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THE EFFECT OF INCOME ON OBESITY AMONG CANADIAN ADULTS

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The Effect of Income on Obesity among Canadian Adults

Abstract

Although a large body of research demonstrates an association between income and obesity, the causal nature of this relationship remains largely unclear. Using five biennial confidential master files (2000/01-2009/10) of the Canadian Community Health Survey, we examine the causal effect of income on adult body mass index (BMI) and obesity in Canada using an instrumental variables (IV) approach. The neighbourhood level unemployment rate and household income are the instruments used to identify the causal effect. Our results show that the income elasticity of BMI is -0.113 for women and -0.027 for men. These findings suggest that for a person of average height, a 1% increase in income leads to a weight reduction of 0.300 kg and 0.084kg for women and men, respectively. We find that a 1% increase in household income leads to a 0.76% and 0.27% decrease in the probability of being obese for women and men, respectively. Our quantile IV results reveal that the negative effect of income on BMI increases consistently over the BMI distribution in women, while for men it is statistically significant only at the higher end of the BMI distribution. Contrary to theoretical expectations, we do not find any evidence of a larger negative effect of income on BMI and obesity for more educated people. Our findings suggest that household income is potentially an important modifiable risk factor for obesity, especially among women.

JEL Classification: I1; I2; I10; C2

Key words: body mass index, obesity, income, Instrumental Variable (IV), Quantile IV, Canada

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1 Introduction

Over the last three decades, the prevalence of obesity has steadily increased in most developed countries. In Canada, the adult obesity rate increased from 10% in 1970/72 to 26% in 2009/11; from 8% to 27% in men and 12% to 25% in women (Janssen, 2013). Recent data on measured weights and heights from 2009-2011 show that more than 60% of Canadian adults are overweight or obese (Statistics Canada, 2012). From a public health and economic perspective, obesity is a major concern because it is associated with increased healthcare utilization (Tsai et al., 2011; Withrow and Alter, 2011), decreased productivity (Frone, 2008; Ricci and Chee, 2005), incidence of several chronic diseases (Guh et al., 2009) and premature death (Katzmarzyk et al., 2003; Popkin et al., 2006). In Canada, the economic costs of obesity in 2008 are estimated to be somewhere between \$4.6 to \$7.1 billion per annum (PHAC and CIHI, 2011). Thus, understanding the factors which affect obesity is of paramount importance. One factor which has received a lot of attention in the literature, but whose impact on obesity requires careful thought, is income.

The theoretical connection between income and obesity can be understood in the context of Grossman's model (Grossman, 1972), in which individuals derive utility from health; specifically, individuals use time and market goods such as medical care, diet, and physical activity to produce health capital. Individuals are assumed to maximize their lifetime utility subject to time and budget constraints. According to this model, an increase in income would promote investments in healthy lifestyles like better eating habits and regular exercise, and would thus lead to a negative relationship between income and obesity. However, this facile conclusion may be confounded, at least theoretically, in three ways: first, higher-income individuals have a higher opportunity cost of time which may discourage time spent on exercise. Second, the way in which the individual discounts time (his or her rate of time preference) will influence the value that is placed on future health. Several papers have documented a positive association between intertemporal preferences and weight outcomes (Borghans and Golsteyn, 2006; Dodd, 2014; Ikeda et al., 2010; Komlos et al., 2004; Smith et al., 2005): people with lower rates of time preference will be less likely to be obese because they are placing more value on future health, and vice versa. Finally, a large empirical literature shows that obese women are more likely to suffer from discrimination in the labour market (Averett and Korenman, 1996; Baum and Ford, 2004; Cawley, 2004; Kline and Tobias, 2008; Mocan and Tekin, 2011) and marriage markets than obese men (Averett and Korenman, 1996; Conley and Glauber, 2007; Fu and Goldman, 1996; Mukhopadhyay, 2008), meaning that the future benefits of having a healthy BMI are likely to be greater for women than men. Consequently, we would expect the effect of income on obesity to differ by gender. These theoretical predictions have been tested in a few studies, with mixed results. For example, Lindahl (2005) finds a negative relationship between income and the probability of being overweight in Sweden, while Schmeiser (2009) finds a positive association only for women in the US. Finally, Cawley et al. (2010) find no evidence of a causal relationship for both men and women in the US.

The Grossman's model also predicts that education will increase the efficiency of health production and that the demand for health increases with education. This positive relationship between education and the demand for health may be due to time preferences (Fuchs, 1982). That is, more educated individuals demand a larger amount of health stock because of a greater value of their future health benefits. Thus, we would expect the income effect on obesity to be much larger among more educated people. Although we are not aware of any study that directly examines how the causal impact of income on obesity varies by educational status, a few studies have tried to investigate the causal relationship between education and obesity with, again, mixed results. For instance, Spasojevic (2003) and Grabner (2009) document a strong negative relationship between education and BMI, while some other studies find no such evidence (Arendt, 2005; Clark and Royer, 2010; Kenkel et al., 2006).

Finally, the Grossman's framework can also be used to examine how the effect of income varies by labour force status. In his model, employed people are expected to invest in health because the opportunity costs associated with sick days are high. Given that people who are not working do not face these opportunity costs, they may be less likely to invest in health. However, the higher opportunity costs facing workers may serve to diminish investments in health because they have less time to allocate towards healthy behaviours that are time-intensive (e.g., healthy eating by preparing own meals and regular physical activity). As a consequence, the effect of employment status on obesity is ambiguous. We are not aware of any study that examines how the causal impact of income on obesity varies by employment status. Numerous studies in the literature find an inverse association between income and BMI or obesity among women (Chang and Lauderdale, 2005; Flegal et al., 1988a; Garca Villar and Quintana-Domeque, 2009; Lauderdale and Rathouz, 2000; Le Petit and Berthelot, 2006; Martn et al., 2008; PHAC & CIHI, 2011; Tjepkema, 2006; Wardle et al., 2002; Zhang and Wang, 2004). However, the evidence is not nearly as clear cut for men. Specifically, some studies find negative associations (Le Petit and Berthelot, 2006; Wardle et al., 2002; Zhang and Wang, 2004), some find positive associations (Chang and Lauderdale, 2005; Flegal et al., 1988b; Tjepkema, 2006; H Ward et al., 2007; Xiao et al., 2013; Yoon et al., 2006), and still others find no statistically significant association (Garca Villar and Quintana-Domeque, 2009; Martn et al., 2008; PHAC and CIHI, 2011). One reason why the link between income and obesity is so mixed is due to the failure to account for biased and inconsistent parameter estimates. Two sources of bias arise in this context. First, unobserved individual-effects, like genetic endowment, the opportunity cost of time, and time preferences, may be correlated with both income and BMI, leading to endogeneity bias. And, second, reverse causality is inevitable if obesity hampers labour market outcomes (such as earnings or wages), which has been found to be the case for women. An instrumental variables (IV) approach can address endogeneity bias, and lead to consistent estimates of the impact of income on obesity, if an appropriate instrument (or instruments) can be found that is both highly correlated with income but uncorrelated with the error term in the outcome (BMI or obesity) equation.

