(0.02)	0.37(0.03)
Education2	0.51(0.02)	0.48(0.02)	0.49(0.05)	0.50(0.02)	0.46(0.03)	0.43(0.04)	0.50(0.02)	0.48(0.02)	0.45(0.03)
Education3	0.13(0.01)	0.16(0.02)	0.13(0.03)	0.11(0.02)	0.14(0.02)	0.22(0.03)	0.12(0.01)	0.15(0.01)	0.18(0.02)
Work	0.73(0.02)	0.79(0.02)	0.76(0.04)	0.52(0.02)	0.55(0.03)	0.48(0.04)	0.64(0.01)	0.68(0.02)	0.60(0.03)
Income	9911(295.38)	10823(565.73)	9967(576.21)	8514(340.27)	8739(317.86)	9798(717.00)	9358(224.48)	9875(342.36)	9870(479.27)
Smoker	0.70(0.02)	0.52(0.02)	0.44(0.05)	0.75(0.02)	0.51(0.03)	0.36(0.04)	0.72(0.01)	0.52(0.02)	0.39(0.03)
Drinker	0.76(0.02)	0.77(0.02)	0.78(0.04)	0.65(0.02)	0.59(0.03)	0.63(0.04)	0.71(0.01)	0.69(0.02)	0.69(0.03)
Calories	1941(21.29)	2030(27.30)	2078(56.75)	1951(26.86)	1989(27.55)	2040(44.49)	1945(16.68)	2011(19.47)	2056(35.19)
Fat	35(0.44)	35(0.49)	36(1.02)	32(0.47)	32(0.49)	35(0.74)	33(0.33)	34(0.35)	35(0.61)
Protein	13(0.14)	13(0.17)	13(0.31)	13(0.17)	14(0.19)	13(0.27)	13(0.11)	13(0.12)	13(0.20)
Fruits&veggies	487(32.45)	565(43.75)	453(110.3)	275(25.89)	269(19.87)	410(91.32)	403(22.33)	430(25.98)	428(70.39)
Meat&fish	1563(117.4)	1677(105.2)	1729(267.97)	780(41.76)	1003(55.54)	1140(115.55)	1254(73.70)	1370(63.63)	1390(132.78)
Dairy	379(20.36)	426(26.71)	348(44.49)	237(14.64)	281(16.38)	303(25.10)	323(13.75)	360(16.50)	322(23.80)
Percentage	54.70	35.81	9.49	45.59	38.07	16.34	50.70	36.80	12.50
Number of observations	680	460	126	578	478	210	1,258	938	336

Table 2c
Characteristics of obese and overweight and their consumption, females only (weighted data)

