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SMOKING AND OBESITY REVISITED: EVIDENCE FROM BELARUS

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Smoking and Obesity Revisited: Evidence from Belarus

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Abstract

It has been hypothesized that the rising obesity rates in many countries are an unintended consequence of anti-smoking policies. However, evidence of a causal effect of smoking on body weight is mixed. Using a large nationally representative survey from Belarus, we estimate the effect of the number of cigarettes smoked per day on individuals' body mass index (BMI) and on the probability of being overweight and obese. We instrument smoking variable using cigarette prices and group-specific smoking rates. We find that smoking is negatively related to BMI, probability of overweight and obesity, and the magnitude of the estimated effects is comparable to the estimates from other countries. In addition, quantile regression analysis uncovers that the negative effect of smoking is higher at the higher percentiles of BMI distribution. Same differences in the effect are found using ordered probit regression analyses. Our results uncover a small negative effect of smoking on body size and obesity. These findings suggest that, while smoking cessation may lead to some weight gain among subjects of healthy weight and above healthy weight, the effects on obese subjects are small and should not be expected to significantly increase obesity prevalence.

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1. Introduction

Smoking prevalence in Belarus is very high. A nationally representative household survey in 2000 found that 53% of men and 9% of women over 18 years old were smokers (Gilmore et al., 2001). 10 years later the situation does not seem to have improved: according to the data from Belarusian Household Survey of Incomes and Expenditures (BHSIE) in 2010 the smoking rate among men was 49.3% and among women – 9.5%. According to some estimates, 28% of male deaths in Belarus in 2004 could be attributed to cigarette smoking (Eriksen et al., 2012). The data from the same survey also demonstrates high overweight and obesity rates. Obesity is shown to be one of the main factors worsening the self-perceived health status of women (Grigoriev and Grigorieva, 2011).

Since in many developed countries the decrease in smoking prevalence coincided in time with the surge in both overweight and obesity rates, the question arises whether the anti-smoking campaigns are in part responsible for the increase in obesity rates. Studies about the link between anti-smoking policies in the U.S. provide mixed evidence (Nonnemaker et al., 2009). A study focusing on China found no significant effect of smoking on obesity (Fang et al., 2009).

Belarus is lagging behind Europe and the United States in policies aimed at the decrease of tobacco control. During the stressful experience of transition out of communism, many post-Soviet countries, including Belarus experienced an increase in smoking prevalence (Cockerham et al., 2006). Unlike its neighbors, Belarus did not open up the tobacco market for foreign direct investment and government remains in full control of the industry, owning all cigarette companies and being the only importer of cigarettes (Gilmore and McKee, 2004). Tobacco taxes and the profits of the state-owned cigarette producers are an important part of the government budget revenues (Kruk and Shymanovich, 2011).

Gilmore et al. (2001) and Pomerlau et al. (2004) analyzed the determinants of smoking in Belarus. Both studies are based on the nationally representative household survey conducted in

2000. Age was found to be the main determinant of smoking, with young people being more likely to smoke. This finding suggests that without drastic anti-smoking measures, smoking prevalence is not going to decrease anytime soon. For women, the important determinants of smoking also include being divorced and residing in urban areas. For men, general disadvantage is an important determinant of smoking.

In 2011, the Ministry of Health of the Republic of Belarus in cooperation with World Health Organization approved an Anti-Tobacco Plan for 2011-2015 (Decree No.385, 2011), which includes a variety of anti-tobacco actions and measures. In particular, the government plans the gradual increase in tobacco taxes; introduction of smoking-free zones and restriction of smoking in public places; and massive informational campaign about the dangers of smoking and ways to quit. These measures can lead to a significant decrease in smoking prevalence. However, an unintended consequence of these policies might be an increase in overweight and obesity rates. The aim of the present study is to evaluate the significance of this possible effect by examining the relationship between tobacco consumption and body weight among Belarusian adults.

Medical literature has extensively documented the inverse relationship between tobacco use and body weight (Klesges et al., 1989; French and Jeffery, 1995). The nature of this relationship remains unclear, although changes in exercise, diet and metabolism are among the suggested mechanisms of tobacco's impact on body weight (Grunberg, 1985). However, there is no consensus in the literature about the possible effects of anti-tobacco campaigns on the overweight and obesity rates. Studies using the U.S. data provide different results depending on methodology and model specifications used in estimations. The positive and significant effect of cigarette taxes and prices on obesity is found in the studies by Chou et al. (2004), Rashad and Grossman (2004), Baum (2009) and Nonnemaker et al. (2009). Flegal (2007) finds that decrease in smoking prevalence may increase obesity rate, but insignificantly. Gruber and Frakes (2006), on the other hand, find that increase in cigarette prices (which leads to decrease in tobacco consumption) may decrease body weight and overweight rates significantly. Using data from China, Fang et al. (2009) took a different approach: instead of measuring the effect of cigarette prices on body weight measures, they captured the effect of smoking on body weight directly. The authors find negative relationship between smoking and BMI, but they also find this effect to be insignificant for those with high BMI. Overall, they find no significant effects of smoking on obesity.

This study seeks to examine the relationship between smoking and overweight and obesity rates in Belarus. As in Fang et al. (2009), we investigate the effect of smoking on the body weight using instrumental variable approach. We use two types of instruments for cigarette consumption: cigarette prices, which reflect economic incentives; and regional smoking prevalence, which reflect social attitudes towards smoking. To date, no study has analyzed the relationship between smoking and body weight in Belarus. To the best of our knowledge, this is also the first study to examine at the relationship between smoking and body weight in Eastern Europe. Because there are big socio-economic and demographic differences across world populations, the findings on this relationship from other populations may not apply to populations in Eastern European countries (Henrich et al. 2010). Furthermore, because Belarus began implementing an anti-tobacco campaign, it is important to understand whether decrease in smoking may lead to significant increase in obesity rates. Following Fang et al. (2009), we test three hypotheses in this study. First, we expect that the relationship between smoking and BMI among Belarusians would be negative. Second, we test whether the effect of smoking on BMI would be different along the BMI distribution. Third, we hypothesize that the decrease in smoking would have insignificant effect on the obesity rate in Belarus.

The remainder of the paper is organized as follows. Section 2 describes the sources of data and variables used in the analysis. Section 3 describes the empirical methods, in particular, the choice of appropriate instruments for smoking. Section 4 presents the results and Section 5 offers conclusions and discusses policy implications.

2. Data

2.1. Data

Our empirical analysis utilizes the 1996-2008 waves of the Belarusian Household Survey of Income and Expenditure (BHSIE). BHSIE was first fielded in 1995 and it incorporates interviews with a random sample of approximately five thousand households per year. BHSIE is considered to be one of the most reliable and comprehensive sources of micro-data in Belarus. It contains a wide range of questions on self-assessed health status, body weight and smoking in addition to many demographic, labor force variables, income and expenditure variables.

Our analysis sample consists of individuals who are at least 18 years old as of the date of interview in each year. The sample includes 133,095 individuals who had non-missing information on all of the analysis variables (see Table 1) and who were interviewed in thirteen years of data (1996-2008).

2.2. Analysis variables

2.2.1. Variables measuring weight status

The BHSIE includes self-reported measures of height and weight for each individual. For each individual, we create Body Mass Index (BMI) [$weight(kg)/height(m)^2$] and binary indicators of weight status, where the individuals are categorized as being underweight (BMI < 18.5), healthy weight (18.5 ≤ BMI < 25), overweight but not obese (25 ≤ BMI < 30) and obese (BMI ≥ 30) (CDCP, 2008).

