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BMI Growth Rates and the Nutrition Transition:
The Role of Income, Inequality and Income Growth in Russia

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BMI Growth Rates and the Nutrition Transition:

The Role of Income, Inequality and Income Growth in Russia

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Abstract

This study analyzes the extent to which nutritional status in terms of weight change has been affected by the income distribution as the economy has grown. Is BMI growth different at different tails of the income distribution? Health and nutritional outcomes are not normally expected to be uniform across the income distribution and over time. Using recent individual level data from the Russia Longitudinal Monitoring Survey (RLMS) from 1994 to 2012, we scrutinize the influence of transitional processes, particularly economic transitions on nutritional and health outcomes. We test the hypothesis that the income gradient of individual body weight growth (i.e. the relationship between income and BMI growth) follows an inverted U-shape and thus changes its sign from positive to negative in the process of economic development. For the case of Russia, we could not find clear evidence that the income-BMI-growth gradient has already shifted. Turning points have not yet been reached. Expenditure increases have significant positive effects on BMI levels and on BMI growth rates. Better educated women have lower BMI levels than women with less than secondary education whereas men who completed tertiary education have higher BMI levels than men with less than secondary education.

JEL classifications: H51, I15, O15, P36

Keywords: Overweight, obesity, health, transition economy, Russia

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List of Abbreviations

BMI	Body Mass Index
CAGR	Compound Annual Growth Rate
FE	Fixed Effects
GNP	Gross National Product
kcal	kilocalories
NR-NCD	Nutrition-related Non-Communicable Diseases
NSR	Non-Self Representing
POLS	Pooled Ordinary Least Squares
PPS	Probability Proportional to Size
PSU	Primary Sampling Unit
RLMS	Russia Longitudinal Monitoring Survey
RUB	Russian Ruble
SR	Self-Representing
SSU	Second Stage Unit
WHO	World Health Organization

1. Introduction

While the first millennium development goal – halving the share of people suffering from hunger by 2015 – has not yet been reached, a quite different nutrition-related phenomenon has arisen on political agendas in several developing and transition countries. Overweight and obesity are emerging in many countries in transition and even in developing countries that were traditionally more associated with hunger and underweight than with obesity (Doak et al., 2004; Doak et al., 2000; Drewnowski and Popkin, 1997; Subramanian et al., 2009). The onset of the nutrition transition in developing countries was in the 1990s and led to the World Health Organization (WHO) discussing an obesity epidemic already in 2000 in their report "Obesity: Preventing and Managing the Global Epidemic" (WHO, 1998).

The transition process is a broad concept that can occur in several dimensions. In the context of overweight and obesity, the topic of the nutrition transition is crucial. Nutrition transition has been described as the shift in dietary composition - from traditional foods high in cereals and fiber to more processed (and animal sourced) foods, sugar, and fats, and hence more kilocalories (kcal) and less energy expenditure (e.g. a more sedentary lifestyle) (Popkin, 1993). As Popkin and Gordon-Larsen (2004) point out, such a nutrition transition is manifested – among others things– in a shift from a high prevalence of infectious diseases to a high prevalence of chronic and degenerative diseases. In this paper, we investigate how the nutrition transition has affected the Russian Federation after the fall of the Iron Curtain. Russia's economy has taken a steep downturn at the beginning of the 1990s and recovered after 1997 (with a short interruption in 1998 due to the *Ruble crisis*). Since Russia is on its *way* from a developing country to a highly developed country it is interesting to see where Russia stands regarding the nutrition transition.

In the early 1990s, several authors found that some long-standing patterns about overweight and obesity have been reversed: Traditionally, positive correlation between (female) body fat and socioeconomic status were regarded as stylized fact (Smuts, 1992). For industrialized countries in 1991 Jeffery et al. found that BMI (Body Mass Index) was inversely related to socioeconomic status (Jeffery et al., 1991), i.e. lower income groups were bigger than richer income groups. Several studies since then have found higher prevalence rates for overweight in poorer income groups in industrialized countries, and in richer income groups in developing countries (Popkin, 1999; Popkin and Gordon-Larsen, 2004; Ball and Crawford, 2005; Asfaw, 2007; Fernald, 2007). Monteiro et al. (2004) showed that this seems to be an oversimplified picture of the story. First, they found that overweight is becoming an issue also in developing countries for groups with lower socioeconomic status, secondly, women seem to become overweight at an earlier stage of economic development than men. Philipson and Posner (2003) did a cross-country investigation to show evidence of how the relationship between income and body weight changes sign at a certain state of economic development, which implies an inverted U-shape as an economy is growing. Some other studies have since shown this switch of sign in the income-BMI-gradient using cross-country regressions. Due to scarce panel data, however, hardly any research has been undertaken to show such a relationship empirically for one country even though within-country evidence is required to rule out that country level contextual factors drive the income-BMI relationship. Tafreschi (2014) shows that income growth is associated with higher individual's body weight in less developed areas, whereas it is associated with lower weight growth in more developed areas in China.

Some of the biggest structural changes in societies and economies took place during the transition from a centrally planned to free market economy in the former Soviet Union at the beginning of the 1990s. Price liberalization, the elimination of food subsidies, and privatization of state enterprises led to an enormous transition in the society and structure of the former socialist countries (Mroz and Popkin, 1995; Zohoori et al., 1998). The fraction of the ultra-poor increased significantly in the region between 1989 and 1992 – from less than 5% to 27.1% between 1991 and 1992 (Cornia, 1994). Consequences included an increase in unemployment and poverty, household income loss and lifestyle changes (increased alcohol consumption, higher stress levels) that led to a significant decline in life expectancy. The substitution of expensive food products to more quantity but less expensive sources of nutrients helped to reduce hunger in the region (more bread and cereals, less meat and milk) (Cornia, 1994; Mroz and Popkin, 1995). The increased consumption of food low in nutrients but high in kilocalories had long-lasting consequences (probably including micronutrient deficiencies). From 1980 to 1990 the Russian Federation only faced minor increases in overweight prevalence rates (Ng et al., 2014). However, overweight and obesity became such a serious problem during the transition that after only two decades more than 50% of the adults were affected (Huffman and Rizov, 2007). As non-communicable diseases (NCDs) are estimated to account for 82% of all deaths in Russia (in comparison to 63% worldwide) (WHO, 2011b) and overweight and obesity seem to be important drivers of NCDs, it is important that the Russian government pays more attention to lower these prevalence rates. The Russian health care system does not adequately respond to the epidemiological transition.[1] The economic recession in the 1990s led to a sharp decline in public expenditures on health; at the same, indirect costs rose due to the fact that mainly working age people were affected by premature death (Petrukhin and Lunina, 2012).

Whereas households' responses to Russia's economic transition after the collapse of the socialist economy in 1991 (e.g. for children's energy intake see Dore et al., (2003)) are well covered in the empirical literature, the extent to which health outcomes are associated with changes in the income distribution poses an important gap in the literature. We focus on health outcomes in terms of BMI. The switching income gradient hypothesis of Philipson and Posner (2003) is empirically tested in this paper. For this hypothesis we analyze the long-run effects of income, income growth, and the income distribution on BMI and BMI growth. The primary contribution of our paper is that we examine the impact of economic growth on people's health outcomes (here BMI and BMI change) at different parts of the income distribution. We also test the effect of gender to establish if men and women react differently to the same determinants of income growth. For the case of Russia, we could not find clear evidence that the income-BMI-growth gradient has already shifted. Expenditure increases have significant positive effects on BMI levels and on BMI growth rates. Regarding expenditure quintiles, higher quintiles have higher BMI levels compared to the poorest quintile.

Not every overweight or obese person suffers from health difficulties, but on an aggregate level obesity can cause many health-related problems. As Chopra et al. (2002) point out, NCDs will become the main cause of morbidity and mortality in the world. The consequences of a higher consumption of animal source food, saturated fats, and sugar on people's health status are diverse nutrition-related non-communicable diseases (NR-NCDs) such as diabetes, heart diseases, cardiovascular diseases (CVD) and some of the most common cancers (Popkin et al., 2001; Montonen et al., 2005). NR-NCDs imply high treatment costs, high expenses for government prevention programs, and high opportunity costs for the people who are affected (Bleich et al., 2008). Dropping out of the labor market results in a loss of income to the laborers and also a loss in productivity to the enterprises and hence a negative effect for the economy as a whole. This adds up to high governmental and even BIP-reducing costs (Suhrcke et al., 2007; Philipson and Posner, 2008; Rtveladze, 2012).

[1] Epidemiologic transition is defined as the shift from a predominance of infectious to noninfectious diseases.