Variables	Round 1994			Round 2004			All rounds		
	normal	overweight	obese	normal	overweight	Obese	normal	overweight	obese
Age	38(0.56)	48(0.56)	50(0.54)	52(0.84)	58(0.64)	58(0.57)	43(0.50)	52(0.44)	54(0.41)
Height	162(0.24)	160(0.26)	160(0.27)	160(0.36)	159(0.29)	159(0.26)	161(0.20)	160(0.19)	159(0.35)
Education1	0.32(0.02)	0.38(0.02)	0.46(0.02)	0.34(0.02)	0.39(0.02)	0.42(0.02)	0.33(0.01)	0.39(0.01)	0.44(0.01)
Education2	0.47(0.02)	0.45(0.02)	0.42(0.02)	0.43(0.02)	0.42(0.02)	0.47(0.02)	0.46(0.01)	0.44(0.01)	0.45(0.01)
Education3	0.21(0.01)	0.16(0.01)	0.12(0.01)	0.22(0.02)	0.19(0.02)	0.11(0.01)	0.22(0.01)	0.17(0.01)	0.11(0.01)
Work	0.57(0.02)	0.56(0.02)	0.54(0.02)	0.50(0.02)	0.42(0.02)	0.41(0.02)	0.54(0.01)	0.50(0.01)	0.48(0.02)
Income	8961(259.02)	9447(318.62)	8829(270.05)	7315(299.86)	7482(262.54)	7607(253.35)	8378(199.36)	8589(214.70)	8225(186.24)
Smoker	0.09(0.01)	0.05(0.01)	0.03(0.01)	0.13(0.02)	0.04(0.01)	0.06(0.01)	0.10(0.01)	0.04(0.01)	0.04(0.01)
Drinker	0.53(0.02)	0.46(0.02)	0.45(0.02)	0.41(0.02)	0.35(0.02)	0.36(0.02)	0.48(0.01)	0.41(0.01)	0.41(0.01)
Calories	1819(17.63)	1772(18.48)	1762(23.09)	1754(23.06)	1832(24.01)	1778(19.91)	1796(14.04)	1798(14.80)	1770(15.27)
Fat	33(0.39)	33(0.38)	32(0.49)	32(0.48)	32(0.40)	32(0.40)	33(0.31)	34(0.28)	32(0.32)
Protein	12(0.13)	13(0.13)	13(0.15)	13(0.18)	13(0.17)	13(0.16)	12(0.10)	13(0.10)	13(0.11)
Fruits&veggies	490(31.61)	475(31.46)	440(39.01)	262(33.34)	252(17.89)	262(17.50)	409(23.80)	378(19.62)	352(21.70)
Meat&fish	1452(101.86)	1599(91.65)	1381(86.85)	730(51.66)	868(45.89)	859(43.34)	1196(68.99)	1280(56.33)	1123(49.43)
Dairy	388(19.24)	365(17.59)	391(22.52)	251(14.89)	254(11.48)	247(11.33)	339(13.63)	317(11.21)	320(12.86)
Percentage	39.02	33.16	27.82	28.79	34.59	36.62	34.66	33.77	31.57
Number of observations	752	651	543	577	676	693	1,329	1,327	1,236

Table 3
OLS Estimates of the health production function (dependent variable lnWeight)

Variable	Pooled Sample	Females	Males
lnHeight	1.855(0.071)***	1.729(0.096)***	2.007(0.101)***
Male	-0.034(0.008)***		
Age	0.016(0.001)***	0.022(0.001)***	0.009(0.001)***
Age2	-0.0001(0)***	-0.0002(0)***	-0.0001(0)***
Education2	0.010(0.006)*	0.013(0.008)	0.007(0.008)
Education3	-0.023(0.008)***	-0.038(0.011)***	0.007(0.011)
Work	0.014(0.005)**	0.009(0.007)	0.017(0.008)**
lnCalories	0.024(0.01)**	0.008(0.013)	0.056(0.014)***
Fat	0.0008(0.0002)***	0.001(0.0003)**	0.001(0.0003)***
Protein	0.003(0.001)***	0.002(0.001)**	0.003(0.001)***
Smoker	-0.063(0.007)***	-0.027(0.014)*	-0.076(0.008)***
Year	0.010(0.003)***	0.012(0.004)***	0.012(0.004)***
Constant	-5.855(0.365)***	-5.244(0.494)***	-6.747(0.527)***
R-squared	0.25	0.22	0.30
Number of observations	6,424	3,892	2,532

Note: * Statistically significant at the 10 percent level or less;
** Statistically significant at the 5 percent level or less;
***Statistically significant at the 1 percent level or less.
Robust standard errors are in parentheses.

Table 4
OLS Estimates of the health production function (dependent variable lnBMI)

Variable	Pooled Sample	Females	Males
Male	-0.047(0.008)***		
Age	0.016(0.001)***	0.022(0.001)***	0.009(0.001)***
Age2	-0.0001(0.00)***	-0.0001(0)***	-0.0001(0)***
Education2	0.010(0.006)	0.011(0.008)	0.007(0.008)
Education3	-0.024(0.008)***	-0.042(0.011)***	0.007(0.011)
Work	0.014(0.005)**	0.009(0.007)	0.017(0.008)**
lnCalories	0.024(0.01)**	0.008(0.013)	0.056(0.014)***
Fat	0.001(0.0002)***	0.001(0.0003)**	0.001(0.0003)***
Protein	0.003(0.001)***	0.002(0.001)**	0.003(0.001)***
Smoker	-0.063(0.007)***	-0.027(0.014)*	-0.076(0.008)***
Year	0.010(0.003)***	0.011(0.004)**	0.012(0.004)***
Constant	2.616(0.076)***	2.591(0.102)***	2.500(0.110)***
R-squared	0.18	0.18	0.14
Number of observations	6,424	3,892	2,532

Note: * Statistically significant at the 10 percent level or less;
** Statistically significant at the 5 percent level or less;
*** Statistically significant at the 1 percent level or less.
Robust standard errors are in parentheses.