A few non-Canadian studies have attempted to estimate the causal effect of income on adult obesity using an IV approach but with mixed results. It is difficult to generalize from these studies as they employed small samples or targeted very specific populations of interest. Using data from three waves of the Swedish Level of Living Surveys, Lindahl (2005) exploits an exogenous variation in household income due to lottery winnings to analyze the effect of income on weight status among 626 Swedes who won lottery prizes between 1968 and 1981. He finds evidence that income significantly decreases the likelihood of a person being overweight. Specifically, he finds that a 1% increase in income is associated with a 0.39% point decrease in the probability of being overweight. Although natural experiments such as lotteries have a great advantage in terms of exogeneity, the estimates may be of limited generalizability. Schmeiser (2009) examines the causal effect of income on the weight of low-income Americans using data from the National Longitudinal Survey of Youth 1979 cohort. Using the maximum combined federal and state Earned Income Tax Credit (EITC) benefit for which a family is eligible as an instrument for income, he finds that a $1,000 annual increase in family income is associated with an average weight increase of between 0.84 and 1.84 pounds for women. However, he finds no significant effect for men with EITC-eligible earnings. Finally, using data from the National Health Interview Surveys, Cawley et al. (2010) analyzed the causal relationship between income and weight for elderly Americans. They exploited the exogenous variation in Social Security income resulting from a natural experiment known as the Social Benefit notch that led the retirees in the notch to receive higher social security incomes than those not in the notch. They do not find any significant causal relationship between income and weight for both men and women.

In short, the question as to the impact of income on obesity remains open. In this paper, we investigate the causal effects of income on BMI and obesity for men and women using five biennial confidential master files (2000/2001-2009/2010) of the Canadian Community Health Survey (CCHS) data, with neighbourhood level unemployment rates and household income as instruments. The neighbourhood unemployment rate is likely to directly affect the labour market outcomes of residents of that neighbourhood and thus will affect household income, but it is not expected to have a direct impact on the individual's BMI. Similarly, because people with the same socioeconomic status generally tend to live in the same area, neighbourhood income should be highly correlated with individual income but not directly related to BMI or obesity at the individual level. The validity of these instruments is discussed further through identification tests. Unlike previous studies, our analysis is based on five nationally representative data sets spanning over a decade. To the best of our knowledge, our paper is the first to examine the causal relationship between income and obesity in the Canadian context.

We find that household income decreases the BMI and the probability of being obese for both men and women, but with effects that are much larger for women. These findings are consistent with the predictions from the Grossman's model of investments in health capital. However, our results do not show any evidence that the income effect is greater among more educated people.

The remainder of this paper is organized as follows. In section 2, we present the data and descriptive statistics. Section 3 presents the empirical specifications and the identification strategy.

In section 4, the results of the estimations are reported and discussed. Finally, section 5 concludes.

2 Data and Descriptive Statistics

For this study we use data from five confidential master files (2000/01-2009/10) of the CCHS conducted by Statistics Canada. Each CCHS cycle is a large nationally representative survey that collects information on health and health determinants of more than 130,000 individuals aged 12 and older living in private dwellings in all provinces and territories in Canada. People living on Crown lands, Indian reserves, Canadian Forces bases, institutions and some remote regions are not included in the survey. We restrict our sample to adults aged 18-65 years, excluding pregnant women and individuals with missing or extreme BMI values. We also exclude individuals with missing information on socio-demographic variables other than household income (our exposure variable of interest), resulting in 410,849 observations. In this paper, we rely on a continuous measure of household income reported by the CCHS respondents. Indeed, in each CCHS cycle, the household income variable is reported using both a continuous and categorical measure. We drop 94,579 individuals with missing values on the continuous household income, leaving us with a sample of 155,459 men and 160,811 women, and we convert household income in each cycle to 2010 Canadian dollars. BMI (defined as weight in kilograms divided by height in meters squared) is computed using self-reported weight and height. Because individuals in the survey generally under-report their weights and over-report their heights, we address this measurement error using the self-reported BMI bias correction factors proposed by Gorber et al. (2008). Obesity is defined as a BMI (kg/m2) of 30 or higher. We used sampling weights for each survey provided by Statistics Canada in all our descriptive and regression analyses.

Table 1 presents the prevalence of obesity and BMI distributions by gender over the study period. We see that between 2000/01 and 2009/10, the average BMI increased from 27.33 to 27.83 and the obesity rate increased from 23.64% to 26.43% for men. It is important to note that the total sample sizes reported in Table 1 (133,638 for men and 139,054) are smaller than the sample sizes after our exclusion restrictions (i.e., 155,459 for men and 160,811 for women) because of missing observations on the instrumental variables. Over the study period, women's average BMI and obesity rate increased from 26.14 to 26.56 and 20.80% to 22.43%, respectively[1].

Table 2 presents the distributions of BMI and obesity over income categories by gender. The data show that the average BMI and the percentage of obese individuals increased with income for men and decreased for women. For instance, for men the prevalence of obesity shot up from 19.48% for those with an average household income of less than $10,000, to 26.09% for those with $80,000 or more; while for women with similar income groups, we find a substantial decrease in the obesity rate from 26.71% to 17.38%. As expected, the data show that the mean BMI and the overall prevalence of obesity are relatively higher among men than women. For men, the mean BMI and the overall prevalence of obesity are 27.57 and 24.83%, respectively. The corresponding values for women are 26.29 and 21.29%.

Tables 3 and 4 present the definitions and the descriptive statistics by sex for all of the variables used in our analysis. It is interesting to note that the two groups are very similar when it comes to average age, immigrant status, education, and average household size. However, they are quite different when it comes to hours worked, and the various life-style indicators. Clearly, these latter variables have the potential to play an important role in determining an individual's avoirdupois.

[1]Note that all of these differences are statistically significant at the 1% level.

3 Econometric Methods

To investigate the relationship between household income and adult obesity, we estimate the following equation:

$$Y_i = \alpha_0 + \alpha_1 I_i + \alpha_2 X_i + \epsilon_i \tag{1}$$

where Y_i is either the BMI of individual i or a dummy variable equal to 1 if the individual is obese, and 0 otherwise; I_i represents the natural logarithm of individual i's household income, X_i is a vector of demographic, socio-economic and life-style factors, and ϵ_i is the standard error term[2]. The vector X_i includes age, age squared, marital status, immigration status, educational status, household size, presence of children, number of hours worked, home ownership, physical activity status, alcohol consumption, smoking behavior. We control for the geographical location and province of residence of the respondent. We also control for the time effect in our models by including four year dummies.

When our outcome variable represents BMI, we first estimate equation (1) using an OLS technique. We also examine how the relationship between income and BMI varies over the BMI distribution by estimating a quantile regression for the 25th, 50th, and 75th percentiles. For the obesity equation, the estimates are obtained using both a linear probability model (LPM) and a probit model. In the probit model, we compute the average partial effect of household income. For interpretation and comparison purposes, we calculate the income elasticity of our outcome variable at the weighed sample mean using the estimated coefficient on the log of income. However, because of the potential endogeneity of income in the BMI or obesity equation our OLS and probit estimates are expected to be biased and inconsistent. In order to obtain consistent estimates of the effect of

[2]We used the natural logarithm of income instead of income to account for the skewedness in the income distribution and also for the potential non-linear relationship between household income and BMI.

household income on obesity, we employ an IV approach. That is, we estimate the following first and second stage equations:

$$I_i = \beta_0 + \beta_1 Z_i + \beta_2 X_i + \mu_i \tag{2}$$

$$Y_i = \alpha_0 + \alpha_1 \hat{I}_i + \alpha_2 X_i + \epsilon_i \tag{3}$$

where Z_i is a vector of exogenous instruments and $\hat{I}_i$ represents the fitted value of I_i from the first-stage regression.