More than 2.8 million people worldwide die each year as a result of overweight and obesity (WHO, 2011a). Since 1980 the prevalence of obesity has nearly doubled worldwide (WHO, 2014). To confront these diseases, policymakers need to know how many people are affected and who these people are, although it is not easy to successfully implement mechanisms that encourage people to adopt healthier lifestyles (Chopra et al., 2002). It would be even more promising to prevent overweight and obesity in developing and transition countries from reaching high levels so that large costs could be avoided. As obesity and overweight can also reduce the quality of life, this topic should not only be regarded as an economic issue, but as an indicator of subjective well-being as well. Independent of health outcomes, in a few countries, however, being overweight or obese is still considered to be an indication of wealth and wisdom, e.g. in some small South-Pacific islands (Prentice, 2006). Among developing countries, there is huge heterogeneity in the patterns, trends, and onset of substantial levels of obesity. Several countries in Latin America began their transition earlier in the past century and hence, entered the NR-NCDs stage of the nutrition transition far earlier than other developing countries (Popkin and Gordon-Larsen, 2004).

Caballero (2007) emphasizes that political leaders should no longer regard obesity as a "disorder of individual behavior" but consider the rising obesity epidemic as highly influenced by the socioeconomic environment (p. 4). A change in the perception of this problem could lead to a change in the strategies implemented to prevent NCDs. Adler and Stewart investigate a public health model that focuses on the prevention of obesity as well as interventions that can modify environmental forces. This could be done through social policies so that the individual is not blamed for not managing his or her weight through diet and exercise (Adler and Stewart, 2009).

The paper continues as follows. We will proceed with a literature review in section 2. In section 3, we shortly describe the Russian background. Then, we introduce the data and the econometric methodology in section 4. Section 5 includes a descriptive analysis of the data. In section 6 we present our empirical results and finally conclude in section 7.

2. Literature Review

Popkin and other epidemiologists have empirically identified the nutrition transition in the 1990s for the developing world (Mroz and Popkin, 1995; Drewnowski and Popkin, 1997). The possibility of there being a difference between how obesity is associated with income in developed and developing societies has already been emphasized by Sobal and Stunkard (1989) in a meta-study. They identified an inverse relationship between socioeconomic status and obesity - at least for women in developed societies - which is driven by the influence of attitudes toward obesity and thinness, respectively. However, not only attitudes but also the availability and affordability of healthy food differ across the income distribution. In westernized countries, overweight is considered to be a reflection of bad health whereas thinness is favored. Popkin and Gordon-Larsen (2004), Mendez et al. (2005) as well as Caballero (2007) found that already in low- and moderate-income countries overweight and obese people (especially women) are more likely to live in lower-income households than in higher-income households. Popkin and Gordon-Larson (2004) even further argue that for low-income countries, belonging to the lower socio-economic group grants protection against obesity, because people cannot afford to become obese, which may be different for lower-middle income countries. For upper-middle countries, in contrast, belonging to the lower socio-economic group implies a systematic risk factor for obesity. In sum, obesity is seen as a "global epidemic" (Caballero, 2007), and through the channel of NCDs as a "silent killer" (Mbanya et al., 2011).

To make it more specific, Popkin and Ng (2007) explain how the above mentioned factors drive a "westernization of the global diet", associated with increased consumption of animal source foods, more added caloric sweeteners, and more sedentary lifestyles. The shift from labor-intensive occupations and leisure activities toward more capital-intensive, less strenuous work and leisure is occurring faster worldwide (Popkin, 2004). Drewnowski (2003) points out how technological advances have led to decreased energy costs for sugar and fat. For many (poor) people, the lowest cost dietary options available are refined grains, added sugars, and fats. This, in turn, leads to the hypothesis that it is very cheap to become obese. The cheap world market price of the energy-dense food – such as fat and sugar – encourages high consumption and high energy intake. Although there is a strong overlap between poverty and food insecurity, we cannot treat these two terms synonymously. Food insecure people face a 20% to 40% higher risk of obesity than people who are not food insecure, which has been consistently observed across the US, Europe, and Australia. However, this is only true for women and is regardless of income, lifestyle behaviors or education (Burns, 2004). Some authors find an inverse relationship of energy density and energy costs; they assume that people who attempt to limit food costs will first select less expensive but more energy-dense foods to maintain energy needs. If food costs then further decrease, the total energy intake may actually increase (Drewnowski and Specter, 2004). It has been further shown that fat consumption is less dependent on the Gross National Product (GNP) than ever before because vegetable oils and fats have become globally available at cheap prices. Hence, dietary transitions in accordance with the nutrition transition can occur at lower levels of GNP than previously in the past (Drewnowski and Popkin, 1997).

Prentice (2006) additionally describes a "psychological brake" to rising BMI levels in the western world, social stigmatism against obese people is high, that it so this has probably helped to limit the rise in obesity, at least to some extent.

3. The Case of Russia

For Russia, the WHO reports alarming numbers for NCD mortality (WHO, 2011b). In total numbers 1,718,300 deaths are related to NCDs (827,900 males and 890,400 females in a population of 142,958,164) which account for 82% all deaths (all numbers, also the following are related to Russia and 2008 estimates). Of these, a total of 11% are related to CVDs and diabetes (7.7% for males and 4.14% for females). These are 62% of total deaths for all ages (66.4% males and 33.6% females). Cancers were calculated separately and had a proportion of 13% of total deaths. Behavioral risk factors identified for NCDs are tobacco smoking (estimated prevalence: 40.5%) and physical inactivity (estimated prevalence: 22.6%); tobacco smoking and excessive alcohol consumption present other important risk factors for CVDs and NCDs. Metabolic risk factors identified by the WHO (among others) are overweight (estimated prevalence: 59.8%) and obesity (estimated prevalence: 26.5%) (WHO, 2011). The health care system of the former Soviet Union did not adequately respond to the epidemiological transition that began in the 1960s, as total mortality and CVDs increased from 1965 to 1990 (Tulchinsky and Varavikova, 1996; Petrukhin and Lunina, 2012). The reduction in public expenditures, due to a sharp recession in the early 1990s, coincides with the deterioration of the health of the Russian population (Petrukhin and Lunina, 2012). But since the high numbers of mortality due to CVDs and NCDs have been known for some years already, the Russian government has set up several programs to address and respond to NCDs. These include programs to address physical inactivity, unhealthy diets, diabetes, and cardiovascular diseases (as reported by the Ministry of Health). A worrying feature of NCD mortality in Russia is that most deaths occur in the working age group (under the age of 60 here).

According to Cornia (1994), the average reported levels of food intake have been considerably higher in Eastern Europe than in most other middle-income countries. In urban areas and among low-income groups, the eating habits of Russians have been characterized by a high proportion of animal fats (cholesterol-rich products), sugar, salt, bread, alcohol – with doses often higher than what is recommended by the WHO - , and a low consumption of vegetables, fruits, and berries (which partly can be explained by the severe climate) for several years. Whereas poor families consumed less food per capita, their diet consisted to a higher degree of bread and fats (in relative and absolute terms) and a lower proportion of more diverse food high in micronutrients. This has led to high prevalence rates of overweight, CVDs, micronutrient deficiencies, and anemia (Cornia, 1994). At the same time, Cornia (1994) only finds a weak relationship between food expenditure and caloric intake (elasticity below 0.4). The relationship between household income and caloric intake is even weaker (below 0.15 in the case of Russia).

Engel's Law states that food's budget share is inversely related to household real income (Houthakker, 1987). For Russia, Manig and Moneta (2009) compare income elasticities of quantity with income elasticities of quality of food consumption and conclude that Russian households tend to choose higher quality food items as income rises. Staudigel and Schröck (2015) confirm this finding using RLMS data. The latter article concludes that demand for food is far from satiated in Russia and future growth in expenditures is to be expected, following Engel's Law. The authors furthermore find that Russians will increase their food demand of high-value products such as meat products, sugar and confectionery, alcohol and beverages, while starchy staples such as bread and bakery, and cereals may lose ground. This finding is in accordance with Bennett's Law (Bennett, 1941), which predicts considerable shifts in the composition of food baskets away from starchy food as an economy is rising. Staudigel (2011) finds that in Russia it is mainly high-income households that significantly react with weight changes to food prices. Regarding determinants of obesity Huffman and Rizov (2010) find that expenditure shares of fats and sugars in consumption drive the rising obesity rates, and better education protects from obesity. Both latter articles use RLMS data.