2.2.2. Cigarette consumption variables

BHSIE asked each respondent whether he/she was a current smoker. For the individuals who responded "yes", the survey asked about the number of cigarettes smoked per day, with possible responses ranging from 1 to 98. We use these responses to create our measure of cigarette consumption. This continuous measure is intended to capture both the incidence and the intensity of smoking, which a binary smoking indicator variable is unable to do.

2.2.3. Other explanatory variables

Our multivariate analysis employs other explanatory variables, which include total monthly expenditure on alcohol that acts as a rough proxy for alcohol consumption. Previous literature has found that alcohol consumption may lead to higher body weight (Colditz et al., 1991; Lukasiewicz et al., 2005; Arif and Rohrer, 2005). Drinking has also been shown to be a complement of smoking, and is considered to be an indicator of personal addictive traits (Arcidiacono et al., 2007; Bask and Melkersson, 2004; Decker and Schwartz, 2000). We also include monthly expenditures on fruit and vegetables (excluding potatoes, which are staple food in Belarus) and expenditures on eating out. After controlling for the total household expenditure, expenditures on these food items are important controls for the composition of the diet in the BMI equation, which favorably contrasts our study from Fang et al. (2009). Furthermore, our multivariate analysis includes total personal income; household size; age; gender; single vs. married indicator; indicators of self-reported health status (good health, fair health, and poor health indicators); number of medical visits in the last 3 months; indicator for having been hospitalized in the last 12 months; indicator for whether health affects ability to work; sports practicing indicator; indicators for the educational attainment (university diploma, secondary education); and indicators for being currently employed, having ever worked, and being a student. We also include year dummies. Household income was measured using total household expenditure, which is considered to be a preferred measure to total household income because of frequent under-reporting of income in transition countries, which have a large informal sector (for a discussion, see Milanovic 1998). Total household expenditure was transformed into expenditure per capita by dividing by the OECD equivalence scale.[4]

An important factor in estimating the relationship between smoking and body weight status is the local environment and institutions, which may be correlated with both weight status and smoking. Local built environment may foster a sedentary lifestyle, low food prices. At the same time, different types of locations have been identified with different smoking prevalence rates (Gilmore et al., 2001), and may also differ in terms of cigarette prices. We are able to control for the unobserved differences in environmental characteristics among communities by the use of region, rural vs. urban indicator, and big city indicator (for cities with population >100,000). The regional identifiers available in the data refer to the six regions of Belarus (corresponding to “oblast” in Russian) and the capital city of Minsk.

3. Empirical Methods

3.1. Modeling the continuous measure of body weight: BMI

We begin by estimating the effect of cigarette consumption on the continuous measure of body weight, BMI. Our empirical specification assumes BMI to be a linear function of the explanatory variables:

$$BMI = \beta_0 + \beta_1 S + \beta_2 X + \varepsilon \quad \text{(Equation 1)}$$

Here, BMI is the body mass index; S is the number of cigarettes an individual smokes per day; X is the vector of other explanatory variables; ε is a error term; and $\beta_0 - \beta_2$ are the coefficients to be estimated. A negative coefficient on the variable measuring the number of cigarettes smoked would indicate a negative association between smoking and body weight. The

[4] The analysis used the so-called “OECD-modified” equivalence scale used by the Statistical Office of the European Union (EUROSTAT). The scale assigns 1 to the household head, 0.5 to each additional adult member and of 0.3 to each child under 19 (Hagenaars, de Vos and Zaidi 1994).

explanatory variables included in vector X would control for the observed characteristics that are correlated with both cigarette smoking and body weight.

3.2. Endogeneity of cigarette consumption

There may still be some unobserved factors, not included in the vector of controls X, that could potentially confound the observed association between cigarette consumption and body weight, making the cigarette smoking variable endogenous. In this case, the estimated coefficient on the smoking variable will be biased and will not reflect the causal effect of cigarette consumption on body weight. Endogeneity could also arise due to reverse causality or simultaneity between smoking and body weight, and due to the presence of measurement error in the smoking variable (Wooldridge, 2001). If the main source of endogeneity in self-reported smoking variable is random reporting bias, it will attenuate the estimate on smoking towards zero, and our estimates may be regarded as conservative estimates of the effect of smoking on body weight. However, the fact that our body weight status measure is self-reported and potentially mismeasured does not introduce a bias in the estimate on smoking, for the measurement error in our dependent variable only affects the precision (i.e. statistical significance) of the estimated effect of smoking.

The source of the omitted variable bias may be the unobserved individual-level heterogeneity in smoking and body weight status. Examples of such unobserved factors may include personality traits and family environment that induce the individual to both consume extra calories and smoke. It may also be variation in the discount rate assigned to the future health consequences of smoking and obesity by the individual (Cawley et al., 2006). Our empirical specification includes only a rough proxy to account for such addictive propensities. The reverse causality (or simultaneity) between smoking and body weight status is possible because overweight and obese individuals may use smoking as a mechanism for weight control (Baum, 2009; Cawley et al., 2004). Our analysis corrects for the potential endogeneity of smoking by using an instrumental variable technique. With the use of appropriate instruments we would be able to generate a consistent estimate of the effect of smoking on body weight status in Eq. 1. Instrumental variable technique assumes a linear first-stage model:

$$S = \gamma_0 + \gamma_1 Z + \gamma_2 X + v \qquad \text{(Equation 2)}$$

where vector Z contains instrumental variables; v is the residual; $\gamma_0 - \gamma_2$ are the model parameters; and the other terms are described in Eq. 1. The details of our instrumental variable strategy are presented in section 3.6.

3.3. Quantile regression

We implement quantile regression analysis to see whether the effect of smoking on body weight differs among individuals located in different percentiles of the BMI distribution (Trogdon et al., 2008; Fang et al., 2009). Detecting a significant effect of smoking on BMI in the upper percentiles of the conditional BMI distribution would suggest that decline in smoking rate would be accompanied by an increase in obesity rate. The attractive feature if the quantile regression is the flexibility of modeling data with heterogeneous conditional distribution (Koenker and Hallock, 2001). We estimate quantile regression for the 10th, 25th, 50th, 75th and 90th percentiles of the conditional BMI distribution using the same empirical specification as in Eq. 1.

In order to adjust for the endogeneity of cigarette smoking, we implement the control function approach (Lee, 2007). Specifically, we included the linear first-stage residual as an additional explanatory variable in the main specification for the effect of smoking on body weight in Eq. 1. This method is also known as two stage residual inclusion estimation (Terza et al., 2008) or limited information maximum likelihood estimation (Rivers and Vuong, 1988). An additional advantage of the control function approach is that it provides a test of endogeneity of the cigarette smoking variable. We use quantile regression at the 50th percentile in order to produce the first-stage residuals. However, using OLS regression for the first stage produced very similar results (not reported).

3.4. Ordered probit

We also study the effect of smoking on the four categories of body weight status as a robustness check of the potentially non-linear relationship between smoking and BMI. Ordered probit is a non-linear model that accounts for ordered categorical nature of the four weight status indicators (underweight = 1; healthy weight = 2; overweight but not obese = 3; obese = 4):

$$BMI\ categories = \beta_0 + \beta_1 S + \beta_2 X + \varepsilon \qquad \text{(Equation 3).}$$

In order to account for potential endogeneity of cigarette smoking, S, we implement control function approach due to the non-linear nature of this regression, which does not allow us using a linear two-stage least squares (2SLS) regression.

