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The Impact of Obesity on Employment Participation and Earnings among Working-Age Women in Canada: Evidence from the NPHS Longitudinal Data

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A thesis submitted in partial fulfillment of the requirements for the degree in Master of Science

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by

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Abstract

Background: The direct medical care costs attributable to obesity are well-known, but little is known about the indirect costs of obesity. In particular, less is known about the impact of obesity on employment participation and earnings, especially among women in Canada.

Objectives: The objectives of this study are to examine the association between obesity and employment participation and earnings, if employed, among Canadian women.

Methods: Data were taken from the last six cycles of the National Population Health Survey from 2000/01-2010/11 longitudinal cohort data from women aged 18-53 years. The association between obesity and labour market participation was analyzed using pooled, random-effects and fixed-effects regression modeling techniques. The association between obesity and earnings (wage and income) was analyzed using pooled, truncated random-effects and truncated fixed-effects regression models.

Results: Wage rate and annual income were found to be negatively associated with obesity. The negative association persisted between obesity and annual income even after accounting for individual-specific effects in the regression analysis. The effect of obesity on employment participation was not significant once health and lifestyle variables were controlled for.

Conclusions: This longitudinal analysis of Canadian women demonstrated that obesity has a negative effect on earnings and this effect remains statistically significant even after controlling for individual-specific heterogeneity.

Keywords

Obesity; Body Mass Index; Employment Participation; Earnings; Wage; Income; Unobserved Heterogeneity; Random-Effects; Fixed-Effects; Mundlak Correction

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List of Abbreviations

BMI – Body mass index

CCHS – Canadian Community Health Survey

CI – Confidence Interval (95%)

IV – Instrumental Variables

ME – Marginal effect

NPHS – National Population Health Survey

OLS – Ordinary least squares

OR – Odds ratio

SE – Standard error

SES – Socioeconomic status

Chapter 1

1 Introduction

Over the past three decades, adult obesity rates in Canada increased substantially (from 10% in 1970 to 25% in 2008)(1) resulting in a huge financial burden on the healthcare system (2). Although the direct medical care costs attributable to obesity are well-known, little is known about the indirect costs of obesity. In particular, very little is known about the influence of obesity on the probability of employment over time or the impact, if employed, on earnings. This limited understanding on the relationship between obesity and labour market participation is particularly true in the Canadian context.

Employment for women has increased in the past three decades (3), likely as a result of changes in social roles and acceptability. Statistics Canada reported that the employment rate of women increased from 41.9% (3.6 million women) in 1976 to 58.3% (8.1 million women) in 2009 (3). Further, in 2009 it was found that 72.9% of women with children under the age of 16 were active in the workforce, a substantial rise from previous decades (3). Despite the increase in the employment rate of women, the effects of obesity on employment participation, wage rate and income are unknown in Canada. Numerous international studies found a negative effect of obesity on labour market participation, hourly wage rate, and income among women (4-8). These findings highlight the need for evidence regarding the relationship between adult obesity and labour market participation among women in Canada.

1.1 Exploring the Association

Obesity and its indirect effect on the socioeconomic structure of a country, such as its influence on the labour market participation and earnings, suggest a dynamic association that may be confounded due to biases such as unobserved heterogeneity (6, 7, 9, 10) and reverse causality (6, 8, 11, 12). Unobserved heterogeneity refers to unobserved individual-specific effects that may be correlated with the exposure or outcome. For example, personality traits such as high dedication or a lack of motivation could be unobserved to the researcher and have an influence on the association between obesity and labour market outcomes. In this thesis, unobserved heterogeneity bias was accounted for by using longitudinal regression methods such as random-effects regression, Generalized Estimating Equations with group means, and truncated regression with group means. These regression techniques allowed for control of time-invariant unobserved heterogeneity bias.