The collapse of the Soviet Union in December 1991 has affected the food economy strongly. Structural and economic reforms led to a significant decrease in food subsidies (particularly meat products) in the region, high unemployment rates, and increasing poverty rates. The economy had already recovered by 1998, when the Ruble crisis caused the economy to totter again and caused high inflation rates. Poverty rates were increasing up until 1999 and then falling afterwards. A slightly different picture is drawn by Gibson et al. (2008). They emphasize that the Russian population has been able to cope with the 1998 shock and buffer their nutrition because of the preceding years of economic growth. In our analysis we will see whether different income quintiles had different health outcomes. Has the Russian society experienced changes in their nutritional status as they have developed economically? Have poorer income groups been affected differently from richer income groups?

4. Data and Econometric Methodology

4.1 Data Set

This study is based on phase II of the Russian Longitudinal Monitoring Survey of the Higher School of Economics (RLMS-HSE).[2] The RLMS is a household survey (including individual survey data) designed to measure the effects of Russian reforms on the health and economic welfare of households and individuals across time. It is based on stratified three-stage[3] clustered samples of residential addresses. Households were repeatedly interviewed and individuals were followed after they had moved to another place and established a new family in 1996, thus observation numbers have been increasing from 1998 onwards. Individuals moving out of the geographical coverage of the surveys (i.e. primary sampling units (PSU)) were not followed. New household members living at the sample dwelling unit (in households interviewed before) were included in the sample. According to the Carolina Population Center at the University of North Carolina and the Demoscope team in Russia this measure of replenishment does not harm the representativeness of the data assuming that new entrants are exchangeable (at least in socioeconomic terms) with those who have left. The annual samples from 1994 to 2012 (excluding 1997 and 1999) each have data for more than 4,000 households and their members. It consists of 38 randomly selected primary sampling units (municipalities) which are representative of the Russian Federation. The collected data include a wide range of information concerning household characteristics such as

[2] Source: "Russia Longitudinal Monitoring survey, RLMS-HSE», conducted by National Research University "Higher School of Economics" and ZAO "Demoscope" together with Carolina Population Center, University of North Carolina at Chapel Hill and the Institute of Sociology RAS. (RLMS-HSE web sites: http://www.cpc.unc.edu/projects/rlms-hse, http://www.hse.ru/org/hse/rlms)

[3] 1. One modified raion (county) was drawn as Primary Sampling Unit (PSU) from each NSR (non-self representing) stratum. The random selection employed the probability-proportional-to-size (PPS) procedure. Each NSR-PSU was assigned 108 dwelling units on average to be drawn in the next steps. 2. Second-stage Units (SSU) were drawn from the 35 NSR-PSU as well as from the SR (self-representing) strata. 3. Household dwellings were selected from the SSU chosen in Stage 2 (Zohoori et al. 1998; Staudigel 2011; Swafford and Kosolapov 2002).

demographic composition, income, expenditures/consumption, education, health, nutrition, medical problems, occupation, and region of residence (Zohoori et al., 1998). The following geographic regions are covered in the sample: Moscow and St. Petersburg as the metropolitan areas, Northern and North Western, Central and Central Black-Earth, Volga-Vaytski and Volga Basin, North Caucasian, Ural, Western Siberian, Eastern Siberian and Far Eastern.

One advantage of this data set is that it can be used as a repeated cross-sectional sample but also shows a panel structure (note, however, that it is an unbalanced panel data set). In combination with the long time period covered (1994-2012), these rich data allow us to analyze drivers and patterns of the transition processes, such as economic or nutritional changes, and their effects on health outcomes of households and individuals.

For the model estimation, we restrict the sample to respondents who were at least 18-years old (for each year), and exclude pregnant women from the sample. BMI is only a suitable indicator of nutritional status for individuals who have reached their final body height.[4] Our sample includes individuals from the period of 1994-2012.[5] We need to exclude observations with missing anthropometric data (weight and height) because this information is essential for measuring BMI. We keep extreme cases in our sample (BMI<18 and BMI>40) since several checks indicated that these were not outliers in the sense of erroneously reported anthropometric information, but rather trustworthy in their dimension. Some few very extreme outliers were dropped as they did not seem plausible (BMI<13 and BMI>60). Inconsistent observations, e.g. negative values in real per capita expenditure were dropped from our sample, albeit there were only a few.

By analyzing the long-run effects of income, income growth and income distribution on BMI and BMI growth, we aim to empirically test the switching income gradient hypotheses of Philipson and Posner (Philipson and Posner, 2003). The main contributions of our paper are as follows: we first examine the hypothesis over time, and we examine the impact of economic growth on peoples' health outcomes (here BMI change) at different tails of the income distribution, which to the best of our knowledge has not yet been done for Russia. In addition, we extend our analysis by separating between males and females since gender has been identified as important factor for BMI levels and growth in the literature. Given the longitudinal dimension of the large data set, we can exploit the rich data set and test for *a*

[4] We use self-reported information on weight and height as is explained in detail in Section 4.3.
[5] The RLMS survey was not conducted in 1997 and 1999.

transition country, Russia, whether the switching income gradient on BMI increase hypothesis holds true over time and across income groups for a given point in time.

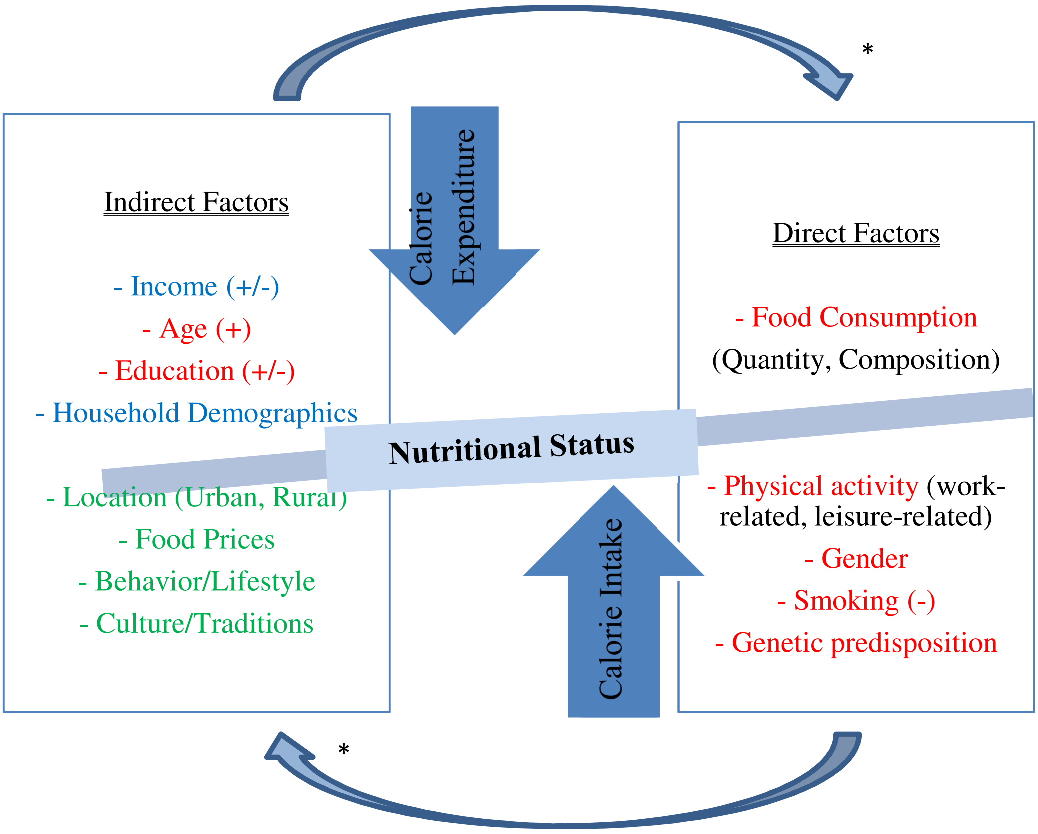
4.2 Conceptual Framework

Figure 1 below shows the conceptual framework which supports our analytical approach. As Stubbs and Lee (2004) point out, the increasing number of obese people in the world cannot be solely reduced due to physical activity levels but also to an increase in per capita energy intake. When the energy balance is not in equilibrium there are these two starting points to explain the imbalance. Either energy intake is too high or the physical activity level is too low, both arguments can favor overweight and obesity. Because of the above mentioned consequences of obesity (namely NR-NCDs), too high body weight should not be considered as desirable but also underweight should not be considered as "healthy" equilibrium. Underweight causes bad health consequences as well (Black et al., 2008).

Several factors influence the amount of energy in form of kilocalories that people consume and the extent to which the move their bodies. Some factors have effects on both components of the energy balance. We discuss the expected effects of the influencing factors below. For the construction of the variables, see Table A1 in the Appendix.