In this paper, we use the unemployment rate and household income at the census dissemination area (DA) level (which represents the smallest geographic entity in Canada) as valid instruments. Note that these types of instruments have been used in many studies in the literature. For instance, Ettner (1996) uses the state unemployment rate as an instrument for family income in the health equation, while Xu and Kaestner (2010) use the unemployment rate at the state or metropolitan statistical area (MSA) level as the instruments when examining the effects of wages and working hours on health behaviours. In addition, a number of studies have employed area-level characteristics to instrument the corresponding characteristics at the individual level (see, for example, Lo Sasso & Buchmueller 2004; Morris 2006; Morris 2007; Fang et al. 2009). Our identifying assumptions are that the local unemployment rate and income are highly correlated with an individual's household income but are excluded from the second stage equation. We test the first assumption using several statistics from the first stage regression. Although the exclusion restriction cannot be tested directly, we test the orthogonality conditions using Hansen J test of over-identification. Conditional on the validity of the instruments used, we perform the endogeneity test. We estimate the BMI equation using 2SLS and quantile IV methods while the obesity equation is estimated using both the linear and IV-probit models. We calculate the income elasticity of BMI and obesity at the weighed sample mean using the estimated coefficient on the log of income to interpret our findings.

In order to test some of the predictions on income and obesity, we use our empirical framework to examine the relationship between income and BMI and obesity across four educational sub-groups (less than a secondary degree, a secondary degree, some post-secondary, and a post-secondary degree) and two employment sub-groups (working vs. not working).

4 Results and Discussion

Table 5 presents the OLS and 2SLS estimates from the full sample for men (first two columns) and women (last two columns). The quantile results (for our variable of interest) from the full sample are reported in Table 6 and the results for the obesity regressions are presented in Table 7. Finally, Table 8 reports the elasticities of BMI and obesity with respect to household income. The elasticity is computed by dividing the coefficient on log income by the sample mean of the dependent variable. We begin with the effect of income on BMI and obesity, followed by a discussion of the other determinants of weight outcomes.

4.1 The effect of household income

4.1.1 Full sample

From table 5 we see that in the OLS models, the association between income and BMI is positive for men and negative for women. The corresponding elasticities (reported in Table 8) show that a 1% increase in household income is associated with a 0.004 unit increase in BMI for men and a 0.013 unit decrease for women. But as noted earlier, because of the potential endogeneity of income, these estimates are unreliable.

The identification test results reported at the bottom of Table 5 show that our instruments are valid. The first-stage F statistic and Cragg-Donald Wald F statistic indicate that our two instruments are sufficiently correlated with income for both men and women. Also, the coefficients from the first stage regressions indicate that the neighbourhood-level unemployment rate and household income are significantly associated with the respondent's income - and, as expected, the association is negative for the unemployment rate and positive for average household income [3]. The test results also show that the null hypothesis of Hansen's J tests of over-identification cannot be rejected, meaning that the orthogonality conditions are fulfilled. Finally, the results from the endogeneity tests indicate that income is endogenous for both men and women, suggesting that the IV estimates are consistent.

The 2SLS estimates differ substantially from those of the OLS. The results show that household income decreases the BMI for both men and women, but the effect is much larger for women. The corresponding elasticities indicate that a 1% increase in household income leads to a 0.027 point decrease in the BMI of males, and a 0.113 points decrease for females. For a person of average height in our sample, it corresponds to a reduction of 0.084 kg and 0.300 kg in weight for men and women, respectively [4]. Our quantile regression estimates show that the effect of income on weight varies across the BMI distribution. For women, income exerts an increasingly large negative effect on BMI: ranging from -1.310 at the 0.25 quantile to -3.192 at the 0.75 quantile. By contrast, for men, the effect is positive and statistically insignificant at the 0.25 quantile but becomes negative and statistically significant from the 0.50 quantile - the effects of a 1% increase in household income ranging from -0.411 to -0.846. In other words, income always has a negative impact on weight of women but its effect is much larger at the higher end of the BMI distribution, while for men, the effect is only found at the higher BMI distribution.

[3] The first-stage regression results are available from the corresponding author upon request.

[4] In our sample, the average height is 176 cm for men and 163 cm for women. These heights are adjusted using the self-reported height bias correction factors proposed by Gorber et al. (2008).

We now turn to the effect of income on obesity. In Table 7 we report only the results from the LPM and the linear IV models because these results are very similar to the probit and the IV probit average marginal effects, respectively. The LPM finds that income is not significantly associated with obesity for men, but that it is negative and statistically significant for women. Specifically, we find that the income elasticity of obesity (reported in Table 8) for women is -0.103: at the weighted sample mean, a 1% increase in household income is associated with a 0.10% point decrease in the probability of being obese. However, as in the case of BMI, income is potentially endogenous in the obesity equations and as a consequence the LPM estimates tend to be biased.

The test results reported at the bottom of Table 7 show that the null hypothesis of Hansen's J tests of over-identification cannot be rejected, suggesting that our two instruments are also valid for the obesity equation. Again, like in the BMI equations, the results from the endogeneity tests indicate that income is endogenous for both men and women. Employing a linear IV procedure results in a much larger effect of income on the probability of being obese for both men and women in comparison to those found by the LPM, and once again, the impact on women is greater than that of men. Specifically, a 1% increase in household income leads to a 0.27% and a 0.76% point decrease in the probability of being obese for men and women, respectively.

To sum up, our results indicate that income leads to a lower BMI and a lower probability of being obese for both men and women, but the effects are much larger for women. These findings suggest that as income increases, people invest more in health capital, with women investing more than men consistent with the theoretical predictions from the Grossman's model. Our findings are similar to Lindahl (2005) who documents a negative causal relationship between income and the probability of being overweight but are in contrast to Schmeiser (2009) and Cawley et al. (2010). Our findings are also consistent with the results from some previous studies (Le Petit and Berthelot, 2006; Wardle et al., 2002; Zhang and Wang, 2004) that find negative associations between income and BMI or obesity for both men and women. However, our results are at odds with studies that document a positive association between income and obesity (Chang & Lauderdale 2005; Tjepkema 2006; Yoon et al. 2006; Heather Ward et al. 2007; Xiao et al. 2013) or no significant association (Garca Villar and Quintana-Domeque, 2009; Martn et al., 2008; PHAC & CIHI, 2011) for men.

4.1.2 Income effect by educational and employment status

As noted earlier, we examine how the income effect varies across educational and employment status. As with the full-sample results, the econometric tests reveal that our two instruments are also valid for the sub-sample analyses. The results indicate that income is endogenous with two exceptions: men with less than a secondary degree in the BMI equation, and men with some-post secondary degree in the obesity equation. For each model we report the estimated coefficient on log of income, the sample mean of the dependent variable, and the corresponding income elasticity. Table 9 summarizes the results by educational status for men while the corresponding results for women are reported in Table 10. Table 11 presents the results by employment status for men and women, respectively. The econometric test results are also reported at the bottom of each table.