1.2 Objectives

To analyze the impact of obesity on female labour market participation and earnings, both the probability of employment and the differences in earnings if employed were considered. The unique aspect of this study was to understand the impact of obesity on labour market participation and earnings longitudinally. More specifically, this study aimed to fill the gaps in the literature regarding the relationship between obesity (as defined as a BMI greater than 30) and employment or earnings, if employed, for Canadian women. The outcome of earnings was measured through hourly wage rate of full-time employees and annual personal income from wages and salaries of all working women. Using the last six cycles of longitudinal data from the Canadian National Population Health Survey (NPHS), the two research questions and corresponding hypotheses explored were:

1) How do labour market participation and earnings (wage rate and income) vary by obesity status among working age women in Canada?

- Hypothesis 1.1: There is a negative association between obesity and labour market participation.
- Hypothesis 1.2: There is a negative association between obesity and earnings (wage rate and income).

2) Do the associations between obesity and employment participation or earnings (wage rate and income) persist once unobserved heterogeneity bias is accounted for?

- Hypothesis 2.1: The negative association between obesity and labour market participation may persist after accounting for unobserved heterogeneity bias.
- Hypothesis 2.2: The negative association between obesity and earnings (wage rate and income) may persist after accounting for unobserved heterogeneity bias.

These two research questions were addressed using data on the cohort of Canadian women ages 18 to 53 in 2000/01 from the National Population Health Survey and followed them until 2010/11. The first research question was analyzed by looking at the multivariable regression analysis of the association between obesity and employment participation, and the association between obesity and earnings (log hourly wage rate and log annual personal income) for the employed population. The second research question was analyzed by assessing the impact of unobserved heterogeneity bias by use of a multivariable random-effects regression model with the inclusion of group means of time-varying explanatory variables.

The next chapter summarizes the key findings from the existing literature and identifies gaps in this area of research. Following the literature review, the conceptual framework and methods are presented. The final two chapters present the results, discussions and conclusions in relation to the original hypotheses.

Chapter 2

2 Literature Review

2.1 Strategy

To review the literature regarding the association between obesity, labour market participation and earnings, both cross-sectional and longitudinal studies were identified through an extensive literature search process. Studies that accounted for unobserved heterogeneity bias using fixed-effects and instrumental variables in the theoretical framework and empirical analysis were also identified. The labour market outcomes of interest in the review were: employment outcomes (employment status, probability of employment and occupational attainment), earnings as defined by wage rate (hourly) and income or salary.

To conduct the literature review, an initial search in PubMed was performed using the following key words: (Women OR woman OR female OR female*) AND (Obesity OR overweight OR obes* OR BMI OR body mass index)) AND (Unemployment OR unemploy* OR occupational status OR workforce OR employment OR employ* OR underemploy* OR employment participation OR labour market). Filters: Publication date from 1995/01/01 to 2013/12/31.

This search strategy was then modified and repeated for the earnings outcomes (wage, income, or salary): (Women OR woman OR female OR female*) AND (Obesity OR overweight OR obes* OR BMI OR body mass index) AND (Wage OR Salary OR Salaries OR Income OR Pay OR Earnings) Filters: Publication date from 1995/01/01 to 2013/12/31.

The literature search was restricted to all OECD countries as the findings may be more relevant to the Canadian population.

The same strategy was utilized in three other search engines: EMBASE, Scopus, and Web of Science. The next phase involved a search in Google Scholar for all pertinent outcomes and a complete review of reference lists from the original studies to find other relevant papers.

During the search for literature, criteria for inclusion were: empirical exposures regarding body mass (overweight, obesity and BMI) and outcomes including labour market variables (specifically employment, wage, or other earnings related variables), membership in one of the twenty-six OECD countries, publication year including and after 1995, outcomes for adults of working age (18-65), no perceived measures (discrimination, and perceived loss of productivity), and inclusive of females (with or without males). This resulted in forty-three relevant studies:

- Obesity and both Employment and Earnings (Wage or Income): 11 studies
- Obesity and Employment: 15 studies
- Obesity and Earnings (Wage or Income): 17 studies

2.2 Overview of Literature Review

The review of relevant literature is structured into sections corresponding to the labour market outcome and then by study type. Section 2.3 reviews the effect of obesity on overall employment participation. This section is then divided into two subsections; Cross-Sectional Findings and Longitudinal Findings. Section 2.4 reviews the effect of obesity on earnings as expressed through wage rate or income. The section is similarly divided into two sections: Cross-Sectional Findings and Longitudinal Findings.