In order to control for the monetary well-being of a household, we use per capita expenditure as a control variable in our model, following the standard assumption that, collected from survey data, this reflects a household's financial situation better than direct income measures (Deaton and Zaidi, 2002). Indeed there is evidence that in Russia, people might understate their income because they fear disclosure of their responses to tax authorities (Gorodnichenko et al., 2010). This is backed by Stillman and Thomas – also using RLMS – who point out that the use of income measures may lead to biased coefficients and recommend using expenditure data (2008). Sometimes the underreporting of income leads to even smaller absolute values for income compared to expenditure, which cannot be traced back to dissaving to the same extent. We therefore regard per capita *expenditure* as a more reliable measure for the actual purchasing power of households in our sample and use it as the main measure of their economic situation. Real term, price deflated, per capita household expenditure is used to allow for comparisons across regions and time. All monetary values were deflated using the monthly consumer price index for food (2005=100) in the Russian Federation, separated by region.

Figure 1 Conceptual Framework of Determinants of Nutritional Status[6]



Source: Own composition, *some factors might have an influence on each other.

BMI is expected to increase with age since the digestive system starts to lose its efficiency and capacity. This has been shown in the literature, we further expect a negative effect from the variable age^2 (Huffman and Rizov 2007).

Some articles have shown that females have higher prevalence rates of overweight and obesity compared to men (Monteiro et al., 2004; Crosnoe, 2007; Ball et al., 2011). Hence, we expect a negative sign for the dummy variable male (which is 1 for males and 0 for females).

We use dummy variables for professional education to capture the educational level. Since in Russia school education is relatively important to the society, the average schooling years are at high levels for several years.[7] We thus insert the following dummy variables: less than secondary education, completed secondary education, and completed tertiary education. The less than secondary education dummy includes simple training programs (e.g. on tractoring

[6] Color codes: Individual Level, Household Level, Environmental Level.

[7]

Mean years of schooling for adults 25+	1980	1985	1990	2000	2005	2010	2013
Russia	7.1	8.1	9.2	11.3	11.6	11.7	11.7

Source: (Human Development Reports 2013).

and typing). Completed secondary education includes technical, medical, music, pedagogical and art school. Completed tertiary education includes receiving a diploma at institutes, universities, academies, and graduate schools. We expect that higher education is negatively related to body weight and BMI growth because better educated people are more conscious about healthy food and lifestyles and are therefore less likely to be overweight or obese. Additionally, less educated people probably earn less and hence are not able to afford the more expensive healthy food and consume more food items dense in kilocalories. Since we control for per capita expenditure we will not be able to directly identify the latter effect.

The variable household size includes all members living in the household. We did not drop extreme values (in only 1.8% of all households did the members size exceed 10 people).

As a social preference for thinness in some westernized societies exists – which has been argued to be stronger for people who are still searching for their future spouse – we include a dummy variable for living with a partner or not (Sobal et al., 1995; Macdiarmid and Blundell, 1998). We do not rely on the marital status alone because we also want to include people who live with their partner in an "informal marriage". We hence include all persons who live in a registered marriage and those who live together but are not registered and value them as 1. People receive the value 0 for this dummy when they have never been married, are divorced or widowed. We assume this dummy to be positively correlated with BMI growth.

A dummy for whether the respondent is a smoker or not is included because several studies, including medical studies, have shown a negative effect of smoking on body weight (Wardle and Steptoe, 2003; Williams et al., 2007; Baum and Chou, 2011; Rizov et al., 2012). Smoking tends to increase metabolism and suppress appetite, thus having a negative effect on BMI.

To control for urbanization, we include a binary variable which shows the effect for the location of the respondent's residence in an urban or a rural area on BMI growth. Urbanization has been found to have a positive impact on body weight as living in urban areas tends to increase the intake of processed food, sugar, fat and salt, while reducing physical activity due to better infrastructure and transportation facilities (Drewnowski and Popkin, 1997; Hoffman, 2001; Popkin, 2004; Schmidhuber and Shetty, 2005; Kearney, 2010).

The year dummy variable controls for changes over time related to transition processes, e.g. regarding the organization of the health system.

We include a dummy variable for whether the respondent was working or not. By inserting this dummy we aim to control for food eaten away from home, which tends to be richer in kilocalories than food prepared at home, as well as control for a higher share of processed food that may be consumed at home due to time constraints (Drewnowski and Popkin, 1997; Popkin and Gordon-Larsen, 2004). Hence, we expect this dummy to be positively correlated with body weight and BMI growth.

Several studies have shown that technological change (including TV watching, fridge and microwave ownership) has led to more sedentary lifestyle, both during work and in leisure time (Philipson and Posner, 2003; Popkin and Gordon-Larsen, 2004; Campbell et al., 2006; Petrukhin and Lunina, 2012). To measure the level of physical activity we include self-reported information (which gives information on activities during leisure time). The value of 0 means the respondent does not engage in physical activity and increases with higher levels of physical activity. Highest is a value of 4 which means the respondent does daily exercise for not less than 30 minutes per day. We know that physical activity reduces BMI growth and therefore expect the variable to show a negative sign.

4.3 Model Specification

To get a basic overview of how determinants have changed over time, we implement a Pooled OLS (POLS) regression model as shown in Equation (1).

$$Y_{it} = \alpha_0 + \beta X_{it} + u_{it} \tag{1}$$

Let Y_{it} denote the outcome (BMI or BMI growth) of individual i at time t, the matrix X_{it} captures individual and household characteristics and includes a constant term α_0. β is a vector of parameters to be estimated. u_{it} is an unobserved random error term. If errors were uncorrelated with the explanatory variables, the above model would allow us to obtain unbiased estimates for β.

A more robust approach to estimating the parameters of interest is to exploit the panel dimension of our data. A fixed effects (FE) estimator allows us to remove unobserved, time-invariant components of the error term that may also affect explanatory variables. By using fixed effects regression models it is possible to explore the relationship between explanatory variables and a dependent variable *within* an individual over time. In contrast to the POLS estimator, the FE estimator results in consistent estimates of β even in the presence of time-invariant, omitted variables.

We hence use fixed-effects regression models (shown in Equation (2) in order to control for time-invariant characteristics that are unique to the individual and are not correlated with other characteristics that we control for. Unobserved heterogeneity in individuals or households plays a main role in the formation of overweight and obesity (Staudigel, 2011). Specification tests (Hausman) give us evidence that the assumption that FE models do map our research question accurately, is valid.[8] Our model of interest is shown in Equation (2).

$$Y_{it} = \alpha_i + \beta X_{it} + u_{it} \qquad (2)$$

Where Y_{it} denotes the outcome (BMI or BMI growth) of individual i at time t, the matrix X_{it} captures individual and household characteristics. β is a vector of parameters to be estimated. α_i captures time-invariant unobserved effects on the level of individuals, and u_{it} is an i.i.d. error term.

When estimating the fixed-effects model we finally use Equation (3). Time-invariant factors (such as gender) including unobserved individual level effects are removed from the model, by applying a within transformation of the data. That is, we generate time-demeaned data by substracting individual specific means for each variable in our model (Wooldridge, 2006). We thus estimate:

$$\ddot{Y}_{it} = \beta \ddot{X}_{it} + \ddot{u}_{it} \qquad (3)$$

where $\ddot{Y}_{it} = Y_{it} - \overline{Y}_i$, $\ddot{X}_{it} = X_{it} - \overline{X}_i$ and $\ddot{u}_{it} = u_{it} - \overline{u}_i$.

Table 1 shows how WHO classified people of different body stature into four BMI categories (more detailed obese classes were added later to be able to develop more targeted recommendations and strategies). For our analysis we refer to these cut-off points for BMI levels but only use the BMI categories underweight, normal, overweight, and obese. BMI levels change according to individual's energy balances. If people consume more energy (energy input in kilocalories (kcal)) than they spend (energy expenditure in kcal) their body weight increases and accordingly, BMI levels increase as well.

In our analysis we will focus on the longitudinal component of the data. This unbalanced panel data set provides detailed information on our variables of interest and for several (if not fully overlapping) time periods per individual.

[8] A FE-Model is also appropriate to use for unbalanced panel data sets. FE models allow attrition to be correlated with α_i, the unobserved effect (Wooldridge, 2002).