The results show that for men, the effects are significant only for individuals with more than a secondary degree. Specifically, we find that a 1% increase in household income leads to a 0.043 and a 0.023 unit decrease in BMI for those with some post-secondary education and a post-secondary degree, respectively. The results also show that a 1% increase in household income leads to a 0.31% and a 0.24% point decrease in the probability of being obese for those with a secondary diploma, and a post-secondary degree, respectively (and is not significant for those with less than a secondary degree and some post-secondary education). For women, we find that the negative effects of income on BMI and obesity are higher among individuals with less than a secondary degree and those with a post-secondary degree: a 1% increase in household income is associated with a 0.133, 0.073, 0.087 and a 0.118 unit decrease in BMI for those with less than a secondary diploma, a secondary diploma, some post-secondary and a post-secondary degree, respectively. The probability of being obese also falls with a 1% increase in household income by 0.65%, 0.55%, 0.61% and 0.70% points as educational level increases. In sum, our findings are not consistent with the theoretical predictions that the estimated effects will be larger among more educated people.

Turning now to employment status, we find that for men, the negative effect of income on BMI is statistically significant only for the employed group, while the negative effect of income on the probability of being obese is higher among non-workers. Specifically, a 1% increase in household income leads to a 0.024 unit decrease in BMI for employed people, whereas it decreases the probability of being obese for male non-workers and workers by 0.30 and 0.25, respectively. For women, the negative effects of income are much larger than for men: a 1% increase in household income leads to a 0.111 and 0.114 unit decrease in BMI, and a 0.65% and 0.79% point decrease in the probability of being obese, for the non-employed and employed, respectively. In short, our results for women are clearly consistent with the theoretical prediction that employed individuals are more likely to invest in health compared to those who are not working.

4.2 Other determinants of BMI and obesity

From Tables 5 and 7, we see that BMI and obesity increase with age but at a decreasing rate for both men and women, consistent with previous studies (Brown and Siahpush, 2007; Tjepkema, 2006). Married people are more likely to have a higher BMI and a higher probability of being obese when compared to singles - an effect that is much larger for women in the BMI equation where marriage increases BMI by 0.721 units for men and 0.817 units for women, and the probability of being obese by 5.2% points for men and 3.6% points for women. We also find that being widowed, separated or divorced (WSD) is associated with a fall in male BMI by 0.196 units on average, while it has a negative association of 0.648 units for women. However, it is only for women that WSD decreases the probability of being obese (by 4.3% points).

Immigrants, either recent (less than 10 years) or long-term, are less likely to have a higher BMI and a higher probability of being obese compared to their Canadian born counterparts. For instance, a recent immigrant has a BMI that is 2.366 units (male) and 3.561 units (female) less than an otherwise comparable Canadian born. For a long-term immigrant, the corresponding figures are 1.275 units for men and 1.444 units for women, consistent with the finding elsewhere that the healthy immigrant effect declines over time (Cairney and Ostbye, 1999; Kaplan et al., 2004; Tremblay et al., 2005). BMI also falls with educational level for men. But having a post-secondary degree is associated with a 3.2 and 1.9 point decrease in the probability of being obese for both men and women, respectively.

Household size has a positive impact on BMI and the probability of being obese; however the effects are much larger for women. One more member in the average household increases male BMI by 0.134 units and female BMI by 0.432 units, while it increases the probability of being obese by 1.2% for men and 2.3% points for women. These findings may suggest that a higher household size leads to more family care and thus increases the opportunity cost of time devoted to healthy behaviours. The presence of younger children (less than 6 years) decreases BMI and the probability of being obese much more than does the presence of older ones (between 6 and 11 years). These effects are also generally much larger for females and are inconsistent as the presence of small children in the household is expected to reduce the time allocated to healthy lifestyles (such as better eating habits and regular exercise), and thus to affect weight outcomes positively. A plausible explanation of our findings is that some of the effects of the presence of small children are potentially captured by the household size variable. Home ownership is positively associated with BMI and obesity, and the effects are much larger among women. Specifically, we find that home ownership increases BMI by 0.300 units for men and 0.642 units for women, while it increases the probability of being obese by 2.4% points for men and 2.7% points for women.

Not surprisingly, the individual's lifestyle plays an important role and our findings are consistent with previous Canadian studies (Le Petit and Berthelot, 2006; Pouliou and Elliott, 2010; Sarma et al., 2014; Tjepkema, 2006). Physical activity clearly matters in the predictable way: least active individuals are more likely to have a higher BMI and a higher probability of being obese, relative to others. We also find that these effects are more pronounced for women. For instance, being physically inactive leads to a 0.564 (men) and a 1.244 unit (women) increase in BMI and a 6.5% (men) and 9.2% (women) point increase in the likelihood of obesity. Compared to people who never or rarely drink, being a regular drinker is negatively associated with BMI and the probability of obesity for women, while being an occasional drinker has a positive effect on BMI and the probability of being obese for both men and women. The last life-style indicator, smoking, is also important. Being a daily smoker is negatively linked with BMI and obesity, with larger effects for men. However, being a former smoker has a positive impact, with larger effects for women. Compared to people who never smoked, being a daily smoker leads to a 1.057 unit and a 0.791 unit decrease in BMI for men and women, respectively. For former smokers, the corresponding increases are 0.314 and 0.621 units, respectively. Finally, our results show that living in an urban area has a negative impact on BMI and obesity for men: compared to men who are living in rural areas, living in an urban area leads to a 0.176 unit and a 1.3% point decrease in BMI and the probability of being obese, respectively.

Although we used a large and nationally representative data sets spanning a decade and deal with the potential endogeneity problem, our findings may suffer from a possible sample selection bias due to the fact that individuals without reporting the continuous household income are excluded from the analysis, which represents some 23% of our sample. In order to eliminate this type of selection bias, we use an imputation procedure if continuous income is missing but categorical income measure is reported in our data. Our imputation procedure involves a random draw from the categorical income distribution where continuous income was missing. This imputation strategy led to inclusion of approximately 12% of the sample (50,501 individuals). The results after including imputed income values are reported in in the Appendix (Tables A1 - A8).[5] The results are generally consistent with our main findings (i.e., the models without imputations) with a few minor exceptions. The only exception worth mentioning is that the test results from the full sample for women (reported at the bottom of Tables A1 and A2) show that the null hypothesis of Hansen's J tests of over-identification are rejected at the 5% level of significance in the full-sample. However, the First-stage F-Statistic and the Cragg-Donald Wald F Statistic are very large, suggesting that our results may not suffer from selection bias.

5 Conclusions

This paper is the first to examine the causal effect of income on adult BMI and obesity for men and women in Canada using five biennial confidential master files of the Canadian Community Health Survey data. We deal with the potential endogeneity of income by using an IV method with the neighbourhood level unemployment rate and household income as instruments.

[5]All regression results are available from the corresponding author upon request.

Attention is also paid as to how these causal effects vary by educational status and employment status, in keeping with the theoretical predictions of Grossman's demand for health capital model.

We find clear and consistent evidence that income has a negative impact on both BMI and obesity, thus confirming that obesity is intimately linked to the socio-economic status of individuals. Policies, therefore, that increase household income will also serve to attenuate the growth in obesity. But, one might ask, in the current climate of fiscal restraint, is it reasonable to expect governments to combat obesity by enhancing household income? It is important to bear in mind that the costs associated with obesity are enormous. As mentioned in the introduction, many chronic conditions like high-blood pressure, high cholesterol, heart problems and diabetes are attributable to high BMIs or obesity. All of these chronic conditions cost the health-care system an enormous amount of money each year. Cawley and Meyerhoefer (2011) estimate that the annual direct medical costs incurred by an obese adult are $2,741 (in 2005 dollars) higher compared to a non-obese person in the United States. Add to this the costs incurred by employers through absenteeism and decreased productivity, and we have a large economic problem that needs to be addressed. In other words, one might alternatively ask whether we can afford not to deal with this problem.