The studies were compared by study type, primarily cross-sectional versus longitudinal methods and then further organized based on countries and outcome specific indicators. The literature review concludes with a discussion that discourses the overall findings of the review, general limitations of the current literature and the major gaps in this area of research. The findings of each paper can also be found in Appendix A.

2.3 The Impact of Obesity on Employment

Of the 26 studies that examined the impact of obesity on employment participation, 12 used cross-sectional surveys, while the remaining 14 utilized longitudinal data. Among these studies, 10 controlled for unobserved heterogeneity bias.

2.3.1 Cross-Sectional Findings

A simple way to look at labour market participation in the literature was through the probability of employment. By making the outcome the probability of being employed versus unemployed it allows for ease of interpretation. Although the cross-sectional studies resulted in findings that were valuable for understanding the association between obesity on labour market participation, these studies were limited to address potential omitted variable bias. Of the ten cross-sectional studies, eight looked at the effect of obesity on employment status or probability of employment at the individual level while the other two considered area-level unemployment (13) and employment gaps over time (5).

A Canadian study used data from the Canadian Community Health Survey (CCHS) from 2000-2001 to perform a population-based analysis of obesity and workforce participation (14). This study assessed employment status in the previous week in relation to self-reported BMI and found that with a higher BMI, the odds ratios (OR's) of workforce participation were lower (OR of 0.97, 0.86 and 0.64 for Class I, II and III, respectively). However, the only significant findings were from class II and III of obesity. Overall, this Canadian study showed that obese individuals are less likely to be employed and this finding was stronger for women.

Another Canadian study, by Naimi *et al*., looked at area-level unemployment in relation to obesity in Montreal (13). Although the sample size was small (n = 342), GEE and Poisson regression models found that there was a positive gradient between BMI and unemployment rates, ranging in prevalence ratios from 1.71 to 2.70. Moreover, even though the outcome was area-level BMI, the study showed the negative impact of obesity on employment participation.

There were many cross-sectional studies conducted in other OECD countries such as the US, UK, Finland, Germany, Iceland and other European nations. Cawley wrote multiple papers to analyze the relationship between body weight and labour market outcomes. His study in 2009 focused on the association for legal US immigrants (15). Using logistic regression it was clear that women with a higher body weight were less likely to be employed after being in the US for less than a year as well as less than 5 years. The marginal effect for obese female immigrants relative to normal weight female immigrants who were new to the U.S. was -0.183 ($p = 0.05$) meaning that among female immigrants, obese women were less likely to be employed.

Two studies used data from the Survey on Health and Aging in Europe (SHARE) regarding ten nations as grouped into northern, central and southern Europe. Both studies focused on the relationship between obesity and labour market participation for the working population over 50 years of age. The first study pooled all countries and found that obesity was associated with a lower probability of being employed (marginal effect of -0.053, $p<0.01$) (16). In addition, stratified regressions by country-groups showed that the influence of obesity varied across

Europe. Akin to many other studies, employment status appeared to be influenced by reduced health status as it reduced the magnitude of the association in the final probit model. The second study, by Alavinia and Burdorf looked at the impact of obesity on being employed versus unemployed, retired or a homemaker (17). Using logistic regression, obese women were more likely to be retired (OR 1.43, 95% CI: 1.20-1.70), unemployed (OR 1.31, 95% CI: 1.01-1.68), or homemakers (OR 1.34, 95% CI: 1.10-1.64) compared to normal weight women. This association remained statistically significant even after numerous health and lifestyle variables were controlled (such as health status, smoking, and drinking).