Table 1: WHO Classifications of obesity

WHO Classifications of obesity		
Classification	**BMI (kg/m²)**	**Risk of comorbidities**
Underweight	< 18.5	Low (but risk of other clinical problems increased)
Normal range	18.5 to 24.9	Average
Overweight	25.0 to 29.9	Increased
Obese Class 1	30.0 to 34.9	Moderate
Obese Class 2	35.0 to 39.9	Severe
Obese Class 3	≥ 40.0	Very Severe

Source: (WHO 1995; James et al. 2001)

For the dependent variable we implemented a smoothed growth rate of BMI per year for each individual (i.e. compound annual growth rate, CAGR). This measure is appropriate to address the unbalanced structure of the panel. For some individuals we lack information for some years, i.e. the individuals were followed again after a few years break. Using the compound annual growth rate we do not simply consider the BMI growth of an individual from one period to the next but we generate a smoothed growth rate (which assumes e.g. that an individual we observed 1995 to 2000 grew at the same rate between these years). So, for the compound annual growth rate we take into account the first year with the BMI information ($V(t_0)$), the year with the most recent information ($V(t_n)$), and the length of the period in between. Below (in Equation (4)) we present the equation used to calculate the compound growth rate for BMI

$$BMI\_CAGR(t_0, t_n) = \left(\frac{V(t_n)}{V(t_0)}\right)^{\frac{1}{t_n - t_0}} - 1 \qquad (4)$$

with the start value $V(t_0)$, finish value $V(t_n)$, and number of years $t_n - t_0$.

For calculating the BMI and the dependent variable BMI growth we use self-reported information of the individuals. We are aware that this may lead to biased results as often weight and height are misreported and can hence distort the measured BMI levels (Macdiarmid and Blundell, 1998). To capture the change of BMI, however, we use compound growth rates and assume that the *degree* of misreporting more or less remains constant over time,[9] so that compound growth rates are likely to be less affected by potential misreporting.[10] By using self-reported information we can use all waves from 1995 to 2012, thus we must rely on their information. T-Tests show us that the means of measured and self-reported data for the *growth rates* are equal whereas they are significantly different from each other for the BMI levels. We hence conclude that it is appropriate to use BMI_CAGR with self-reported information from an econometric perspective. We additionally used the Wilcoxon signed-rank test to evaluate the median values of the implemented dependent variable because we know of some outlier values in the sample, and our analysis goes beyond analyzing effects for population means. Here as well we find confirmation that it is better to use BMI_CAGR instead of BMI level values if we want to use self-reported information. Nevertheless, we will use both, BMI and BMI_CAGR, as dependent variables for our empirical analysis to obtain a more detailed understanding of the situation in Russia but use precaution when interpreting the results.

5. Descriptive Results

To get a first impression of the sample characteristics, Table 2 presents the definitions, means and standard deviations for all variables used in the econometric analysis.

In our sample we have 57% females and 43% males (in our pooled sample: N=97,140 versus N=72,766, respectively). The bias towards women most likely stems from the fact that women are more likely to be at home when the enumerators visit the dwelling units and additionally there are more women living in Russia than men (87 males per 100 females; UN, 2015).

Females are somewhat older than males in our sample (47.3 and 43.1 years, respectively) which to a small extent can explain why females have a higher BMI than males (26.6 and 25.2, respectively).[11] Women have a smaller income (measured as household real expenditure, per capita, per month) than men (3,420 Russian Rubles, RUB and 3,530 RUB, respectively). Regarding professional education women and men show comparable numbers for dummy variables: women are more likely to have completed secondary or tertiary

[9] If the degree of misreporting does change over time due to e.g. changes in preferences for thinness, then people might systematically underreport their weight, maybe women even more than man. Controlling for gender and time meets this problem.

[10] For the most recent seven years we would have lost information if we had only used measured data because after 2005 only self-reported information were conducted and not measured information any more. Since we clearly want to have up-to-date information we accept this issue.

[11] Regressing age on BMI levels we find a positive relationship.

education than men. A greater percentage of men are working compared to women (64% and 49%, respectively). Household size is 4.2 on average and most of the respondents have children (71%). Most of the respondents reported that they live together with a partner (71% of the men and 53% of the women). Males report a higher frequency of physical activity compared to women. Around 74% of the respondents live in urban areas.

Table 2: Descriptive Statistics for RLMS Sample, 1994-2012

	Total			Females			Males		
Variable	**N**	**Mean**	**Std.Dev.**	**N**	**Mean**	**Std.Dev.**	**N**	**Mean**	**Std.Dev.**
BMI (self-reported)	169,906	26.03	5.13	97,140	26.60	5.71	72,766	25.26	4.10
Age	169,906	45.53	17.63	97,140	47.33	18.35	72,766	43.11	16.31
Gender	169,906	0.43	0.50	97,140	0	0	72,766	1	0
Expenditure , p.c.(real)	169,906	3468	5825	97,140	3420	5788	72,766	3530	5875
Less Second. Educat.	169,906	0.44	0.49	97,140	0.42	0.49	72,766	0.47	0.49
Complet. Secon. Educ.	169,906	0.35	0.48	97,140	0.37	0.48	72,766	0.34	0.47
Comple. Tertiary	196,906	0.20	0.40	97,140	0.21	0.41	72,766	0.19	0.39
Working	169,906	0.56	0.50	97,140	0.49	0.50	72,766	0.64	0.48
Household Size	169,906	4.20	2.23	97,140	4.08	2.24	72,766	4.37	2.21
Living with Partner	169,906	0.60	0.49	97,140	0.53	0.50	72,766	0.71	0.46
Has Kids	169,885	0.71	0.46	97,129	0.72	0.45	72,756	0.69	0.46
Smokes	169,780	0.34	0.47	97,062	0.14	0.35	72,718	0.60	0.49
Physical Activity	166,154	0.40	1.00	95,256	0.35	0.94	70,898	0.47	1.08
Urban	169,906	0.74	0.44	97,140	0.74	0.44	72,766	0.73	0.45

Source: Own computation based on RLMS, 1994-2012.

Observations are almost equally distributed throughout the years 1994 to 2009, meaning we have around 5% of observations in these years, from 2010 to 2012 we have higher shares of observations, around 9% per year. This means that the more recent years are slightly 'overrepresented' in our sample. The main reason lies in the replenishment of the sample, starting in year 1998 (See Table A 2 in the Appendix).

Table 3: Geographic Regions

Geographic Region	**Total**	
BMI categories	**Frequency**	**Percent**
Moscow and St. Petersburg	16,878	9.9
Northern and North Western	10,588	6.2
Central and Central Black Earth	32,297	19.0
Volga-Vaytski and Volga Basin	30,968	18.2
North Caucasian	23,544	16.9
Ural	24,301	14.3
Western Sibirian	15,450	9.1
Eastern Sibirian and Far Eastern	15,880	9.3
Total	169,906	100

Source: own calculations using RLMS sample.

Table 3 gives an overview of the geographic distribution in the sample. Urban areas like Moscow and St. Petersburg are represented with 9.9%. The regions Northern and North

Western, Western Sibirian, and Eastern Sibirian and Far Eastern are less densely populated and therefore, represent a smaller share in the sample (6.2%, 9.1%, and 9.3%, respectively).

Table 4 shows the distribution of the population in the BMI categories.[12] We can see that a much higher share of the women is obese relative to the men (25.7% and 12.4%, respectively). As a whole, it is worrying that around one-fifth of the whole sample is obese. For overweight prevalence rates are much higher. Around 30% of the women are overweight whereas 34% of the men are overweight and hence have a BMI between 25 and 30. In total, this means that more than 50% of the population is either classified overweight or obese. This clearly shows how urgently the Russian government needs to take steps and strategies to raise peoples' awareness about health risks and comorbidities caused by obesity. If we compare these numbers with the measured, rather than self-reported information, we get an even more alarming picture. Measured BMIs show much higher levels and much higher percentage points for overweight and obesity (numbers not shown).

Table 4: BMI Categories

	Total		**Females**		**Males**	
BMI categories	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Underweight	5,235	3.08	3,843	3.96	1,392	1.91
Normal	77,746	45.76	39,809	40.98	37,937	52.14
Overweight	52,984	31.18	28,575	29.42	24,409	33.54
Obese	33,941	19.98	24,913	25.65	9,028	12.41
Total	169,906	100	97,140	100	72,766	100

Source: own calculations using RLMS sample.

Regarding the income distribution and income groups (here: expenditure quintiles) we can tell that highest 'persistence' is found in the richest and the lowest quintiles; the middle expenditure quintiles are less likely to stay in the same quintile relative to the previous period. 58% of the respondents of the first quintile remained in the same income quintile as in the previous period, 50% of the richest quintile had already been rich in the previous period. In the middle quintiles we see less variance (see Table A 3 in the Appendix).