3.5. Binary indicators of body weight status: overweight and obese

As an additional check of the potentially non-linear relationship between smoking and BMI, we estimate specifications with the dependent variables being one of the two binary indicators of body weight status: overweight and obese. We first look at the effect of smoking on the probability of overweight or obesity (BMI ≥ 25) within a specification that is similar to Eq. 1:

$$\text{Prob(overweight or obese)} = \beta_0 + \beta_1 S + \beta_2 X + \varepsilon \qquad \text{(Equation 4).}$$

The dependent variable in Eq. 4 is a dichotomous indicator equal to 1 if individual's BMI equals to or exceeds 25; and 0 otherwise. The main estimation method is a probit regression. We implement a control function approach to account for the potential endogeneity of the cigarette smoking measure. In addition, we estimate OLS and 2SLS models as robustness checks of the main specification. We repeat the estimation for the probability of being obese, where the dependent variable is a binary indicator equal to 1 if the person's BMI equals to or exceeds 30; and 0 otherwise.

3.6. Instrumental variables

The use of instrumental variables is intended to correct for the endogeneity of the smoking measure and produce consistent estimates of the effect of smoking on body weight status. In order to be a valid instrument, the variable has to satisfy two conditions. First, it has to be strongly associated with the endogenous smoking variable. Second, the instrumental variable should not affect body weight status other than through its effect on smoking, i.e. it has to be "excludable" from the main estimation specification (Wooldridge, 2001).

We employ two instrumental variables in our estimation: (i) the mean number of cigarettes smoked per day in the same year-region-gender- and education group as the respondent, and (ii) the average yearly price per pack of cigarettes in the region where the respondent lives. Gilmore et al. (2001) identify important demographic and socio-economic differences in smoking rates, which dictates our use of gender and education categories (below secondary, secondary, university degree) to construct groups of observations that will be followed over time. The use of region as a grouping variable allows us to capture the social norm associated with smoking at the regional level. We exclude the individual's own cigarette smoking when we create group-level means. Group-specific smoking prevalence is likely to be predictive of the individual's own smoking preferences, but is unlikely to have a direct effect on individual's weight status other than through the effect on individual's smoking. This kind of instrument has been used in the literature before, including studies of body weight (Morris, 2007; Fang et al., 2009) and suicidal behavior and productive activities (Tekin and Markowitz, 2008). After accounting for the fixed differences in average smoking among regions, genders, and education groups within each year, the source of variation that is available to identify the effect of the instrument on individual's smoking is the differences in smoking prevalence among various interactions of year-, region-, gender- and education categories.

Region-specific cigarette price indices were provided by the National Statistical Committee of the Republic of Belarus (2011). These price indices were used along with the average cigarette price for 2010 to reconstruct the price per pack of cigarettes from 1995 to 2007. Prices were further converted into real 2008 U.S. dollars. We use lagged prices as instrument for current year cigarette consumption of the individuals in order to account for the addictive and inelastic nature of demand for smoking and the inability to quickly change smoking behavior after the price change. Further, we use natural log of cigarette prices in order to account for the potentially non-linear effect on the number of cigarettes smoked. Cigarette prices are likely to influence individual's BMI only through their effect on smoking. The first-stage equation estimates (not shown but available upon request) using both instruments reveal that group-specific average smoking has a very strong effect on individual's own smoking, while cigarette prices have negative (but not statistically significant at the conventional levels) effect on smoking. When used separately as an instrument however, cigarette price has a negative and statistically significant at the 5% level effect on individual's smoking rate. I all of the analysis below, we use both instruments and report the results of the Sargan over-identification test of the excludability (exogeneity) of our instruments, which is only possible when at least two instruments are available.

4. Results

4.1. Descriptive statistics of the analysis sample

Table 1A tabulates descriptive statistics for the variables used in the analysis below. The mean BMI among in the sample is 25.5, which suggests that an average Belarusian adult is just on the border between healthy weight and overweight. In particular, 2.2% are underweight, 48.8% are in the healthy weight range, 34.4 are overweight, and 14.6% are obese during the period under analysis (1996-2008). However, the distribution of weight status has undergone substantial changes over time: The percentage of individuals in the right tail of the BMI distribution has increased over time, with the percentage of obese increasing faster than the percentage of overweight individuals (Table 1B and Figure 1). An average percent of smokers is 26.7%, and an average adult smoked 3.7 cigarettes per day. The average price of a pack of cigarettes across all regions during the period 1995-2007 is 0.59 of 2008 U.S. dollars, and the average number of cigarettes smoked per day across all groups is 3.64.

4.2. Results of multivariate analysis: OLS and 2SLS

Multivariate estimation results using BMI as a dependent variable are presented in Table 2. The coefficient on the number of cigarettes smoked is -0.041 and is statistically significant at the 1% level. This implies that one additional cigarette smoked per day reduces BMI by 0.041 units after holding all else constant. However, this OLS estimate does not account for the potential endogeneity of smoking. The 2SLS estimate on the number of cigarettes smoked per day is -0.227 and is statistically significant at the 1% level. This suggests that after accounting for the endogeneity of smoking, the effect of the number of cigarettes smoked on BMI increases in magnitude more than five-fold. This estimate also implies that for a Belarusian adult with an average height of 5.5 ft, smoking one additional cigarette per day can reduce his/her weight by 1.41 pounds. If a person who smokes 3.704 cigarettes per day (the sample average number of cigarettes) quits smoking, his/her weight will increase by 5.21 pounds. With the average weight in the sample being approximately 159 pounds, a 5. 21 pound increase in weight due to quitting smoking accounts for only about 3.28% of the average body weight. Among smokers in the sample, individuals on average smoke 14 cigarettes per day. When a smoker stops smoking, he/she is predicted to increase his/her BMI by 3.18 units, and gain on average 19.7 pounds (or 12%). This could potentially move an overweight individual into the obese category.

The results presented in Table 2 support the validity of our instruments and the hypothesis that the cigarette smoking variable is endogenous based on the stark difference in the magnitude of the OLS and the 2SLS estimates, where OLS estimation leads to downward bias in the estimate of the effect of smoking on body weight status. The large magnitude of the 2SLS estimate also suggests that smoking could account for a large weight status difference between smokers and non-smokers. This result supports our first hypothesis and is consistent with the previous literature that finds that higher cigarette taxes and prices lead to the increase in BMI. In other words, the opportunity cost of smoking abatement could be an increase in body weight (Chou et al., 2004; Rashad and Grossman, 2004; Baum, 2009).

4.3. Results of multivariate analysis: quantile regressions

It is possible that the effect of smoking on body weight is not uniform. This effect may vary by the location of the conditional BMI distribution that the individual is at. It could be that smoking has a larger effect on healthy-weight individuals compared to overweight and obese individuals. OLS does not allow identifying such differences in the effects.

Finding differential effect of smoking on body weight across the BMI distribution is also important in terms of policy implications. For example, if smoking has most of its effect concentrated in the healthy weight range, then a reduction in the incidence of smoking would not lead to increase in the rate of obesity. However, an opposite would be true if smoking has a uniform effect across the BMI distribution. In order to explore such effects, we estimate quantile regressions at the 10th, 25th, 50th, 75th, and 90th percentiles. The results of this analysis are reported in Table 3. In the ordinary quantile regression, the coefficient on smoking at the median of BMI distribution percentile is -0.041 and is statistically significant at the 1% level. However, after we employ the control function quantile regression, the coefficient on smoking increases in magnitude to -0.116 and remains statistically significant at the 1% level.