Turning the attention to the United Kingdom, in 2007 Heineck sought to estimate the relationship between weight and employment (18). A unique feature of this study was that obesity was measured through total body fat (TBF), fat free mass (FFM), percentage of body fat (BF %) and adiposity. Overall, there were only a few differing results using BMI versus the other alternative measures of fatness. Using the indictor of BF % in a multinomial logit model, being obese resulted in a 0.02% reduction in employment compared to non-obese women.

Similarly, a study in Finland by Johannson *et al*. examined the relationship between obesity and labour market participation using multiple body composition measurements such as weight, height, fat mass and waist circumference (19). Their results showed a significant, negative association for women. Moreover, a 1 kilogram increase in weight resulted in a 0.3% decrease in employment probability while a 1 kilogram increase in fat mass resulted in a 0.5% decrease in employment probability. Similar to previous studies, the inclusion of self-reported health status reduced the size of the effect. Another Finnish study examined the relationship between BMI and employment disadvantage (20). By use of a cross-sectional survey and data linkage to the nations taxation register, the authors were able to look at both current unemployment and long-term unemployment. The majority of labour market disadvantages were more likely to be experienced by women. Being overweight was most associated with current unemployment (OR 1.4, 95% CI: 1.0-1.8), while obesity was more related with long-term unemployment (OR 2.5, 95% CI: 1.5-4.2), compared to normal weight women.

Likewise, Asgeirsdottir also found a significant negative relationship for the probability of employment for obese women in Iceland (4). The marginal effect of BMI on employment was found to be -0.051 (0.029). Interestingly, the author claimed that Iceland had high equality between the sexes; although the cross-sectional findings suggested a gender bias against women for the effect of BMI on employability. Overall, BMI was negatively correlated with employment for women which was larger in magnitude when the control for health effects was excluded.

A recent cross-sectional study from 2012 looked at the transitions from unemployment to employment in Germany (5). Using Decomposition techniques in OLS regressions it was found that as compared to normal weight women obese women were more likely to have a significant gap in their transition from unemployment to employment.

Although less common, two cross-sectional studies attempted to account for unobserved heterogeneity bias using an instrumental variable (IV) method of estimation. IV estimation technique is commonly used to account for the endogeneity bias (a source of unobserved heterogeneity bias) if strong instruments are found that are correlated with the exposure but uncorrelated with the error term in the outcome equation (21).

In 2007 Morris investigated the impact of obesity on employment in England using individual-level data (22). For both males and females the association was statistically significant and negative. In an IV model, which used the area prevalence of obesity for which the participant lived as an instrument, the estimated effect showed that obese females had a 0.213 lower probability of employment compared to non-obese females. The IV estimation was not statistically significant for men. Although cross-sectional data was used, he argued that area-level obesity was able to control for the unobserved individual differences and in turn control for omitted variable bias. Similarly, a study by Mora also used mean BMI from individuals of the same education and geographic area in Spain (23). Using a probit regression model with the area-level obesity as an instrument, the coefficient for obese women was -0.019 and was statistically significant at the 5% level. Even though these studies did not use longitudinal methods to account for unobserved heterogeneity, their use of IV method of estimation appeared to be justified.

2.3.2 Longitudinal Findings

The majority of longitudinal studies sought to look at the impact of obesity on probability of employment, however a few studies looked at alternative outcomes such as occupational attainment over the life course (24), years unemployed (25), and employment status a few years later (26).

A 2006 American study by Tunceli *et al*. found that obesity at baseline was associated with a decreased workforce participation for both men and women at follow-up, while work limitations were more associated with women at follow-up (27). Multivariable probit models showed that obese women were associated with a reduction in employment by 5.8% compared to normal weight women. Women were also more affected by poor self-reported health as inclusion of health status in the regression model caused the overall association to weaken. This study exhibited the influence of health status on labour market participation.