6. Empirical Results

Before we implement the fixed effects regression, we first try to get an idea of the relationship between income growth and BMI by running Pooled OLS regressions, separated by selected years. We chose the first year 1995 (to get the growth expenditure variable we have to allow

[12] The categories are mutually exclusive but jointly exhaustive.

for a time lag) and then chose steps spanning 5 years when possible.[13] Hence, we first have a look at OLS regressions for 1995, 2001, 2006, and 2012.

Table 5 shows our estimation results for base regressions, found by inserting different types of variables that represent the monetary well-being of an individual. These base models show us the extent to which expenditure (log), expenditure (log) growth or quintile dummies have an effect on the BMI (level). We analyze these variables to capture the impact that monetary well-being has on the individual BMI. By using these base models, we find that increasing expenditure has significant positive effects on the BMI. For a woman of average weight and average height, this would mean that an increase of 1% in income would result in a weight gain of 42.5 gr (for 1995, 1st column). The squared term of expenditure (log) shows a negative sign, which reflects diminishing returns of an additional 1% of expenditure. The growth of expenditure (from one year to the next) does not indicate significant effects, which means that individual expenditure does not affect BMI levels. Inserting quintile dummies (with the poorest quintile as the left out category) shows significant positive effects on BMI levels for the years 2001, 2006, and 2012. Richer quintiles have a significant positive higher BMI than the poorest income quintile. To illustrate the effect, let's look at a man of average weight and average height that in 2001 belonged to the richest income quintile: this man has a BMI which is 0.692 kg/m^2 higher than that of a man who belonged to the poorest income quintile, it is 2.07 kg more for men of average height and weight. The difference of BMI between females and males is becoming smaller over time, so it seems that males gain weight faster than females. The effect of age stays more or less the same over time, around 0.4 $kg/m^2$of BMI (+/- 0.03).

Turning points for the quadratic regression estimates of expenditure, per capita (first column per year) for the years 1995, 2001, 2006, and 2012 are: 7,856 RUB; 6,234 RUB; 10,716 RUB; and 9,436 RUB, respectively.[14] Hence, we can expect that rising expenditure will lead to higher BMI levels in the future because turning points are reached at even higher monetary values only, compared to mean expenditure in each year.

[13] As already mentioned, the survey has not been conducted in the years 1997 and 1999.

[14] Mean per capita expenditure for mentioned years are: 2,811 RUB in 1995; 2,398 RUB in 2001; 3,590 RUB in 2006; and 5,184 RUB in 2012.

Table 5: Impact of income variables on BMI for selected years, base models – Pooled OLS regression results

VARIABLES	1995	1995	1995	2001	2001	2001	2006	2006	2006	2012	2012	2012
Male	-1.619***	-1.619***	-1.801***	-1.363***	-1.362***	-1.609***	-0.948***	-0.950***	-1.099***	-0.666***	-0.666***	-0.786***
	(0.126)	(0.126)	(0.140)	(0.159)	(0.158)	(0.136)	(0.126)	(0.126)	(0.138)	(0.123)	(0.123)	(0.125)
2nd Quintile		0.0358			0.370**			0.115			0.249*	
		(0.176)			(0.176)			(0.132)			(0.134)	
3rd Quintile		0.0761			0.595***			0.0961			0.369***	
		(0.207)			(0.165)			(0.152)			(0.129)	
4th Quintile		0.343			0.548***			0.436***			0.403***	
		(0.224)			(0.154)			(0.137)			(0.144)	
5th Quintile		0.279			0.692***			0.419**			0.441***	
		(0.214)			(0.167)			(0.186)			(0.158)	
Age	0.406***	0.406***	0.412***	0.406***	0.406***	0.427***	0.423***	0.423***	0.423***	0.444***	0.445***	0.456***
	(0.0142)	(0.0143)	(0.0154)	(0.0151)	(0.0150)	(0.0153)	(0.0124)	(0.0125)	(0.0160)	(0.0147)	(0.0148)	(0.0168)
Age^2	-0.00346***	-0.00346***	-0.00354***	-0.00326***	-0.00326***	-0.00348***	-0.00329***	-0.00329***	-0.00331***	-0.00342***	-0.00342***	-0.00354***
	(0.000163)	(0.000164)	(0.000166)	(0.000165)	(0.000165)	(0.000158)	(0.000131)	(0.000131)	(0.000167)	(0.000152)	(0.000152)	(0.000165)
Expenditure, p.c. (log)	1.627*			1.799**			1.207**			1.922***		
	(0.864)			(0.793)			(0.555)			(0.599)		
Expenditure, p.c. $(log)^2$	-0.0907			-0.103*			-0.0654*			-0.105***		
	(0.0554)			(0.0530)			(0.0348)			(0.0372)		
Expenditure growth, p.c. (log)			-0.00820			0.114			-0.0129			0.0391
			(0.0754)			(0.0912)			(0.0971)			(0.0741)
Constant	9.039**	15.95***	16.09***	7.922**	15.09***	15.29***	9.669***	14.82***	15.17***	5.940**	14.28***	14.43***
	(3.457)	(0.313)	(0.321)	(3.011)	(0.328)	(0.352)	(2.301)	(0.289)	(0.352)	(2.484)	(0.314)	(0.374)
Observations	7,084	7,084	5,438	8,580	8,580	7,067	10,716	10,716	8,005	16,391	16,391	13,735
R^2	0.141	0.140	0.125	0.169	0.169	0.152	0.186	0.185	0.161	0.177	0.176	0.159

Robust standard errors in parentheses. Left out categories is: 1st Quintile,
*** p<0.01, ** p<0.05, * p<0.1.
Source: Own calculations using RLMS sample.

To get deeper insights into other factors affecting the BMI level, we ran extended regressions with more explanatory variables, as shown in Table 6. Compared to the base model, the coefficient of the gender variable loses in magnitude which means that some of the other variables capture some part of the effect. For example, we have seen before, that smoking habits are correlated with gender. An interesting finding is that living with a partner has a bigger effect on people's BMI than age. Both factors have a significant positive impact on BMI. The coefficient of household size shows a positive and significant influence on BMI. One factor may be that households with more members buy and prepare food in more efficient ways, so that each family member is able to consume more food. It is also possible that higher numbers of people eating together increase the individual food intake. Interaction terms between expenditure and expenditure quintiles show that only among the richest quintile the richest people have lower BMI levels than the poorest quintile (not shown here).

The coefficient of the factor physical activity is significant and negative. This confirms that more physical activity reduces BMI. The effects of living with a partner, household size, and smoking become smaller over time, whereas the effects of physical activity and urban areas become larger over time.

We know that over time the percentage of people who state that they do not engage in physical activity is clearly decreasing and the percentage of people who state that they do light physical exercise or daily exercise at least 30 min./day is increasing, respectively.

The Pooled OLS regression estimates in Table 6 show a significant negative sign for the urban dummy. This is in contrast to previous findings in the nutrition transition literature (Popkin, 2004; Popkin and Ng, 2007; Asfaw, 2007; Hawkes, 2007). Our findings show that people in urban areas are not as heavy (have a lower BMI) as people living in rural areas.

The effect becomes larger over time. Our hypothesis was that urbanization has a positive effect on BMI due to better transportation and infrastructure and a higher offer of meals eaten outside of the home. One explanation for the negative sign might be that "healthy nutrition" has become modern in the sense that people prefer to eat less meat and less fat. Hence, it is possible that the urban dummy captures other lifestyle factors that lead to lower BMI levels.