The results from this paper help to clarify the link between income and obesity. For instance, we can see from Table 7 that a 1% increase in income can lead to a reduction of 0.16 points in the probability that a woman is obese, and a reduction of 0.07 points for a man. Based on the results from Table 7, the estimated probability of being female and obese is 0.41 and male and obese is 0.53. [6] The Canadian population aged 18 and over, is comprise of 12,556,995 females and 11,787,210 males, which means that we have approximately 5,148,368 obese women and 6,247,221 obese men.

[6] These probabilities are estimated for the reference individual. The reference respondent (male or female) is 41 years old, is married, is born in Canada, has a post-secondary degree, has an average household size equals to three, lives without the presence of small children, is a home owner, is physically inactive, is a regular drinker, lives in an urban area, and lives in Ontario. The reference male has an average household income of $86,367 (in 2010 dollars) and works 38 hours per week, while the reference female has $76,847 (in 2010 dollars) and works 28 hours per week. Finally, the reference male is a former smoker, while the reference female had never smoked.

Reducing these figures by 0.16% and 0.07% respectively leads to 12,610 fewer obese individuals. One can see quite clearly how the number of physician and specialist visits could easily fall, not to mention reductions in the use of other health-care services, like ER visits. If these reductions were to lead to, say, a small fall in obesity-related costs - and if we assume that the direct medical costs estimated by Cawley and Meyerhoefer (2011) are comparable in the Canadian context, then we could see a savings of approximately $40 million in current dollars per year.[7] Moreover, since obese parents tend to have obese children (Gibson et al., 2007; Maffeis et al., 1998; Wang et al., 2002; Whitaker et al., 1997), important second-order effects arising from even a tiny reduction in obesity are likely. While one might balk at public policies that serve to increase household income, one might also question how we can ignore this important, economic, issue.

[7] To convert health care costs from 2005 dollars to current dollars, we use the annual Consumer Price Index (CPI) for all items (provided by Statistics Canada) for the years 2005 and 2013. These CPI are 107.0 and 122.8, respectively.

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Table 1: Distribution of BMI and Obesity over Time

	Males		Females	
Cycles	Mean BMI	% Obese	Mean BMI	% Obese
Cycle 1 (2000-2001)	27.33	23.64	26.14	20.8
Cycle 2 (2003-2004)	27.42	23.4	26.09	20.27
Cycle 3 (2005-2006)	27.57	25.14	26.31	21.08
Cycle 4 (2007-2008)	27.67	25.48	26.37	21.91
Cycle 5 (2009-2010)	27.83	26.43	26.56	22.43
Overall	27.57	24.83	26.29	21.29
Observations	133,638	133,638	139,054	139,054

Table 2: Distribution of BMI and Obesity by Income Group

	Males		Females	
Household income	Mean BMI	% Obese	Mean BMI	% Obese
$< \$10,000$	26.41	19.48	26.84	26.71
\$10,000-\$20,000	27.03	22.42	27.03	26.79
\$20,000-\$30,000	26.87	22.02	26.69	24.94
\$30,000-\$40,000	27.15	22.35	26.8	24.87
\$40,000-\$50,000	27.38	24.29	26.68	24.06
\$50,000-\$60,000	27.45	24.26	26.43	21.87
\$60,000-\$80,000	27.71	25.77	26.33	21.24
$> \$80,000$	27.88	26.09	25.78	17.38
Overall	27.57	24.83	26.29	21.29
Observations	133,638	133,638	139,054	139,054

Table 3: Variable Definitions

Variables	Definition
Dependent variables	
BMI	Weight in kilograms divided by height in meters squared
Obesity	= 1 if BMI $\geq$ 30 kg/m^2, 0 otherwise
Socio-demographic variables	
Age	Age in completed years
Marital status	
Married	=1 if married or in common law relationship, 0 otherwise
Single	=1 if single, 0 otherwise
WSD	=1 if widow, separated or divorced, 0 otherwise
Immigration status	
Canadian born	=1 if Canadian born, 0 otherwise
Immigrant $<$ 10	=1 if immigrated to Canada less than or equal 10 years, 0 otherwise
Immigrant $>$10	=1 if immigrated to Canada more than 10 years, 0 otherwise
Socio-economic variables	
Household income	Household annual income in dollars
Educational status	
$<$ Secondary	=1 if less than secondary education, 0 otherwise
Secondary	=1 if secondary school degree, 0 otherwise
$<$ Post-secondary	=1 if some post-secondary education, 0 otherwise
Post-secondary	=1 if post-secondary school degree, 0 otherwise
Household size	Total number of household size
Children $<$ 5	=1 if the presence of children aged less than 6 years, 0 otherwise
Children 6-11	=1 if the presence of children aged between 6 and 11 years, 0 otherwise
Hours worked	Total number of hours worked in a week
Home owner	=1 if home owned, 0 otherwise
Life-style variables	
Physical Activity status	
Active	=1 if physically active, 0 otherwise
Moderately active	=1 if moderately active, 0 otherwise
Inactive	=1 if physically inactive, 0 otherwise
Alcohol consumption	
Non-drinker	=1 if non-drinker, 0 otherwise
Regular drinker	=1 if regular drinker, 0 otherwise
Occasional drinker	=1 if occasional drinker, 0 otherwise
Smoking behaviour	
Never smoker	=1 if never smoked, 0 otherwise
Daily smoker	=1 if daily smoker, 0 otherwise
Occasional smoker	=1 if occasional smoker, 0 otherwise
Former smoker	=1 if former smoker, 0 otherwise
Geographical variables	
Urban	=1 if living in an urban area; 0 if rural
NFL	=1 if living in the province of Newfoundland, 0 otherwise
PEI	=1 if living in the province of Prince Edward Island, 0 otherwise
NS	=1 if living in the province of Nova Scotia, 0 otherwise
NB	=1 if living in the province of New Brunswick, 0 otherwise
QUE	=1 if living in the province of Quebec, 0 otherwise
ON	=1 if living in the province of Ontario, 0 otherwise
MA	=1 if living in the province of Manitoba, 0 otherwise
SAS	=1 if living in the province of Saskatchewan, 0 otherwise
AL	=1 if living in the province of Alberta, 0 otherwise
BC	=1 if living in the province of British Columbia, 0 otherwise
YU	=1 if living in Yukon, 0 otherwise
NWT	=1 if living in Northwest Territories, 0 otherwise
NU	=1 if living in Nunavut, 0 otherwise