Another American study by Glass *et al*. estimated the influence of body mass index over three decades of occupational attainment for individuals in Wisconsin (24). What differed from other American studies was that three mechanisms were hypothesized to mediate the effect: employment-based discrimination, education-level, and the marriage market process. It was found that heavier women received less post-secondary schooling (0.3 fewer years) than their normal weight counterparts which adversely affected their career throughout life. However, overweight women delayed family formation by 1.18 years on average which actually had a beneficial influence on initial and mid-career attainment. Unfortunately, the effect of lower education was four times larger than the positive effect of delayed family formation meaning that the overall association of overweight women investing less in educational attainment was likely a mediator for occupational attainment. Although this study did not directly assess the impact of obesity on employment, it provided valuable insight into potential mediating factors.

There were two French studies that examined the relationship between obesity in women and employment. The first, by Paraponaris *et al*., used weight status (obesity) and employability (years spent unemployed and the ability to regain employment) to focus primarily on the transitions between employment and unemployment (25). A unique characteristic of this study was the focus on the amount of time spent unemployed. Like many other studies, a negative association between body weight and employment participation among women was found. Specifically, they found that the percentage of time spent unemployed increased with each kilogram per meter squared (kg/m^2) deviation from the mean BMI (measured at age 20), with a sharp increase at a BMI greater than 5 kg/m^2 over the median. For women greater than 5 kg/m^2 over the median, 15% of their working years were spent unemployed (for those who had experienced at least 1 period of unemployment). In addition, the probability of remaining unemployed for 6-12 months was 13% higher for obese women.

The second French study examined the combined effects of health and health-related behaviors on unemployment to distinguish the direct from indirect effects of obesity for women aged 30-54 (26). They referred to direct effects such as disease while indirect effects involved work behaviors and overall employability. Looking at unemployment four years after the baseline, it was found that women were more likely to be unemployed compared to men and even more so if they were obese and reported poor health (OR 2.0, 95% CI: 1.2-3.4). After controlling for self-rated health and smoking, obesity was still a significant risk factor for unemployment for women. In addition, non-optimal health was once again shown to be a significant precursor to unemployment in women.

In contrast to the first three longitudinal studies, the next two studies failed to find significance in their final models. The first study, by Laitinen and others, assessed obesity at 14 years of age and unemployment at 31 years of age in Finland (28). Using logistic regression, they were unable to find significance for obesity on employment status, but there was a significant effect on marital status and education. Similarly, in 2012 Pit and Byles examined the same exposure and outcome for Australian women aged 45-50 (29). Using a Generalized Estimating Equation (GEE) technique they found that obese women were more likely to be unemployed (OR: 0.85, 95% CI: 0.77-0.94) compared to normal weight women. However, in the fully-adjusted model with quality of life and health issues the association failed to reach a 5% level of significance.

The vast majority of studies that accounted for unobserved heterogeneity bias were conducted using prospective cohort surveys. All but one analyzed the impact of obesity on employment probability; the other study looked at transitions between employment states (30).

In 2000, Cawley sought to estimate the effect of weight on employment status for American women (6). Using the National Longitudinal Survey of Youth (NLSY) he looked at the effect of weight on employment status for white, black and Hispanic women in the US. To adjust for potential endogeneity and unobserved heterogeneity biases between obesity and employment he used the weight of the woman's child as an instrument in his IV analysis. His findings showed a negative association between weight and employment status for white women, however the final IV results had no statistically significant findings.

In 2008, Norton and Han estimated the effect of BMI on the probability of employment for women (31). This was done using the National Longitudinal Study of Adolescent Health (Add Health) in addition to a subset of DNA sampling. They used sibling BMI as an instrument in their IV analysis to account for the potential omitted variable bias. In their final model, using both lagged-BMI and the sibling IV, the association was negative but failed to reach a 5% level of significance. However, the use of genetics and sibling BMI as IVs proved to be strong in their study.

A 2009 study by Han and colleagues used a fixed-effects regression model to account for the possible unobserved heterogeneity bias (31). In order to examine the association between obesity and employment participation, they used American women aged 20-27 at baseline in 1985 and followed them for seventeen years. Their fixed-effects logistic regression models showed that obese white and obese Hispanic women were more likely to have a lower probability of employment. Moreover, white and Hispanic women were 1.5 and 4.5% less likely to be employed compared to normal weight white and Hispanic women, respectively. There were no statistically significant findings for Black obese women, however.