Table 6: Impact of income variables on BMI for selected years, extended models – Pooled OLS regression results

VARIABLES	1995	1995	2001	2001	2006	2006	2012	2012
Gender	-1.114***	-1.127***	-0.757***	-0.757***	-0.450***	-0.436***	-0.405***	-0.393***
	(0.129)	(0.122)	(0.141)	(0.138)	(0.109)	(0.107)	(0.102)	(0.101)
Expenditure, p.c. (log)	1.281		2.012**		1.336**		2.251***	
	(0.839)		(0.797)		(0.515)		(0.590)	
Expenditure, p.c. (log)^2	-0.0592		-0.107**		-0.0640*		-0.115***	
	(0.0536)		(0.0521)		(0.0322)		(0.0357)	
2nd Quintile		0.0529		0.422**		0.171		0.321**
		(0.182)		(0.165)		(0.136)		(0.135)
3rd Quintile		0.126		0.699***		0.201		0.508***
		(0.209)		(0.154)		(0.155)		(0.129)
4thQuintile		0.385*		0.696***		0.581***		0.576***
		(0.226)		(0.139)		(0.145)		(0.150)
5th Quintile		0.430*		0.891***		0.575***		0.671***
		(0.225)		(0.165)		(0.198)		(0.155)
Less than Secondary Education	1.006***		0.603***		0.859***		0.694***	
	(0.146)		(0.133)		(0.134)		(0.108)	
Completed Secondary Education	0.891***		0.504***		0.793***		0.785***	
	(0.142)		(0.154)		(0.0925)		(0.130)	
Age	0.383***	0.370***	0.392***	0.383***	0.415***	0.405***	0.432***	0.430***
	(0.0162)	(0.0172)	(0.0166)	(0.0166)	(0.0160)	(0.0150)	(0.0164)	(0.0157)
Age^2	- 0.00321***	- 0.00308***	- 0.00314***	- 0.00306***	- 0.00322***	- 0.00313***	- 0.00331***	- 0.00329***
	(0.000189)	(0.000196)	(0.000180)	(0.000177)	(0.000168)	(0.000160)	(0.000171)	(0.000164)
Household Size	0.0915**	0.0671	0.0970**	0.0826**	0.0728***	0.0577**	0.0615**	0.0513*
	(0.0424)	(0.0423)	(0.0391)	(0.0367)	(0.0233)	(0.0248)	(0.0280)	(0.0265)
Working,	0.469***	0.412***	0.262**	0.209*	0.360***	0.299**	0.128	0.0821
	(0.138)	(0.137)	(0.122)	(0.123)	(0.127)	(0.123)	(0.0993)	(0.0935)
Lives with Partner	0.425***	0.402***	0.342**	0.350**	0.244*	0.248*	0.303***	0.288***
	(0.140)	(0.139)	(0.134)	(0.132)	(0.125)	(0.128)	(0.0825)	(0.0826)
Smokes	-1.262***	-1.181***	-1.496***	-1.443***	-1.426***	-1.342***	-0.965***	-0.876***
	(0.116)	(0.114)	(0.100)	(0.101)	(0.139)	(0.144)	(0.132)	(0.134)
Physical Activity	-0.0199	-0.0511	-0.154***	-0.170***	-0.0552	-0.0795**	-0.176***	-0.191***
	(0.0636)	(0.0662)	(0.0469)	(0.0458)	(0.0353)	(0.0375)	(0.0301)	(0.0316)
Urban	-0.358*	-0.440**	-0.163	-0.222	-0.325*	-0.389**	-0.450*	-0.504**
	(0.195)	(0.197)	(0.224)	(0.220)	(0.164)	(0.168)	(0.238)	(0.244)
Constant	9.082**	16.41***	6.150*	15.34***	8.015***	15.17***	3.824	14.73***
	(3.435)	(0.413)	(3.121)	(0.454)	(2.127)	(0.296)	(2.487)	(0.331)
Observations	7,030	7,030	8,553	8,553	10,681	10,681	16,308	16,308
R-squared	0.161	0.155	0.189	0.187	0.204	0.200	0.190	0.186

Robust standard errors in parentheses. Left out categories are: 1st Quintile; Completed Tertiary Education.
*** p<0.01, ** p<0.05, * p<0.1.
Source: Own calculations using RLMS sample.

Fixed effects regressions (in Table 7) give information on the time-demeaned data on the BMI.

Table 7: Fixed Effects Regression Results

VARIABLES	BMI Total	BMI Females	BMI Males
Expenditure, p.c. (log)	0.310***	0.493***	0.0494
	(0.0957)	(0.135)	(0.130)
Expenditure, p.c. (log)^2	-0.0130**	-0.0236***	0.00219
	(0.00599)	(0.00842)	(0.00821)
Completed Secondary Education	-0.00380	-0.0343	0.0308
	(0.0289)	(0.0446)	(0.0360)
Completed Tertiary Education	-0.0437	-0.206***	0.140*
	(0.0561)	(0.0777)	(0.0796)
Age	0.309***	0.367***	0.233***
	(0.0501)	(0.0623)	(0.0691)
Age^2	-0.00235***	-0.00249***	-0.00233***
	(8.58e-05)	(0.000115)	(0.000127)
Household Size	0.0276*	0.0196	0.0345*
	(0.0141)	(0.0202)	(0.0187)
Working	-0.0509**	-0.171***	0.0880***
	(0.0217)	(0.0306)	(0.0292)
Lives with partner	0.214***	0.234***	0.214***
	(0.0323)	(0.0429)	(0.0480)
Smokes	-0.314***	-0.372***	-0.311***
	(0.0376)	(0.0590)	(0.0484)
Physical Activity	-0.0160**	-0.0145	-0.0218**
	(0.00689)	(0.00970)	(0.00969)
Urban	0.147	0.461	-0.298
	(0.217)	(0.308)	(0.273)
Constant	15.37***	12.79***	18.88***
	(1.771)	(2.320)	(2.286)
Observations	166,034	95,180	70,854
R-squared	0.095	0.097	0.100
Rho	0.834	0.843	0.812
Number of individuals	34,298	18,840	15,458
Year FE	YES	YES	YES

Robust standard errors in parentheses. Left out categories are: 1st Quintile; Completed Tertiary Education.
*** p<0.01, ** p<0.05, * p<0.1.
Source: Own calculations using RLMS sample.

Since fixed effects regressions omit time-invariant factors like gender, we run the regressions for both sexes (BMI Total) and separated by gender to get deeper insights. The influence of expenditure is smaller than in the Pooled OLS regressions. There is less within variation (within individuals) of the factors than between (between individuals). This means expenditure has a smaller effect for one particular individual than it has for different individuals. Interestingly, an increase in expenditure only has a positive effect on BMI for females, not for males (with diminishing returns for both). Turning points for the effect of an increase of expenditure are much higher than compared to the pooled sample. Turning points for both, males and females are at 150,704 RUB; and at 34,369 RUB for females. This means that only after reaching these turning points people are expected to lose weight when increasing their expenditure by 1%. Since this is far more than the average per capita expenditure is, it can be expected that people will gain further weight as their income level increases.

The dummy variable for completed secondary education is not significantly different from less than secondary education (left out category). We have another interesting finding for the dummy variable completed tertiary education. Women with completed tertiary education have a significantly lower BMI compared to women with less than secondary education (at 1% significance level). This finding is in line with Inglis et al. (2005), Dammann and Smith (2009), and Sobal (1991); this holds true if we consider women with completed tertiary education as belonging to a higher socioeconomic group. For men the opposite is true. Men with completed tertiary education have significantly higher BMIs than men with less than secondary education (at 10% significance level). Age has positive and significant effects on BMI for both, males and females, but has a larger coefficient for women. Household size only has a small positive effect for men, not for women (at the 10% significance level).

The sign of the work coefficient also depends on the gender: For men the effect of working is positive and for women it is negative (both at the 1% significance level). Reasons might be that women experience a higher activity level when they are working and have to do the household chores, too, so that they are more active. On the other hand, studies have shown that working is often correlated with higher consumption of food eaten outside the home, which is often regarded as containing more calories than homemade food (Gillis and Bar-Or, 2003; Stewart, 2011).

Table 8: BMI growth per period, Pooled OLS regression

VARIABLES	BMI Growth Total	BMI Growth Females	BMI Growth Males
First BMI per Period	-0.00121***	-0.00110***	-0.00171***
	(0.000102)	(0.000105)	(0.000156)
Male	-0.00115**		
	(0.000479)		
Expenditure, p.c. (log)	0.0125***	0.0103**	0.0149**
	(0.00396)	(0.00497)	(0.00595)
Expenditure, p.c. $(\log)^2$	-0.000698***	-0.000555*	-0.000856**
	(0.000254)	(0.000318)	(0.000377)
Completed Secondary Education	-0.00201***	-0.00179*	-0.00243***
	(0.000717)	(0.000918)	(0.000928)
Completed Tertiary Education	-0.00298***	-0.00326***	-0.00185*
	(0.000772)	(0.00100)	(0.00101)
Age	0.000224**	0.000610***	-0.000316**
	(0.000102)	(0.000129)	(0.000147)
Age^2	-3.33e-06***	-6.63e-06***	1.40e-06
	(1.03e-06)	(1.28e-06)	(1.56e-06)
Duration (in each period)	0.000232	0.000317	1.07e-05
	(0.000273)	(0.000345)	(0.000355)
Household Size	0.000212	0.000196	0.000204
	(0.000166)	(0.000202)	(0.000215)
Working	0.00216***	0.00190**	0.00225**
	(0.000737)	(0.000936)	(0.00108)
Lives with partner	0.000626	0.00119*	0.00234**
	(0.000574)	(0.000716)	(0.00103)
Smokes	-0.00424***	-0.00321***	-0.00476***
	(0.000674)	(0.000977)	(0.000863)
Physical Activity	-0.000594*	-0.000868**	-0.000713*
	(0.000306)	(0.000435)	(0.000400)
Urban	-0.00122**	-0.00182**	-0.000493
	(0.000611)	(0.000762)	(0.000851)
Constant	-0.0176	-0.0203	-0.00559
	(0.0153)	(0.0196)	(0.0232)
Observations	49,054	27,893	21,161
R-squared	0.020	0.019	0.029
Period FE	YES	YES	YES

Robust standard errors in parentheses. Left out categories are: 1st Quintile; Completed Tertiary Education.
*** p<0.01, ** p<0.05, * p<0.1. Periods are grouped as 1994-1998, 1999-2003, 2004-2007, and 2008-2012.
Source: Own calculations using RLMS sample.