Interestingly, the quantile regression using the control function approach demonstrates that smoking has a monotonically increasing effect on body weight status. The largest effect is obtained at the 75th and 90th percentiles, and the smallest effects are at 10th and 25th percentiles. All of the effects are statistically significant at the 1% level. In addition, the results at the 50th percentile in the ordinary quantile regression are identical to those in the OLS regression. However, the results at the 50th percentile in the control function quantile regression are much lower than the corresponding 2SLS results. This conforms to our expectation that smoking effects change across the conditional BMI distribution (our second hypothesis). However, smoking has a large effect on the body weight of individuals who are at the upper tail of the BMI distribution, which contradicts out third hypothesis. These findings suggest that a reduction in smoking rate may lead to an increase obesity rates by inducing a large weight gain among the population near the top end of the BMI distribution.

4.4. Results of multivariate analysis: ordered probit

The results of ordered probit regression analysis are reported in Table 4. We report the marginal effect of smoking one additional cigarette on the probabilities of each of the four BMI categories. The marginal effects in simple ordered probit regressions are relatively small but statistically significant at the 1% level. The marginal effects after controlling for endogeneity using control function approach are much larger and also statistically significant at the 1% level. In particular, one additional cigarette smoked per day increases the probability of being underweight by 0.18%, increases the probability of having healthy weight by 1.99%. On the other hand, it decreases the probability of being overweight (but not obese) by 1.06%, and decreases the probability of being obese by 1.1%. The coefficients on the first-stage residual by the ordered probit control function regression are all highly statistically significant (p value < 0.01), indicating that the cigarette smoking variable is endogenous (Terza et al., 2008).

4.5. Results of multivariate analysis: binary indicators for overweight and obesity

In order to conduct an additional test of the non-linear effects of smoking on body weight, we use overweight as our dependent variable in a probit regression. These results appear in Table 5. The marginal effect of smoking in the ordinary probit regression is -0.006 and statistically significant at the 1% level. The marginal effect after accounting for endogeneity using control function approach is -0.026 and statistically significant at the 1% level. This suggests that, if the number of cigarettes smoked per day increases by one, the probability of being overweight will decrease by 2.6%. Further, we estimate OLS and 2SLS model as a robustness check. The coefficients from both OLS and 2SLS regressions are very similar to the corresponding probit estimates. Altogether, these results suggest that a reduction in smoking prevalence will result in an increase in the rates of overweight. Finally we estimate the effect of smoking on the probability of being obese using the same specifications. The results from all models in Table 6 indicate that there is a significant negative relationship between smoking and the probability of being obese, with the magnitude of the effects being approximately half of the size of the corresponding effects on overweight. Overall, these results suggest that a decrease in smoking may be accompanied by an increase in weight and the effect would be moderate increase in the obesity rate in Belarus. This finding is consistent with recent results in Nonnemaker et al. (2009) and in Flegal (2007), who report a small effect of a decline in smoking prevalence on obesity rates in the U.S. Additionally, we find that individuals who are employed or ever worked are thicker than their counterparts. On the other hand, students and individuals practicing sports are thinner. This could reflect differences in physical activity levels. Self-reported health status that is less than very good is associated with higher BMI (except for poor health status, which has the same association with BMI as very good health). Subjects with more medical visits, higher expenditures on alcohol, and/or higher income (proxied by the total expenditures) have a higher BMI.

5. Concluding discussion

In this paper we studied the relationship between cigarette smoking and body weight status using data from a nationally representative sample of Belarusian adults. With rare exceptions (e.g., Fang et al., 2009), the majority of the previous studies on smoking and body weight have focused either on the cost of smoking (using cigarette prices and taxes) and its relation to body weight or on how body weight influences the initiation of smoking. We examined the association between smoking and body weight by using a continuous measure of smoking (number of cigarette smoked per day) and using various measures of body weight. In particular, we used the probability of being overweight or obese, in addition to BMI. We addressed the potential endogeneity of the smoking measure by the use of instrumental variable techniques. We estimated quantile regressions and ordered probit regressions in order to determine whether smoking had a different influence on BMI of subjects located at different points of the conditional BMI distribution.

Our endogeneity-corrected estimates suggest that one additional cigarette per day would decrease BMI by roughly 0.23 units, and would reduce the probability of being overweight by approximately 2.5%. Furthermore, there is a small but significant effect on the likelihood of being obese: an additional cigarette smoked per day decreases the probability of being obese by 1.3%. Our results suggest an important implication that smoking is inversely related to body weight, and has some effect on obesity rates. Our results seem to reinforce small but statistically significant effect of smoking on obesity in the recent studies conducted on the U.S. population by Nonnemaker et al. (2009) and Flegal (2007). Our results are also broadly consistent with the results from a similar study on China (Fang et al., 2009), however the magnitudes of the effects of smoking on various measures of body weight in our study are approximately twice the size of similar estimates found in that study. This difference in results may be explained by the fact that we included both males and females in our sample, while the study by Fang et al. (2009) only included males. To the best of our knowledge, our study is the first to look at the relationship between smoking and body weight in an Eastern European population. Because there are big socio-economic and demographic differences among the U.S., the Chinese populations, and the Eastern European populations, one can expect different relationship between smoking and body weight across such different populations (Henrich et al. 2010).

We believe that our instruments are valid, and the exclusion tests seemed to confirm that our two instrumental variables may be excluded from the body weight status equation. We note, however, that any instrumental variable strategy is a judgment call and we would like to regard our results as demonstrating an association between smoking and body weight. If more evidence from future studies confirms our findings, the resulting body of literature may lead readers to infer causality. Our single study just points in that direction. In addition, we rely on self-reported health status measures, which may introduce some bias in the estimates of the effect of smoking.

We note that the adverse health effects of smoking are numerous and the health benefits of smoking cessation are far in excess of the risk of body weight gain (Xu et al., 2007). The current high prevalence of smoking in Belarus and the high body weight present major public health concerns. Our results suggest that the prevalence of overweight and obesity might be exacerbated by the reduction in smoking rate. From a policy perspective, an increase in obesity rates among the general population may be a reasonable concern for policy instruments targeted at reducing the overall smoking rates. However, the potentially modest weight gain is likely to be more than offset by the general health improvements associated with a decline in smoking rates.

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Table 1: Summary statistics

Variable	N	Mean	SD	Min	Max
Body weight measures					
Body mass index (BMI)	133095	25.541	4.328	11.719	64.924
Underweight (BMI < 18.5)	133095	0.022	0.148	0	1
Healthy weight (18.5 ≤ BMI < 25)	133095	0.488	0.5	0	1
Overweight (25 ≤ BMI < 30)	133095	0.343	0.475	0	1
Obese (30 ≤ BMI)	133095	0.146	0.353	0	1
BMI for smokers	36091	24.642	3.431	13.559	55.18
BMI for non-smokers	97004	25.868	4.567	11.719	64.924
Body weight (pounds)	133095	158.783	28.888	8.818	396.828
Body height (ft)	133095	5.508	0.281	1.837	6.724
Cigarette consumption					
Number of cigarettes per day (including non-smokers)	133095	3.704	7.117	0	67
Current smoker	133095	0.267	0.442	0	1
Instrumental variables					
Regional yearly mean price of cigarettes per pack, 1995-2007	133095	0.594	0.141	0.229	0.917
Average number of cigarettes smoked in the same year-region-gender-education group	133095	3.648	3.804	0	11.435
Other explanatory variables					
Household size	133095	2.999	1.308	1	16
Age	133095	46.45	17.361	18	100
Male	133095	0.429	0.495	0	1
Rural	133095	0.319	0.466	0	1
Big city (population > 100,000)	133095	0.452	0.498	0	1
Single	133095	0.504	0.5	0	1
Good health	133095	0.562	0.496	0	1
Fair health	133095	0.197	0.398	0	1
Poor health	133095	0.018	0.135	0	1
Number of medical visits (last 3 months)	133095	1.092	2.163	0	90
Hospitalized (last 12 months)	133095	0.138	0.345	0	1
Health affects ability to work	133095	0.197	0.398	0	1
Sports practicing	133095	0.149	0.356	0	1
University diploma	133095	0.163	0.369	0	1
Secondary education	133095	0.58	0.494	0	1
Employed	133095	0.612	0.487	0	1
Ever worked	133095	0.799	0.401	0	1
Student	133095	0.038	0.19	0	1
Expenditures on alcohol (monthly)	133095	7.492	9.816	0	309.738