Comparatively, a 2010 study looked at both the direct and indirect effects of obesity on U.S. labour market outcomes of older working age adults (pre-retirement) (32). The outcome variable for labour market participation was defined by three statuses: working, not working due to disability, or not working due to early retirement. The authors used fixed-effects to account for unobserved heterogeneity bias. The results for women showed that obesity (class II and III) increased the probability of early retirement by 2.5% and disability in the older adults by 1.7%. After controlling for physical impairments, the probability of being unemployed decreased suggesting that the direct effect of obesity may have been more influential than the indirect effects.

A study from Finland by Härkönen analyzed the obesity gap for female unemployment using data from the European Community Household Panel (ECHP) (30). Akin to many other studies, the dependent variable was unemployment status while the independent variable was obesity as a binary outcome (BMI of 30 or above as obese). Uniquely, the analysis involved decomposing the obesity gap into transition periods (from unemployment to employment). The obesity gap transitions from unemployment to employment were still present after controlling for demographics and education or personality traits. In terms of the transition probabilities, non-obese women were approximately three times more likely to move from inactivity to employment than obese women, while obese women were twice as likely to move from employment to inactivity as compared to non-obese women. From unemployment to employment, non-obese women were 1.6 times more likely to make the transition; however, the transition from employment to inactivity became statistically non-significant after controlling for health status.

A 2008 Danish study analyzed the relationship between BMI and employment status using fixed-effects and a genetic related IV method (10). Greve looked at the impact of weight on employment in Denmark and found that for women, once a BMI of 22-25 had been reached, probability of employment began to decrease and as a result, obese women were 8.5% less likely to have employment compared to normal weight counterparts. In regards to the use of IVs to account for potential unobserved heterogeneity and endogeneity biases, the use of family member prescriptions related to obesity was shown to be a weak instrument , but the use of maternal obesity medication as an IV for women proved to be a strong instrument and predictor of female obesity

Another study that utilized a genetic IV was by Lindeboom and colleagues who looked longitudinally at a group of British individuals using the British National Child Development Study (NCDS) (9). The obesity status of the participants' biological parents was used to predict the effect of genetic variations on employment status. To account for unobserved hetereogeneity bias, the authors utilized a first difference technique. The baseline OLS results showed a 4.9%

reduction in employment probability for obese women at age 42 and a 20% penalty for obese women at age 33. The first difference regression resulted in a negative but statistically non-significant finding. The IV was found to be a strong predictor of obesity in women; however the coefficients became positive and statistically non-significant. The authors claim that the lack of significance when using the IV may mean an undetected influence was at work other than pure genetics. This study is similar to the results of Cawley (2000).

Like previous studies, Garica and Quintana-Domeque used the European panel survey (ECHP) to examine the association between obesity and employment status for nine European countries (12). All of the models revealed a far greater impact of obesity on unemployment for women. However, after modeling the association using fixed-effects regression and lagged-BMI in addition to controlling for health status, no significant results were found for the association between obesity and employment. The authors did conclude that the associations were heterogeneous across countries which were likely attributed to differing labour market institutions.

2.4 The Impact of Obesity on Earnings

2.4.1 Cross-Sectional Findings

There were eleven cross-sectional studies regarding the association between obesity and earnings. Three used American data that included hourly wage. Of these, all but one found a significant negative impact of obesity on wage rate for women. Four studies were conducted for European countries in which all but one found a significant interaction between obesity and earnings among women. The final four studies in this section differed from the others in that annual income was used as the outcome to represent earnings, as opposed to hourly wage rate.