Table 4: Distribution of BMI and Obesity by Income Group

	Males		Females	
Variables	Mean	SD	Mean	SD
Dependent variables				
BMI	27.567	4.754	26.295	5.624
Obesity	0.248		0.213	
Socio-demographic variables				
Age	41.29	12.391	41.231	12.239
Marital status				
Married	0.686		0.664	
Single	0.241		0.206	
WSD	0.073		0.13	
Immigration status				
Canadian born	0.781		0.786	
Immigrant < 10	0.072		0.069	
Immigrant >10	0.147		0.146	
Socio-economic variables				
Household income	86367	63265.68	76846.76	57184
Educational status				
< Secondary	0.126		0.114	
Secondary	0.17		0.177	
< Post-secondary	0.085		0.086	
Post-secondary	0.619		0.623	
Household size	2.962	1.392	2.935	1.365
Children < 5	0.227		0.235	
Children 6-11	0.234		0.259	
Hours worked	38.263	20.378	27.821	19.759
Home owner	0.725		0.711	
Life-style variables				
Physical Activity status				
Active	0.269		0.216	
Moderately active	0.251		0.262	
Inactive	0.48		0.521	
Alcohol consumption				
Non-drinker	0.124		0.181	
Regular drinker	0.764		0.604	
Occasional drinker	0.112		0.215	
Smoking behaviour				
Never smoker	0.294		0.38	
Daily smoker	0.229		0.194	
Occasional smoker	0.059		0.05	
Former smoker	0.419		0.376	
Geographical location				
Urban	0.83		0.837	

Table 5: OLS and 2SLS Estimates (full-sample)

	Males		Females	
	(1)	(2)	(3)	(4)
Variables	OLS	2SLS	OLS	2SLS
Log income	0.102***	-0.739***	-0.345***	-2.977***
	(0.029)	(0.186)	(0.034)	(0.199)
Age	0.251***	0.248***	0.239***	0.248***
	(0.014)	(0.014)	(0.014)	(0.015)
Age^2	-0.002***	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Married	0.574***	0.721***	-0.021	0.817***
	(0.060)	(0.067)	(0.073)	(0.102)
WSD	0.216***	0.196**	-0.325***	-0.648***
	(0.081)	(0.082)	(0.093)	(0.102)
Immigrant < 10	-2.083***	-2.366***	-2.816***	-3.561***
	(0.097)	(0.117)	(0.103)	(0.125)
Immigrant11	-1.175***	-1.275***	-1.214***	-1.444***
	(0.071)	(0.076)	(0.075)	(0.079)
Secondary	-0.229***	-0.094	-0.491***	-0.01
	(0.084)	(0.089)	(0.094)	(0.104)
$<$ Post-secondary	-0.355***	-0.167*	-0.522***	0.06
	(0.094)	(0.099)	(0.116)	(0.128)
Post-secondary	-0.522***	-0.251***	-0.914***	0.017
	(0.071)	(0.087)	(0.087)	(0.112)
Household size	0.028	0.134***	0.062**	0.432***
	(0.026)	(0.034)	(0.027)	(0.040)
Children < 5	0.001	-0.115**	0.128***	-0.153***
	(0.045)	(0.050)	(0.047)	(0.054)
Children 6-11	-0.080*	-0.199***	-0.068	-0.422***
	(0.045)	(0.051)	(0.048)	(0.057)
Hours worked	0.006***	0.014***	0.002	0.023***
	(0.001)	(0.002)	(0.001)	(0.002)
Home owner	-0.062	0.300***	-0.562***	0.642***
	(0.062)	(0.106)	(0.064)	(0.107)

Moderately active	0.361***	0.328***	0.776***	0.738***
	(0.051)	(0.052)	(0.056)	(0.059)
Inactive	0.665***	0.564***	1.477***	1.244***
	(0.050)	(0.053)	(0.054)	(0.060)
Regular drinker	-0.138*	0.055	-0.965***	-0.363***
	(0.075)	(0.090)	(0.071)	(0.090)
Occasional drinker	0.376***	0.426***	0.485***	0.677***
	(0.098)	(0.100)	(0.082)	(0.087)
Daily smoker	-0.946***	-1.057***	-0.544***	-0.791***
	(0.062)	(0.065)	(0.070)	(0.077)
Occasional smoker	-0.135	-0.158	-0.061	-0.182*
	(0.124)	(0.121)	(0.099)	(0.108)
Former smoker	0.324***	0.314***	0.572***	0.621***
	(0.053)	(0.053)	(0.055)	(0.058)
Urban	-0.285***	-0.176***	-0.367***	0.006
	(0.053)	(0.061)	(0.055)	(0.065)
NFL	0.685***	0.455***	0.926***	0.15
	(0.107)	(0.121)	(0.122)	(0.140)
PEI	0.310**	0.118	0.613***	-0.107
	(0.141)	(0.150)	(0.159)	(0.175)
NS	0.435***	0.262**	0.792***	0.225*
	(0.102)	(0.111)	(0.113)	(0.124)
NB	0.299***	0.08	0.947***	0.304**
	(0.099)	(0.112)	(0.123)	(0.135)
QUE	-0.510***	-0.640***	-0.844***	-1.255***
	(0.061)	(0.072)	(0.066)	(0.077)
MA	0.340***	0.212*	0.691***	0.194
	(0.105)	(0.111)	(0.160)	(0.167)
SAS	0.571***	0.484***	0.481***	0.083
	(0.096)	(0.099)	(0.110)	(0.119)
AL	0.155**	0.191**	0.240***	0.344***
	(0.076)	(0.076)	(0.082)	(0.086)
BC	-0.501***	-0.599***	-0.604***	-0.901***
	(0.060)	(0.067)	(0.066)	(0.074)
YU	-0.27	-0.254	0.862***	0.819***
	(0.186)	(0.188)	(0.307)	(0.316)
NWT	0.809***	0.995***	1.532***	2.035***

	(0.170)	(0.176)	(0.202)	(0.234)
NU	0.523*	0.630**	1.288***	1.871***
	(0.267)	(0.237)	(0.307)	(0.395)
Cycle 2 (2003/2004)	0.138**	0.164***	0.154***	0.268***
	(0.060)	(0.060)	(0.067)	(0.072)
Cycle 3 (2005/2006)	0.282***	0.324***	0.438***	0.584***
	(0.057)	(0.058)	(0.064)	(0.070)
Cycle 4 (2007/2008)	0.418***	0.520***	0.551***	0.846***
	(0.070)	(0.075)	(0.068)	(0.087)
Cycle 5 (2009/2010)	0.591***	0.678***	0.696***	1.023***
	(0.070)	(0.072)	(0.081)	(0.087)
Constant	20.439***	28.631***	24.466***	49.223***
	(0.417)	(1.867)	(0.420)	(1.856)
First-stage F		691.51		696.84
Cragg-Donald Wald F Statistic		2405.52		2512.01
Hansen J Statistic		0.5		2.314
P-value		0.48		0.128
Observations	133,638	133,638	139,054	139,054
R-squared	0.079	0.065	0.103	0.005

Table 6: Quantile Regression Estimates (full-sample)

	Quantile 0.25		Quantile 0.50		Quantile 0.75	
Sex	Simple	IV	Simple	IV	Simple	IV
Males	0.282***	0.121	0.183***	-0.412***	0.086***	-0.846***
	(0.021)	(0.092)	(0.021)	(0.112)	(0.021)	(0.141)
Females	-0.118***	-1.310***	-0.301***	-2.245***	-0.586***	-3.192***
	(0.018)	(0.114)	(0.030)	(0.137)	(0.039)	(0.180)

Table 7: LPM and Linear IV estimates (full-sample)