Living with a partner for both sexes increases BMI and smoking decreases BMI. The level of physical activity is only significant and negative for men, which is plausible because men are more likely to report that they engage in physical exercise.

In order to identify drivers of individual BMI growth we ran Pooled OLS as displayed in Table 8. We grouped the years into 4 periods[15] as then we can use the first BMI per period as an explanatory factor (instead of simply using the lagged BMI) without having to worry about endogeneity. This will probably show a more pronounced effect than the lagged BMI. Grouping the years means clustering periods of 4 years. Since the dependent variable is a compound variable which is able to cover different points in time in an unbalanced panel data set, we can rule out attenuation bias.

A higher initial BMI leads to smaller BMI growth rates, which reflects a convergence effect. Note, that we find small marginal effects for most variables because of the structure of the dependent variable (i.e. being a compound annual growth rate). With a higher initial BMI people gain weight less rapidly, hence we can assume that they are closer to their "final weight". From Table 8 we can see that males gain weight less rapidly than females; with increasing expenditures people gain weight faster. Calculating turning points again, we find that the turning point (after which increases in expenditure lead to negative BMI growth) is lower for males than for females (at 6,022 RUB and 10,536 RUB, respectively).[16] It is at 7,641 RUB for both sexes. People that have less then completed tertiary education gain weight faster than persons that have completed tertiary education. This is more relevant for females than for males (in magnitude of coefficients and level of significance). Interestingly, now we see that men do gain weight less rapidly when they become older whereas women gain weight faster as they get older (but only to a certain age). We control for the duration of which we have information of the respondent to make sure that this does not affect the outcome of BMI growth and do not find significant effects for it. Another interesting finding is that we now see significant positive effects of working on BMI growth for both sexes, thus both men and women gain weight faster when they are working.

7. Discussion and Conclusion

This paper employs different empirical models to enable the understanding of increasing body weight and its influencing factors in Russia at the start of and during the transition from a planned to a market economy. It was of special interest who is most affected in the society by increasing BMI levels as income grows. During the observed time period from 1994 to 2012

[15] Period 1: 1994 – 1998, Period 2: 1999 – 2003, Period 3: 2004 – 2007, and Period 4: 2008 – 2012.
[16] Mean per capita expenditure for periods are: 2,951 RUB in Period 1; 2,598 RUB in Period 2; 3,564 RUB in Period 3; and 4,863 RUB in Period 4.

overweight and obesity rates significantly increased. At the same time, income growth was much more volatile. By using different measures of economic welfare, such as expenditure per capita (log), and expenditure quintiles, we try to detect the influence of a transitional process in terms of nutritional and health outcomes on different income groups. Since a country's capacity to enhance economic growth depends also on the well-being of its inhabitants, it is imperative to know how a society develops and at whom to address potential health improving strategies. If people are overweight or obese, they are less productive and also cause healthcare costs (Rtveladze, 2012; Hoffman, 2001; Lakdawalla et al., 2005). Since we assume an inverted U-shape relationship of BMI with income, it is essential to find out which people are most affected in the Russian society so that policymakers know which group to address (Tafreschi, 2014). Are the richer income groups more affected by high BMI levels or has this changed and now poorer income groups are bigger? For the case of Russia we could not find clear evidence that the income-BMI gradient has already shifted from a positive to negative sign. Calculating turning points and comparing them with average per capita expenditure for several regression estimates leads to the conclusion that the turning points of the income-BMI gradient have not yet been reached. This means, increasing expenditure still positively influences BMI levels of the respondents in our sample; also BMI growth is significant and positive influenced by rising expenditure (with diminishing returns).

Regarding expenditure quintiles, regression results gave us interesting insights. All quintiles from second to fifth show higher BMI levels compared to the lowest quintile. Only among the richest people in the fifth expenditure quintile we have found that they have lower BMI levels than people from the poorest quintile. Expenditure growth did not have significant effects in any of our regressions. Regarding the influence of professional education on BMI, we got a diverse picture. In general, we found that lower educated people had higher BMI levels compared to people who have completed tertiary education, but separated by gender we found that this does not hold true for men. Thus, males that have a higher education are heavier than males with a less than secondary education.

Overweight and obesity can lead to several NCDs, e.g. diabetes, cardiovascular diseases, hypertension, musculoskeletal disorders (especially osteoarthritis), and various cancers. Diabetes is difficult to treat, thus, prevention is critical and can even have multigenerational impact. Some of the undertaken strategies of the Russian government to make the population follow dietary recommendations (eat more fruits and vegetables, less salt, fewer sugary and fatty foods and some fish) failed because excess weight does not seem to have high priority for many Russians (Smetanina, 2010). Understanding the drivers of BMI growth is important in order to define what strategies are most likely to be effective in preventing harmful body weight gain. Overweight and obesity is increasing among children in Russia, too, though not as alarming as prevalence rates of childhood obesity are in other countries (UK, Switzerland, Spain, Italy) (Smetanina, 2010).

Since there is not much hope that the problem of rising obesity rates will vanish as income levels increase in the near future, other transmission channels have to be established. High education levels are associated lower BMI levels for women (though not for men), which gives reason to hope that education measures might be the right path to reduce overweight and obesity. However, these kinds of strategies have to be well-planned.

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Appendix

Table A 1 Construction of Variables

Variable	Description
BMI (self-reported)	Self-reported BMI, defined as weight in kilograms divided by squared height in meters
Expenditure (real), per capita	Total household expenditure, deflated by regional CPI, divided per household size
Log Expenditure (real), per capita	Logarithm of Expenditure (real), p.c.
Gender (dummy)	0 for females, 1 for males
Age	Age, measured in years
Less than Secondary Education (dummy)	1 if respondent has no professional education at all, or less than 7 years of schooling, or only received simple training programs; 0 otherwise
Completed Secondary Education (dummy)	1 if respondent has completed secondary education, or received a diploma at technical, trade, medical, music, pedagogical or art school; 0 otherwise
Completed Tertiary Education (dummy)	1 if respondent received a diploma at institute, university, academy, or graduate school; 0 otherwise
Working (dummy)	1 if respondent is working; 0 otherwise
Household Size	Number of persons living in the same household as respondent
Living with partner (dummy)	1 if respondent is married or lives with a partner in same household; 0 otherwise
Kids (dummy)	1 if respondents has children; 0 otherwise
Smokes (dummy)	1 if respondent is smoker; 0 otherwise
Physical activity	Categorical Variable: 0 if respondent does not engage in physical activity 1 if respondent does light physical exercise 2 if respondent does medium/intensive physical exercise 3 if respondent does intensive physical exercise 4 if respondent does daily exercise at least 30 min./day
Urban (dummy)	1 if respondent lives in urban and small urban settlement; 0 if respondent lives in rural areas

Table A 2 Distribution of Observations among Years (1994 to 2012)

Year	Frequency	Percent
1994	7,403	4.36
1995	7,084	4.17
1996	7,212	4.24
1998	7,455	4.39
2000	7,805	4.59
2001	8,580	5.05
2002	9,001	5.30
2003	9,123	5.37
2004	9,114	5.36
2005	8,989	5.29
2006	10,716	6.31
2007	10,555	6.21
2008	10,131	5.96
2009	10,149	5.97
2010	14,379	8.46
2011	15,819	9.31
2012	16,391	9.65
N	169,906	100

Source: own calculations using RLMS sample.

Table A 3 Transition Matrix for Income Quintiles

Quintile	Quintile					Total
	1	**2**	**3**	**4**	**5**	
1	58.19	23.84	10.41	4.85	2.71	100
2	25.90	32.27	22.68	13.15	6.00	100
3	11.72	24.67	29.98	22.16	11.47	100
4	6.29	14.09	24.40	32.00	23.21	100
5	3.37	7.25	13.27	25.99	50.12	100
Total	21.33	20.55	20.18	19.53	18.40	100