Expenditures on fruit/vegetables (monthly)	133095	13.389	13.499	0	170.083
Expenditures on eating out (monthly)	133095	5.878	14.165	0	643.222
Total expenditures per capita (monthly)	133095	163.319	149.253	0	5938.008
Year	133095	2001.99	3.717	1996	2008
Region (Oblast)					
Brest	133095	0.146	0.353	0	1
Vitebsk	133095	0.137	0.344	0	1
Gomel	133095	0.154	0.361	0	1
Grodno	133095	0.119	0.324	0	1
Minsk city	133095	0.17	0.376	0	1
Minsk	133095	0.153	0.36	0	1
Mogilev	133095	0.12	0.325	0	1

Table 1B. Shares of the four weight categories, 1996-2008.

Years 1996-1999

	N	Mean	SD
Underweight	41017	0.02	0.14
Normal weight	41017	0.522	0.5
Overweight	41017	0.336	0.472
Obese	41017	0.122	0.327

Years 2000-2003

	N	Mean	SD
Underweight	40079	0.023	0.15
Normal weight	40079	0.5	0.5
Overweight	40079	0.34	0.474
Obese	40079	0.137	0.344

Years 2004-2008

	N	Mean	SD
Underweight	51999	0.024	0.152
Normal weight	51999	0.451	0.498
Overweight	51999	0.352	0.478
Obese	51999	0.173	0.379

Note to Tables 1A and 1B: BHBS data, authors' estimates. Averages are based on pooled data from the corresponding yearly files: 1996-1999, 2000-2003, 2004-2008. The estimates are weighted using BHBS sampling weights.

Table 2. Multivariate estimation on BMI using OLS and 2SLS.

	BMI, OLS		BMI, 2SLS	
Number of cigarettes per day	-0.041***	(0.002)	-0.227***	(0.018)
Household size	0.100***	(0.008)	0.099***	(0.010)
Age	0.093***	(0.005)	0.087***	(0.001)
Male	-0.168	(0.100)	1.217***	(0.137)
Rural	-0.103	(0.062)	-0.050	(0.032)
Big city	-0.153**	(0.051)	-0.136***	(0.034)
Single	-0.071	(0.048)	0.035	(0.026)
Good health	0.328***	(0.060)	0.337***	(0.029)
Fair health	0.229**	(0.086)	0.252***	(0.051)
Poor health	0.123	(0.222)	0.235*	(0.121)
Number of medical visits	0.033**	(0.011)	0.026***	(0.007)
Hospitalized	0.126*	(0.062)	0.093**	(0.041)
Health affects ability to work	-0.200	(0.134)	-0.262***	(0.043)
Sports practicing	-0.419***	(0.034)	-0.718***	(0.044)
University diploma	-0.118	(0.115)	-0.309***	(0.041)
Secondary education	0.511***	(0.057)	0.587***	(0.029)
Employed	1.315***	(0.044)	1.454***	(0.033)
Ever worked	0.590***	(0.040)	0.750***	(0.050)
Student	-0.493***	(0.095)	-0.843***	(0.078)
Expenditures on alcohol	0.007***	(0.002)	0.011***	(0.001)
Expenditures on fruit/vegetables (monthly)	0.005*	(0.002)	0.001	(0.001)
Expenditures on eating out (monthly)	-0.009**	(0.003)	-0.009***	(0.001)
Total expenditures per capita	0.002**	(0.001)	0.002***	(0.000)
Observations	133095		133095	
R-squared	0.152		0.080	
Overid test (p-value)			0.228	
F-statistic (first stage)			466.879	
F-test p-value			0.000	

Notes: Significance: *p<0.1, **p<0.05, ***p<0.01. Robust standard errors clustered by region are in parentheses. BHBS data, authors' estimates. The estimates are weighted using BHBS sampling weights. Year dummies and region dummies (for six regions and the city of Minsk) are included in all models.

Table 3A. Multivariate estimation on BMI using quantile regression.

	10th percentile		25th percentile		50th percentile		75th percentile		90th percentile	
Number of cigarettes per day	-0.029***	(0.002)	-0.034***	(0.002)	-0.041***	(0.002)	-0.044***	(0.003)	-0.045***	(0.004)
Household size	0.027**	(0.012)	0.076***	(0.010)	0.124***	(0.011)	0.167***	(0.014)	0.166***	(0.021)
Age	0.074***	(0.001)	0.083***	(0.001)	0.096***	(0.001)	0.108***	(0.001)	0.111***	(0.002)
Male	1.000***	(0.031)	0.738***	(0.028)	0.174***	(0.029)	-0.677***	(0.039)	-1.562***	(0.060)
Rural	0.069**	(0.035)	-0.016	(0.031)	-0.061*	(0.033)	-0.183***	(0.045)	-0.133*	(0.068)
Big city	-0.168***	(0.037)	-0.183***	(0.033)	-0.170***	(0.035)	-0.193***	(0.047)	-0.079	(0.072)
Single	-0.099***	(0.027)	-0.061**	(0.024)	-0.029	(0.025)	-0.037	(0.034)	-0.070	(0.052)
Good health	0.063*	(0.034)	0.078**	(0.030)	0.192***	(0.032)	0.353***	(0.043)	0.480***	(0.065)
Fair health	-0.439***	(0.053)	-0.301***	(0.048)	0.008	(0.050)	0.391***	(0.069)	0.846***	(0.107)
Poor health	-1.133***	(0.121)	-0.698***	(0.110)	-0.189	(0.116)	0.518***	(0.159)	1.264***	(0.244)
Number of medical visits	0.003	(0.007)	0.015**	(0.006)	0.034***	(0.006)	0.043***	(0.008)	0.043***	(0.012)
Hospitalized	-0.047	(0.041)	0.021	(0.037)	0.117***	(0.039)	0.161***	(0.053)	0.249***	(0.080)
Health affects ability to work	-0.607***	(0.040)	-0.439***	(0.037)	-0.360***	(0.040)	-0.076	(0.055)	0.212**	(0.085)
Sports practicing	-0.090**	(0.039)	-0.114***	(0.035)	-0.289***	(0.037)	-0.540***	(0.050)	-0.786***	(0.076)
University diploma	0.054	(0.039)	-0.077**	(0.035)	-0.088**	(0.037)	-0.125**	(0.051)	-0.210***	(0.077)
Secondary education	0.399***	(0.029)	0.393***	(0.026)	0.454***	(0.028)	0.493***	(0.039)	0.486***	(0.060)
Employed	1.037***	(0.032)	1.059***	(0.029)	1.195***	(0.032)	1.411***	(0.044)	1.612***	(0.068)
Ever worked	0.390***	(0.050)	0.462***	(0.045)	0.478***	(0.047)	0.599***	(0.063)	0.749***	(0.095)
Student	-0.176**	(0.083)	-0.327***	(0.074)	-0.455***	(0.077)	-0.510***	(0.105)	-0.620***	(0.159)
Expenditures on alcohol	0.005***	(0.002)	0.005***	(0.001)	0.006***	(0.001)	0.007***	(0.002)	0.006**	(0.003)
Expenditures on fruit/vegetables	-0.000	(0.001)	0.001	(0.001)	0.003***	(0.001)	0.007***	(0.002)	0.006**	(0.003)
Expenditures on eating out	-0.004***	(0.001)	-0.007***	(0.001)	-0.009***	(0.001)	-0.010***	(0.001)	-0.010***	(0.002)
Total expenditures per capita	0.001***	(0.000)	0.002***	(0.000)	0.002***	(0.000)	0.003***	(0.000)	0.004***	(0.000)
Observations	133095		133095		133095		133095		133095	

Table 3B. Multivariate estimation on BMI using quantile regression with control function.