	Males		Females	
	(1)	(2)	(3)	(4)
Variables	LPM	Linear IV	LPM	Linear IV
Log income	0.001	-0.068***	-0.022***	-0.161***
	(0.003)	(0.015)	(0.003)	(0.014)
Age	0.012***	0.012***	0.011***	0.012***
	(0.001)	(0.001)	(0.001)	(0.001)
Age^2	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Married	0.040***	0.052***	-0.009*	0.036***
	(0.005)	(0.006)	(0.005)	(0.007)
WSD	0.007	0.007	-0.026***	-0.043***
	(0.007)	(0.007)	(0.007)	(0.007)
Immigrant < 10	-0.148***	-0.172***	-0.160***	-0.200***
	(0.008)	(0.010)	(0.007)	(0.008)
Immigrant11	-0.088***	-0.097***	-0.071***	-0.083***
	(0.006)	(0.007)	(0.006)	(0.006)
Secondary	-0.023***	-0.012	-0.046***	-0.020***
	(0.007)	(0.008)	(0.007)	(0.008)
< Post-secondary	-0.029***	-0.013	-0.038***	-0.007
	(0.008)	(0.009)	(0.009)	(0.009)
Post-secondary	-0.054***	-0.032***	-0.068***	-0.019**
	(0.006)	(0.008)	(0.007)	(0.008)
Household size	0.003	0.012***	0.003*	0.023***
	(0.002)	(0.003)	(0.002)	(0.003)
Children < 5	-0.005	-0.014***	0.002	-0.013***
	(0.004)	(0.004)	(0.003)	(0.004)
Children 6-11	-0.010**	-0.020***	-0.004	-0.023***
	(0.004)	(0.005)	(0.004)	(0.004)
Hours worked	0.000***	0.001***	0	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Home owner	-0.006	0.024***	-0.037***	0.027***
	(0.005)	(0.008)	(0.005)	(0.008)
Moderately active	0.042***	0.040***	0.056***	0.054***

	(0.005)	(0.005)	(0.004)	(0.004)
Inactive	0.073***	0.065***	0.104***	0.092***
	(0.004)	(0.005)	(0.004)	(0.004)
Regular drinker	-0.020***	-0.005	-0.067***	-0.035***
	(0.006)	(0.007)	(0.005)	(0.007)
Occasional drinker	0.023***	0.027***	0.027***	0.037***
	(0.008)	(0.008)	(0.006)	(0.006)
Daily smoker	-0.056***	-0.065***	-0.026***	-0.039***
	(0.005)	(0.006)	(0.005)	(0.005)
Occasional smoker	-0.009	-0.011	-0.006	-0.012
	(0.009)	(0.009)	(0.007)	(0.008)
Former smoker	0.024***	0.023***	0.035***	0.037***
	(0.005)	(0.005)	(0.004)	(0.004)
Urban	-0.022***	-0.013**	-0.019***	0.001
	(0.005)	(0.005)	(0.004)	(0.005)
NFL	0.056***	0.037***	0.055***	0.014
	(0.011)	(0.011)	(0.010)	(0.011)
PEI	0.008	-0.008	0.030**	-0.009
	(0.013)	(0.014)	(0.012)	(0.013)
NS	0.030***	0.016	0.049***	0.019*
	(0.010)	(0.010)	(0.009)	(0.009)
NB	0.020**	0.002	0.057***	0.023**
	(0.009)	(0.010)	(0.009)	(0.009)
QUE	-0.043***	-0.054***	-0.044***	-0.066***
	(0.005)	(0.006)	(0.005)	(0.005)
MA	0.015	0.004	0.027***	0.001
	(0.009)	(0.010)	(0.009)	(0.010)
SAS	0.047***	0.039***	0.030***	0.009
	(0.009)	(0.010)	(0.008)	(0.009)
AL	0.005	0.008	0.015**	0.019***
	(0.007)	(0.007)	(0.006)	(0.006)
BC	-0.045***	-0.053***	-0.032***	-0.048***
	(0.006)	(0.006)	(0.005)	(0.005)
YU	-0.024	-0.023	0.030*	0.028*
	(0.017)	(0.017)	(0.016)	(0.017)
NWT	0.075***	0.091***	0.095***	0.121***
	(0.017)	(0.017)	(0.016)	(0.017)

NU	0.050**	0.059**	0.067***	0.098***
	(0.023)	(0.023)	(0.025)	(0.027)
Cycle 2 (2003/2004)	0.003	0.006	0.009*	0.014***
	(0.005)	(0.005)	(0.005)	(0.005)
Cycle 3 (2005/2006)	0.021***	0.024***	0.021***	0.028***
	(0.005)	(0.005)	(0.005)	(0.005)
Cycle 4 (2007/2008)	0.028***	0.035***	0.032***	0.048***
	(0.006)	(0.006)	(0.005)	(0.006)
Cycle 5 (2009/2010)	0.038***	0.045***	0.036***	0.053***
	(0.006)	(0.006)	(0.006)	(0.006)
Constant	-0.059*	0.613***	0.224***	1.534***
	(0.034)	(0.154)	(0.030)	(0.137)
First-stage F		691.51		696.84
Cragg-Donald Wald F-Statistic		2405.52		2512.01
Hansen J Statistic		0.214		2.421
P-value		0.643		0.12
Observations	133,638	133,638	139,054	139,054

Table 8: Income Elasticity Estimates

	BMI (full-sample)			
	Males		Females	
Variables	OLS	2SLS	OLS	2SLS
Coef. Log income	0.102***	-0.739***	-0.345***	-2.977***
Sample mean	27.57	27.57	26.29	26.29
Elasticity	0.004	-0.027	-0.013	-0.113
	Obesity (full-sample)			
	Males		Females	
Variables	LPM	Linear IV	LPM	Linear IV
Coef. Log income	0.001	-0.068***	-0.022***	-0.161***
Sample mean	0.2483	0.2483	0.2129	0.2129
Elasticity	0.004	-0.274	-0.103	-0.756

Table 9: Income Elasticity Estimates by Educational Status (Male Sample)

		BMI		
Variables	< Secondary	Secondary	< Post-secondary	Post-secondary
Coef. Log income	-0.468	-0.727	-1.169**	-0.650***
Sample mean	27.94	27.62	27.1	27.85
Elasticity	-0.017	-0.026	-0.043	-0.023
First-stage F	102.28	131.34	75.93	389.91
Cragg-Donald Wald F Statistic	336.13	432.93	160.19	1433.73
Hansen J Statistic	0.005	0.758	0.893	2.102
P-value	0.9437	0.3839	0.3446	0.1471
Observations	21,032	23,067	10,776	78,763
		Obesity		
Variables	< Secondary	Secondary	< Post-secondary	Post-secondary
Coef. Log income	-0.056	-0.082**	-0.048	-0.064***
Sample mean	0.2946	0.2609	0.2316	0.2629
Elasticity	-0.19	-0.314	-0.207	-0.243
First-stage F	102.28	131.34	75.93	389.91
Cragg-Donald Wald F Statistic	336.13	432.93	160.19	1433.73
Hansen J Statistic	0.426	0.219	0.955	1.484
P-value	0.5139	0.6397	0.3284	0.223
Observations	21,032	23,067	10,776	78,763

Table 10: Income Elasticity Estimates by Educational Status (Female Sample)