Table 5
OLS Coefficients for caloric demand and interval regression coefficients for fruits and vegetables, meat and fish and dairy products

Variable	lnCalories	lnFruits&Veggies	lnMeat	lnDairy
lnEqnum		-1.149(0.196) ***	-0.893(0.159) ***	-0.756(153) ***
lnHeight	0.061(0.114)	1.490(2.037)	4.057(1.587)**	4.809(1.575)***
Male	0.097(0.014)***	-0.647(0.236) **	-0.636(0.175)***	-0.592(0.186)***
Age	0.003(0.002) *	-0.099(0.027)***	-0.008(0.022)	-0.076(0.022)***
Age2	0.00005(0.000)***	0.001(0.0003)***	0.0001(0.0002)	0.001(0.0001)***
Education2	-0.001(0.01)	0.273(0.173)*	0.165(0.131)	0.372(0.141)**
Education3	0.007(0.013)	1.109(0.206)***	0.657(0.150)***	1.154(0.157)***
Smoker	-0.030(0.012)**	-0.209(0.205)	0.045(0.146)	-0.226(0.127)
lnIncome	0.300(0.072)***	11.223(1.530)***	9.467(1.247)***	8.264(1.128)***
lnIncome_sq	-0.015(0.004)***	-0.524(0.086)***	-0.442(0.070)***	-0.396(0.070)***
Year	0.023(0.004)***	0.799(0.145)***	0.890(0.110)***	0.698(0.105)***
North and Northwest	0.108(0.036)***	-0.645(0.321)**	-0.425(0.239)*	-0.976(0.283)***
Central	0.117(0.030)***	-1.547(0.261)***	-0.326(0.196)*	-0.609(0.207)***
Volga region	0.138(0.030)***	-2.751(0.276)***	-0.814(0.201) ***	-1.372(0.222)***
North Caucases	0.239(0.031)***	-2.050(0.316)***	-1.294(0.246)***	-1.582(0.250) ***
Ural region	0.159(0.030)***	-1.439(0.272)***	-0.611(0.210)***	-0.739(0.217)***
West Siberia	0.176(0.033)***	-2.923(0.355)***	-2.336(0.296)***	-1.722(0.290)***
East Siberia	0.194(0.033)***	-2.103(0.326)***	-2.116(0.286)***	-1.693(0.284)***
Constant	5.542(0.659)***	-57.298(11.91)***	-62.876(9.499)***	-59.525(9.617)***
R-squared/Log	0.09			
Pseudolikelihood		-7725.415	-8484.997	-8070.076
Number of observations	6,424	3,710	3,710	3,710

Note:* Statistically significant at the 10 percent level or less;
** Statistically significant at the 5 percent level or less;
*** Statistically significant at the 1 percent level or less.
Robust standard errors are in parentheses.

Table 6
Probit estimation of the demand for alcohol (probability of drinking)

Variable	Coefficients		Marginal effects	
lnHeight	-0.661	(0.470)	-0.262	(0.186)
Male	0.526	(0.055)***	0.204	(0.021)***
Age	0.029	(0.007)***	-0.002	(0.0003)***
Age2	-0.000	(0.000)		
Education2	0.026	(0.043)	0.010	(0.017)
Education3	0.283	(0.055)***	0.110	(0.021)***
Smoker	0.329	(0.051)***	0.128	(0.019)***
lnIncome	0.141	(0.360)	0.047	(0.006)***
lnIncome_sq	0.004	(0.021)		
Year	-0.154	(0.032)***	-0.061	(0.013)***
North and North west	0.209	(0.123)*	0.081	(0.047)*
Central	0.178	(0.105)*	0.070	(0.041)*
Volga region	0.103	(0.105)	0.041	(0.041)
North Caucases	-0.233	(0.108)**	-0.093	(0.043)**
Ural region	0.321	(0.107)***	0.124	(0.040)***
West Siberia	0.028	(0.117)	0.011	(0.046)
East Siberia	0.152	(0.117)	0.059	(0.045)
Constant	1.204	(2.817)		
Pseudo R-squared	0.12			
Number of observations	6,424			

Note: * Statistically significant at the 10 percent level or less;
** Statistically significant at the 5 percent level or less;
*** Statistically significant at the 1 percent level or less.
Robust standard errors are in parentheses.