	10th percentile		25th percentile		50th percentile		75th percentile		90th percentile	
Number of cigarettes per day	-0.077***	(0.012)	-0.077***	(0.010)	-0.116***	(0.011)	-0.153***	(0.014)	-0.207***	(0.021)
First-stage residual	0.049***	(0.012)	0.044***	(0.010)	0.076***	(0.011)	0.111***	(0.014)	0.166***	(0.021)
Household size	0.029**	(0.012)	0.075***	(0.010)	0.124***	(0.011)	0.166***	(0.014)	0.168***	(0.021)
Age	0.074***	(0.001)	0.083***	(0.001)	0.096***	(0.001)	0.107***	(0.001)	0.111***	(0.002)
Male	1.262***	(0.070)	0.958***	(0.060)	0.579***	(0.063)	-0.091	(0.086)	-0.697***	(0.124)
Rural	0.068*	(0.036)	-0.022	(0.031)	-0.064*	(0.033)	-0.187***	(0.045)	-0.148**	(0.066)
Big city	-0.169***	(0.038)	-0.196***	(0.033)	-0.184***	(0.035)	-0.197***	(0.048)	-0.059	(0.070)
Single	-0.102***	(0.028)	-0.052**	(0.024)	-0.024	(0.026)	-0.018	(0.035)	-0.046	(0.050)
Good health	0.062*	(0.035)	0.075**	(0.030)	0.205***	(0.032)	0.355***	(0.043)	0.472***	(0.063)
Fair health	-0.431***	(0.055)	-0.308***	(0.048)	0.016	(0.051)	0.391***	(0.070)	0.843***	(0.103)
Poor health	-1.118***	(0.125)	-0.687***	(0.110)	-0.151	(0.117)	0.516***	(0.161)	1.312***	(0.237)
Number of medical visits	0.004	(0.007)	0.015**	(0.006)	0.034***	(0.006)	0.044***	(0.008)	0.042***	(0.012)

Hospitalized	-0.047	(0.042)	0.015	(0.037)	0.112***	(0.039)	0.161***	(0.053)	0.259***	(0.077)
Health affects ability to work	-0.610***	(0.041)	-0.429***	(0.037)	-0.372***	(0.040)	-0.089	(0.056)	0.202**	(0.083)
Sports practicing	-0.091**	(0.040)	-0.112***	(0.035)	-0.298***	(0.037)	-0.557***	(0.051)	-0.782***	(0.074)
University diploma	-0.004	(0.043)	-0.133***	(0.037)	-0.189***	(0.040)	-0.300***	(0.054)	-0.469***	(0.078)
Secondary education	0.437***	(0.032)	0.446***	(0.028)	0.521***	(0.030)	0.614***	(0.041)	0.651***	(0.061)
Employed	1.045***	(0.033)	1.063***	(0.029)	1.195***	(0.032)	1.420***	(0.045)	1.595***	(0.066)
Ever worked	0.392***	(0.052)	0.461***	(0.045)	0.489***	(0.048)	0.591***	(0.064)	0.764***	(0.092)
Student	-0.190**	(0.086)	-0.328***	(0.074)	-0.460***	(0.078)	-0.543***	(0.106)	-0.680***	(0.154)
Expenditures on alcohol	0.005***	(0.002)	0.005***	(0.001)	0.006***	(0.001)	0.007***	(0.002)	0.006**	(0.003)
Expenditures on fruit/vegetables	-0.001	(0.001)	0.001	(0.001)	0.003**	(0.001)	0.007***	(0.002)	0.006**	(0.002)
Expenditures on eating out	-0.004***	(0.001)	-0.008***	(0.001)	-0.009***	(0.001)	-0.010***	(0.001)	-0.010***	(0.002)
Total expenditures per capita	0.001***	(0.000)	0.002***	(0.000)	0.002***	(0.000)	0.003***	(0.000)	0.004***	(0.000)
Observations	133095		133095		133095		133095		133095	

Notes: Significance: *p<0.1, **p<0.05, ***p<0.01. Standard errors are in parentheses. BHBS data, authors' estimates. The estimates are weighted using BHBS sampling weights. Year dummies and region dummies (for six regions and the city of Minsk) are included in all models.

Table 4A. Multivariate estimation on BMI categories using ordered probit regression.

	Prob. of underweight		Prob. of normal weight		Prob. of overweight		Prob. of obese	
Number of cigarettes per day	0.0004***	(0.0000)	0.0043***	(0.0002)	-0.0023***	(0.0001)	-0.0024***	(0.0001)
Household size	-0.0009***	(0.0001)	-0.0104***	(0.0010)	0.0055***	(0.0005)	0.0058***	(0.0005)
Age	-0.0008***	(0.0001)	-0.0093***	(0.0005)	0.0050***	(0.0003)	0.0052***	(0.0003)
Male	0.0015*	(0.0009)	0.0165	(0.0100)	-0.0088*	(0.0054)	-0.0091*	(0.0055)
Rural	0.0012**	(0.0006)	0.0129**	(0.0059)	-0.0069**	(0.0032)	-0.0071**	(0.0033)
Big city	0.0014***	(0.0004)	0.0159***	(0.0047)	-0.0085***	(0.0025)	-0.0088***	(0.0026)
Single	0.0007*	(0.0004)	0.0083*	(0.0046)	-0.0044*	(0.0024)	-0.0046*	(0.0025)
Good health	-0.0030***	(0.0004)	-0.0329***	(0.0041)	0.0176***	(0.0022)	0.0182***	(0.0023)
Fair health	-0.0016**	(0.0006)	-0.0183***	(0.0071)	0.0096***	(0.0036)	0.0103**	(0.0041)
Poor health	-0.0010	(0.0019)	-0.0112	(0.0226)	0.0058	(0.0116)	0.0063	(0.0129)
Number of medical visits	-0.0003***	(0.0001)	-0.0029***	(0.0009)	0.0016***	(0.0005)	0.0016***	(0.0005)
Hospitalized	-0.0010***	(0.0004)	-0.0121**	(0.0051)	0.0064**	(0.0026)	0.0068**	(0.0029)
Health affects ability to work	0.0025*	(0.0013)	0.0265**	(0.0120)	-0.0145**	(0.0068)	-0.0144**	(0.0065)
Sports practicing	0.0038***	(0.0004)	0.0392***	(0.0035)	-0.0219***	(0.0021)	-0.0211***	(0.0017)
University diploma	0.0008	(0.0012)	0.0090	(0.0122)	-0.0048	(0.0066)	-0.0049	(0.0067)
Secondary education	-0.0042***	(0.0005)	-0.0458***	(0.0061)	0.0247***	(0.0035)	0.0253***	(0.0031)
Employed	-0.0134***	(0.0008)	-0.1325***	(0.0045)	0.0742***	(0.0032)	0.0717***	(0.0020)
Ever worked	-0.0059***	(0.0007)	-0.0585***	(0.0056)	0.0332***	(0.0036)	0.0312***	(0.0026)
Student	0.0071***	(0.0013)	0.0642***	(0.0103)	-0.0380***	(0.0066)	-0.0332***	(0.0049)
Expenditures on alcohol	-0.0001***	(0.0000)	-0.0006***	(0.0002)	0.0003***	(0.0001)	0.0003***	(0.0001)
Expenditures on fruit/vegetables	-0.0000**	(0.0000)	-0.0005**	(0.0002)	0.0003**	(0.0001)	0.0003**	(0.0001)
Expenditures on eating out	0.0001***	(0.0000)	0.0009***	(0.0003)	-0.0005***	(0.0001)	-0.0005***	(0.0001)
Total expenditures per capita	-0.0000***	(0.0000)	-0.0002***	(0.0001)	0.0001***	(0.0000)	0.0001***	(0.0000)
Observations	133095		133095		133095		133095	

Table 4B. Multivariate estimation on BMI categories using ordered probit regression with control function.