		BMI		
Variables	< Secondary	Secondary	< Post-secondary	Post-secondary
Coef. Log income	-3.693***	-1.943***	-2.276***	-3.141***
Sample mean	27.76	26.7	26.03	26.6
Elasticity	-0.133	-0.073	-0.087	-0.118
First-stage F	48.57	156.35	80.05	422.85
Cragg-Donald Wald F Statistic	146.74	415.99	160.86	1769.01
Hansen J Statistic	0.114	0.009	0.3382	0.309
P-value	0.7357	0.9259	0.0659	0.578
Observations	18,878	24,653	11,469	84,054
		Obesity		
Variables	< Secondary	Secondary	< Post-secondary	Post-secondary
Coef. Log income	-0.204***	-0.127***	-0.128***	-0.159***
Sample mean	0.3146	0.2328	0.2102	0.2284
Elasticity	-0.648	-0.545	-0.609	-0.696
First-stage F	48.57	156.35	80.05	422.85
Cragg-Donald Wald F Statistic	146.74	415.99	160.86	1769.01
Hansen J Statistic	0.066	0.042	2.413	0.892
P-value	0.7979	0.8371	0.1203	0.345
Observations	18,878	24,653	11,469	84,054

Table 11: Income Elasticity Estimates by Employment Status

	Male Sample			
	Unemployed		Employed	
Variables	BMI	Obesity	BMI	Obesity
Coef. Log income	-0.788	-0.075**	-0.673***	-0.063***
Sample mean	27.46	0.2515	27.59	0.2477
Elasticity	-0.029	-0.298	-0.024	-0.254
First-stage F	102.99	102.99	559.39	559.39
Cragg-Donald Wald F Statistic	319.62	319.62	1961.74	1961.74
Hansen J Statistic	0.04	0.1	1.079	0.543
P-value	0.842	0.7519	0.2989	0.4611
Observations	23,889	23,889	109,749	109,749
	Female Sample			
	Unemployed		Employed	
Variables	BMI	Obesity	BMI	Obesity
Coef. Log income	-2.987***	-0.164***	-2.970***	-0.158***
Sample mean	26.86	0.2511	26.11	0.2001
Elasticity	-0.111	-0.653	-0.114	-0.79
First-stage F	247.33	247.33	443.28	443.28
Cragg-Donald Wald F Statistic	741.93	741.93	1698.08	1698.08
Hansen J Statistic	1.984	0.839	0.765	1.359
P-value	0.159	0.3597	0.3817	0.2437
Observations	38,587	38,587	100,467	100,467

6 Appendix

Table A1: Income Elasticity of BMI (Full Sample)

	Males		Females	
Variables	OLS	2SLS	OLS	2SLS
Coef. Log income	0.103***	-0.825***	-0.334***	-2.972***
Sample mean	27.52	27.52	26.25	26.25
Elasticity	0.004	-0.03	-0.013	-0.113
First-stage F		808.6		846.82
Cragg-Donald Wald F Statistic		2732.82		3105.29
Hansen J Statistic		0.414		4.299
P-value		0.52		0.0381
Observations	150,830	150,830	164,541	164,541

Table A2: Income Elasticity of Obesity (Full Sample)

	Males		Females	
Variables	LPM	Linear IV	LPM	Linear IV
Coef. Log income	0.001	-0.074***	-0.022***	-0.163***
Sample mean	0.2464	0.2464	0.2108	0.2108
Elasticity	0.004	-0.3	-0.104	-0.773
First-stage F		808.6		846.82
Cragg-Donald Wald F Statistic		2732.82		3105.29
Hansen J Statistic		0.047		4.813
P-value		0.8281		0.0283
Observations	150,830	150,830	164,541	164,541

Table A3: Income Elasticity of BMI by Educational Status (Male Sample)

Variables	< Secondary	Secondary	< Post-secondary	Post-secondary
Coef. Log income	-0.35	-0.842*	-1.343**	-0.754***
Sample mean	27.89	27.51	27	27.52
Elasticity	-0.013	-0.031	-0.05	-0.027
First-stage F	120.93	155.97	80.67	454.14
Cragg-Donald Wald F Statistic	393.29	488.6	182.06	1614.83
Hansen J Statistic	0.307	1.298	0.896	3.399
P-value	0.5795	0.2546	0.3439	0.0653
Observations	24,650	26,493	12,499	87,188

Table A4: Income Elasticity of Obesity by Educational Levels (Men Sample)

Variables	< Secondary	Secondary	< Post-secondary	Post-secondary
Coef. Log income	-0.05	-0.088**	-0.061	-0.071***
Sample mean	0.2909	0.2532	0.2269	0.2376
Elasticity	-0.172	-0.348	-0.269	-0.299
First-stage F	120.93	155.97	80.67	454.14
Cragg-Donald Wald F Statistic	393.29	488.6	182.06	1614.83
Hansen J Statistic	1.614	1.096	0.433	2.349
P-value	0.2039	0.2951	0.5105	0.1254
Observations	24,650	26,493	12,499	87,188

Table A5: Income Elasticity of BMI by Educational Status (Female Sample)

Variables	< Secondary	Secondary	< Post-secondary	Post-secondary
Coef. Log income	-3.285***	-2.141***	-2.427***	-3.125***
Sample mean	27.76	26.61	25.87	25.91
Elasticity	-0.118	-0.08	-0.094	-0.121
First-stage F	62.37	167.6	106.2	507.84
Cragg-Donald Wald F Statistic	193.46	533.77	224.53	2100.6
Hansen J Statistic	0.069	0.008	2.083	2.143
P-value	0.7934	0.929	0.149	0.1432
Observations	23,305	29,794	14,043	97,399

Table A6: Income Elasticity of Obesity by Educational Status (Female Sample)

Variables	< Secondary	Secondary	< Post-secondary	Post-secondary
Coef. Log income	-0.171***	-0.144***	-0.154***	-0.160***
Sample mean	0.3128	0.2275	0.2002	0.1879
Elasticity	-0.547	-0.633	-0.769	-0.852
First-stage F	62.37	167.6	106.2	507.84
Cragg-Donald Wald F Statistic	193.46	533.77	224.53	2100.6
Hansen J Statistic	0.218	0.194	0.983	2.881
P-value	0.6405	0.6597	0.3214	0.0896
Observations	23,305	29,794	14,043	97,399

Table A7: Income Elasticity of BMI and Obesity by Employment Status (Male Sample)

	Unemployed		Employed	
Variables	BMI	Obesity	BMI	Obesity
Coef. Log income	-0.748	-0.066**	-0.782***	-0.073***
Sample mean	27.4	0.252	27.54	0.2454
Elasticity	-0.027	-0.258	-0.028	-0.297
First-stage F	117.09	117.09	660.09	660.09
Cragg-Donald Wald F Statistic	375.92	375.92	2239.47	2239.47
Hansen J Statistic	0.026	0.029	1.174	0.346
P-value	0.8719	0.8656	0.2786	0.5567
Observations	27,812	27,812	123,018	123,018

Table A8: Income Elasticity of BMI and Obesity by Employment Status (Male Sample)

	Unemployed		Employed	
Variables	BMI	Obesity	BMI	Obesity
Coef. Log income	-2.927***	-0.166***	-2.988***	-0.161***
Sample mean	26.82	0.2487	26.05	0.1976
Elasticity	-0.109	-0.667	-0.115	-0.815
First-stage F	299.81	299.81	539.05	539.05
Cragg-Donald Wald F Statistic	945.36	945.36	2082.98	2082.98
Hansen J Statistic	1.207	0.626	2.667	3.905
P-value	0.2719	0.4288	0.1025	0.0481
Observations	47,177	47,177	117,364	117,364