Table 7
OLS Estimates of the health supply function (dependent variable lnWeight)

Variable	Pooled Sample	Females	Males
lnHeight	1.857(0.071)***	1.732(0.096)***	2.023(0.103)***
Male	-0.035(0.008)***		
Age	0.016(0.001)***	0.022(0.001)***	0.010(0.001)***
Age2	-0.0001(0)***	-0.0002(0) ***	-0.0001(0)***
Education2	0.011(0.006)**	0.012(0.008)*	0.007(0.008)
Education3	-0.023(0.008)**	-0.039(0.011)***	0.003(0.011)
Smoker	-0.062(0.007)***	-0.026(0.014)*	-0.077(0.008)***
lnIncome	0.056(0.048)	0.052(0.063)	0.112(0.047)*
lnIncome_sq	-0.002(0.003)	-0.002(0.004)	-0.005(0.004)
Year	0.012(0.003)***	0.014(0.004)***	0.011(0.004)**
North and Northwest	0.023(0.019)	0.032(0.025)	0.010(0.024)
Central	0.023(0.016)	0.025(0.022)	0.025(0.021)
Volga region	0.009(0.016)	0.014(0.022)	0.011(0.021)
North Caucases	0.034(0.016)**	0.029(0.023)	0.050(0.022)**
Ural region	0.011(0.017)	0.016(0.022)	0.012(0.022)
West Siberia	0.017(0.018)	0.026(0.025)	0.010(0.024)
East Siberia	0.031(0.018)*	0.042(0.025)*	0.022(0.024)
Constant	-5.977(0.418)***	-5.491(0.572)***	-6.931(0.611)***
R-squared	0.25	0.23	0.29
Number of observations	6,424	3,892	2,532

Note: * Statistically significant at the 10 percent level or less;
** Statistically significant at the 5 percent level or less;
*** Statistically significant at the 1 percent level or less.
Robust standard errors are in parentheses.

Table 8
OLS Estimates of the health supply function (dependent variable lnBMI)

Variable	Pooled Sample	Females	Males
Male	-0.045(0.006)***		
Age	0.016(0.001)***	0.022(0.001)***	0.010(0.001)***
Age2	-0.0001(0.00)***	-0.0002(0.00)***	-0.0001(0.00)***
Education2	0.010(0.006) *	0.011(0.008)	0.006(0.008)
Education3	-0.025(0.008)***	-0.042(0.011)***	0.003(0.012)
Smoker	-0.062(0.007)***	-0.027(0.014)*	-0.077(0.008)***
lnIncome	0.054(0.048)	0.045(0.070)	0.111(0.067)*
lnIncome_sq	-0.002(0.003)	-0.001(0.004)	-0.005(0.004)
Year	0.012(0.003)***	0.013(0.004)***	0.012(0.004)**
North and Northwest	0.026(0.019)	0.038(0.025)	0.009(0.024)
Central	0.024(0.016)	0.026(0.022)	0.025(0.021)
Volga region	0.010(0.016)	0.015(0.022)	0.010(0.021)
North Caucases	0.034(0.017)**	0.028(0.023)	0.050(0.021) **
Ural region	0.012(0.017)	0.018(0.022)	0.012(0.022)
West Siberia	0.018(0.018)	0.028(0.025)	0.010(0.024)
East Siberia	0.034(0.018)*	0.046(0.025)*	0.022(0.024)
Constant	2.510(0.210)***	2.384(0.306)***	2.403(0.300)***
R-squared	0.19	0.19	0.13
Number of observations	6,424	3,892	2,532

Note: * Statistically significant at the 10 percent level or less;
** Statistically significant at the 5 percent level or less;
*** Statistically significant at the 1 percent level or less.
Robust standard errors are in parentheses.