	Prob. of underweight		Prob. of normal weight		Prob. of overweight		Prob. of obese	
Number of cigarettes per day	0.0018***	(0.0004)	0.0199***	(0.0041)	-0.0106***	(0.0021)	-0.0110***	(0.0024)
First-stage residual	-0.0014***	(0.0004)	-0.0158***	(0.0042)	0.0084***	(0.0022)	0.0088***	(0.0024)
Household size	-0.0009***	(0.0001)	-0.0105***	(0.0009)	0.0056***	(0.0005)	0.0059***	(0.0005)
Age	-0.0008***	(0.0001)	-0.0089***	(0.0004)	0.0047***	(0.0002)	0.0049***	(0.0002)
Male	-0.0087***	(0.0030)	-0.1009***	(0.0329)	0.0522***	(0.0161)	0.0574***	(0.0198)
Rural	0.0008	(0.0006)	0.0084	(0.0060)	-0.0045	(0.0032)	-0.0047	(0.0033)
Big city	0.0013***	(0.0004)	0.0146***	(0.0047)	-0.0078***	(0.0025)	-0.0081***	(0.0026)
Single	-0.0001	(0.0006)	-0.0012	(0.0065)	0.0006	(0.0034)	0.0007	(0.0036)
Good health	-0.0030***	(0.0004)	-0.0335***	(0.0041)	0.0180***	(0.0021)	0.0186***	(0.0023)
Fair health	-0.0017***	(0.0006)	-0.0202***	(0.0071)	0.0105***	(0.0037)	0.0114***	(0.0041)
Poor health	-0.0017	(0.0018)	-0.0204	(0.0233)	0.0105	(0.0115)	0.0116	(0.0137)
Number of medical visits	-0.0002**	(0.0001)	-0.0023**	(0.0009)	0.0012**	(0.0005)	0.0013**	(0.0005)
Hospitalized	-0.0008**	(0.0004)	-0.0092*	(0.0050)	0.0048*	(0.0026)	0.0051*	(0.0028)
Health affects ability to work	0.0030**	(0.0014)	0.0319**	(0.0129)	-0.0176**	(0.0074)	-0.0173**	(0.0069)

Sports practicing	0.0066***	(0.0008)	0.0637***	(0.0052)	-0.0368***	(0.0030)	-0.0335***	(0.0030)
University diploma	0.0024	(0.0016)	0.0253*	(0.0150)	-0.0139*	(0.0085)	-0.0138*	(0.0082)
Secondary education	-0.0048***	(0.0004)	-0.0522***	(0.0057)	0.0282***	(0.0032)	0.0288***	(0.0029)
Employed	-0.0147***	(0.0009)	-0.1436***	(0.0045)	0.0807***	(0.0030)	0.0776***	(0.0026)
Ever worked	-0.0073***	(0.0008)	-0.0705***	(0.0046)	0.0405***	(0.0031)	0.0373***	(0.0024)
Student	0.0111***	(0.0018)	0.0914***	(0.0107)	-0.0566***	(0.0073)	-0.0459***	(0.0052)
Expenditures on alcohol	-0.0001***	(0.0000)	-0.0009***	(0.0002)	0.0005***	(0.0001)	0.0005***	(0.0001)
Expenditures on fruit/vegetables	-0.0000	(0.0000)	-0.0002	(0.0003)	0.0001	(0.0002)	0.0001	(0.0002)
Expenditures on eating out	0.0001***	(0.0000)	0.0009***	(0.0003)	-0.0005***	(0.0001)	-0.0005***	(0.0002)
Total expenditures per capita	-0.0000***	(0.0000)	-0.0002***	(0.0001)	0.0001***	(0.0000)	0.0001***	(0.0000)
Observations	133095		133095		133095		133095	

Notes: Significance: *p<0.1, **p<0.05, ***p<0.01. Standard errors are in parentheses. BHBS data, authors' estimates. The estimates are weighted using BHBS sampling weights. Year dummies and region dummies (for six regions and the city of Minsk) are included in all models.

Table 5. Multivariate estimation on overweight using probit, OLS, control function probit, and 2SLS regressions.

	Overweight, Probit		Overweight, OLS		Overweight, CF Probit		Overweight, 2SLS	
Number of cigarettes per day	-0.006***	(0.000)	-0.005***	(0.000)	-0.026***	(0.005)	-0.025***	(0.002)
First-stage residual					0.021***	(0.005)		
Household size	0.011***	(0.001)	0.011***	(0.001)	0.012***	(0.001)	0.011***	(0.001)
Age	0.011***	(0.001)	0.010***	(0.000)	0.010***	(0.001)	0.010***	(0.000)
Male	0.006	(0.011)	0.006	(0.010)	0.161***	(0.034)	0.151***	(0.017)
Rural	-0.010	(0.006)	-0.009	(0.006)	-0.004	(0.007)	-0.004	(0.004)
Big city	-0.017**	(0.008)	-0.016*	(0.007)	-0.016**	(0.008)	-0.014***	(0.004)
Single	-0.014***	(0.005)	-0.013**	(0.005)	-0.002	(0.007)	-0.001	(0.003)
Good health	0.036***	(0.006)	0.033***	(0.005)	0.037***	(0.006)	0.034***	(0.004)
Fair health	0.011	(0.007)	0.008	(0.007)	0.013*	(0.007)	0.010*	(0.006)
Poor health	-0.005	(0.023)	-0.009	(0.022)	0.007	(0.023)	0.003	(0.014)
Number of medical visits	0.004***	(0.001)	0.004**	(0.001)	0.003***	(0.001)	0.003***	(0.001)
Hospitalized	0.011	(0.007)	0.010	(0.006)	0.007	(0.007)	0.006	(0.004)
Health affects ability to work	-0.041***	(0.013)	-0.040**	(0.012)	-0.048***	(0.014)	-0.046***	(0.005)
Sports practicing	-0.049***	(0.006)	-0.040***	(0.005)	-0.083***	(0.006)	-0.072***	(0.005)
University diploma	-0.007	(0.014)	-0.008	(0.013)	-0.029*	(0.017)	-0.028***	(0.005)
Secondary education	0.055***	(0.007)	0.050***	(0.007)	0.063***	(0.007)	0.058***	(0.003)
Employed	0.155***	(0.006)	0.133***	(0.006)	0.170***	(0.005)	0.148***	(0.004)
Ever worked	0.075***	(0.007)	0.043***	(0.006)	0.092***	(0.005)	0.059***	(0.005)
Student	-0.105***	(0.008)	-0.034***	(0.008)	-0.142***	(0.014)	-0.071***	(0.008)
Expenditures on alcohol	0.001***	(0.000)	0.001**	(0.000)	0.001***	(0.000)	0.001***	(0.000)
Expenditures on fruit/vegetables	0.000*	(0.000)	0.000	(0.000)	0.000	(0.000)	-0.000	(0.000)
Expenditures on eating out	-0.001***	(0.000)	-0.001**	(0.000)	-0.001***	(0.000)	-0.001***	(0.000)
Total expenditures per capita	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)
Observations	133095		133095		133095		133095	
R-squared			0.123				0.065	
Pseudo R-sq.	0.096				0.096			
Overid test (p-value)							0.177	
F-statistic (first stage)							466.879	
F-test p-value							0.000	

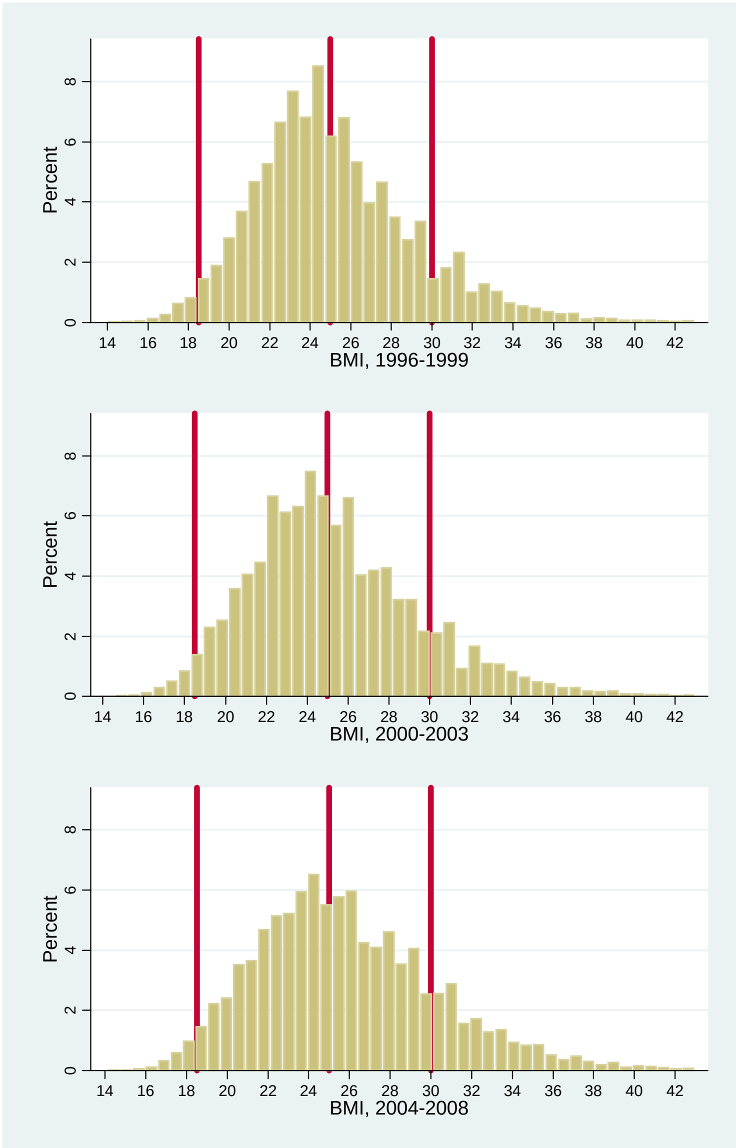
Notes: Significance: *p<0.1, **p<0.05, ***p<0.01. Robust standard errors clustered by region are in parentheses. BHBS data, authors' estimates. The estimates are weighted using BHBS sampling weights. Year dummies and region dummies (for six regions and the city of Minsk) are included in all models.

Table 6. Multivariate estimation on obese using probit, OLS, control function probit, and 2SLS regressions.

	Obese, Probit		Obese, OLS		Obese, CF Probit		Obese, 2SLS	
Number of cigarettes per day	-0.003***	(0.000)	-0.002***	(0.000)	-0.013***	(0.002)	-0.013***	(0.002)
First-stage residual					0.010***	(0.002)		
Household size	0.004***	(0.001)	0.005***	(0.001)	0.004***	(0.001)	0.005***	(0.001)
Age	0.004***	(0.000)	0.004***	(0.000)	0.003***	(0.000)	0.003***	(0.000)
Male	-0.067***	(0.004)	-0.068***	(0.005)	0.008	(0.017)	0.011	(0.012)
Rural	-0.015***	(0.004)	-0.017***	(0.004)	-0.012***	(0.004)	-0.014***	(0.003)
Big city	-0.003	(0.002)	-0.003	(0.002)	-0.002	(0.002)	-0.002	(0.003)
Single	-0.006**	(0.003)	-0.004	(0.003)	0.000	(0.004)	0.002	(0.002)
Good health	0.032***	(0.004)	0.027***	(0.004)	0.032***	(0.004)	0.028***	(0.002)
Fair health	0.045***	(0.010)	0.037***	(0.010)	0.046***	(0.010)	0.038***	(0.004)
Poor health	0.070***	(0.023)	0.048**	(0.017)	0.078***	(0.023)	0.054***	(0.010)
Number of medical visits	0.002***	(0.001)	0.002**	(0.001)	0.002**	(0.001)	0.002***	(0.001)
Hospitalized	0.013***	(0.004)	0.013**	(0.005)	0.011***	(0.004)	0.011***	(0.003)
Health affects ability to work	0.002	(0.007)	0.004	(0.009)	-0.002	(0.007)	0.000	(0.004)
Sports practicing	-0.035***	(0.003)	-0.027***	(0.003)	-0.049***	(0.006)	-0.044***	(0.004)
University diploma	-0.007	(0.005)	-0.012*	(0.006)	-0.016***	(0.006)	-0.023***	(0.003)
Secondary education	0.026***	(0.004)	0.028***	(0.004)	0.029***	(0.004)	0.032***	(0.003)
Employed	0.061***	(0.003)	0.047***	(0.003)	0.068***	(0.004)	0.055***	(0.003)
Ever worked	0.022***	(0.005)	0.011**	(0.004)	0.030***	(0.005)	0.020***	(0.004)
Student	-0.044***	(0.007)	0.005	(0.008)	-0.057***	(0.004)	-0.015***	(0.005)
Expenditures on alcohol	0.000***	(0.000)	0.000**	(0.000)	0.001***	(0.000)	0.001***	(0.000)
Expenditures on fruit/vegetables	0.001***	(0.000)	0.000***	(0.000)	0.000***	(0.000)	0.000**	(0.000)
Expenditures on eating out	-0.000***	(0.000)	-0.001**	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
Total expenditures per capita	0.000***	(0.000)	0.000**	(0.000)	0.000***	(0.000)	0.000***	(0.000)
Observations	133095		133095		133095		133095	
R-squared			0.061				0.023	
Pseudo R-sq.	0.081				0.082			
Overid test (p-value)							0.613	
F-statistic (first stage)							466.879	
F-test p-value							0.000	

Notes: Significance: *p<0.1, **p<0.05, ***p<0.01. Robust standard errors clustered by region are in parentheses. BHBS data, authors' estimates. The estimates are weighted using BHBS sampling weights. Year dummies and region dummies (for six regions and the city of Minsk) are included in all models.

Figure 1. The evolution of BMI distribution in Belarus, 1996-2008.



Notes: BHBS data, authors' estimates. Averages are based on pooled data from the corresponding yearly files: 1996-1999, 2000-2003, 2004-2008. The red lines indicate BMI cut-offs between the weight categories: underweight (BMI below 18.5), normal weight (BMI between 18.5 and 25), overweight (BMI between 25 and 30), and obese (BMI above 30).