Two studies utilized the National Longitudinal Survey of Youth (NLSY) from the United States. The first, from 1997, analyzed the relationships between obesity and earnings as depicted by a wage-obesity link (33). The Occupational Distribution Differences Index (ODDI) was used to predict occupation segregation and for women, it was found that obesity resulted in a significant labour market penalty. Using the ODDI, they found that obese women faced far greater occupational segregation than men (19.5% of obese women would have to change occupation to equalize the distributions compared to only 8.4% of men). For earnings, a log wage model yielded a significant, negative coefficient of -0.202 ($p<0.001$); meaning that obese women suffered a greater wage penalty compared to normal weight men. The second NLSY study was from 2009 and sought to estimate the effect of obesity on wages for American women in different types of occupations (34). Using OLS regression, the study found that compared to normal weight women obese and morbidly obese women suffered wage penalties of 11 and 25%, respectively. In regards to differences between occupations, it was found that obese women in sales or service positions suffered the greatest wage penalty. Although occupation type is not an objective of this study, it displays an interesting source of heterogeneity.

Cawley *et al*. also examined the effect of obesity on wage rate for immigrants who were in the U.S for less than a year and less than five years (15). Their OLS regression results showed that as BMI increased in women their wage rate fell, however the multivariable logistic regression model failed to find a statistically significant association.

Turning to the European studies, Lundborg and colleagues focused on the relationship between obesity and labour market outcomes for the working population over 50 years of age (16). This cross-sectional study used data from ten European nations grouped into northern, central and southern Europe to look at the effect of obesity on log hourly wage rate. Pooling all countries together, obese women were found to have earned 10% less than their non-obese counterparts and when including health status in the model, it fell by about 1%.

A Finnish study by Johannson *et al.* examined the relationship between obesity and log hourly wage rate using multiple body composition measurements such as weight, height, fat mass and waist circumference (19). Using an indicator variable for employment status, it was found that waist circumference had a negative association with wages for women but fat mass did not. Moreover, a 1 cm increase in waist circumference was associated with a 0.1% reduction in the wage rate.

Similarly, in 2007 Heineck estimated the relationship between weight and wage rate but failed to find a statistically significant association (18). As previously explained, fatness was depicted through total body fat (TBF), fat free mass (FFM), percentage of body fat (BF %) and adiposity. Overall, there were only a few differing results using BMI versus the other alternative measures of fatness. The threshold at which earnings decreased was estimated to be around a BMI of 26.6 or a BF% of 37.

A German study, by Caliendo and Lee, estimated the difference between obese, overweight and normal weight individuals in regards to their wages (5). As commonly found, the gap was much more significant for women than men. Obese women earned 0.102 less per log-hourly wage compared to their normal weight counterparts. This led the authors to theorize that uncontrollable discriminatory influences were the cause of the gap between the sexes, thus claiming that weight discrimination may be the “missing key”.

The next four studies utilized income as the outcome of interest. The first study by Haskins and Ransford explored the relationship between weight, income and occupational standing for American women (35). They hypothesized that overweight women would have lower career payoffs (income and position) with most consequences occurring in male-dominated or external contact positions. Although the sample size was very small (n=306), they found that weight was related to income, but only for entry-level positions in professional and managerial occupations ($\beta = -0.18$, $p<0.05$). However, in a model controlling for educational attainment, entry occupation, length of service and age variables, over 40% of the income variation was accounted for.

Barkin and others developed an economic model to investigate the consequence of obesity on aggregate lifetime earnings in the United States (36). The methodology was different from other studies in that an economic model to predict lifetime earnings was used. The predictive model yielded results showing that collectively, obese women earned on average $956 billion less than normal weight adults (compared to obese men who will earn on average $43 billion less). Overall, the empirical evidence showed that the consequences of obesity on earnings are far greater for women.

Sarlio-Lahteenkorva and colleagues conducted two studies in Finland regarding the impact of obesity on income. In 1999 they examined the relationship between BMI and disadvantage in income (20). By use of a cross-sectional survey and data linkage to the nations taxation register for both men and women, household and individual earnings were considered. Using multivariable logistic regression they found that the majority of disadvantages were more likely to be experienced by women. Moreover, obese women were associated with lower household and individual income (ORs 1.5-1.7), while overweight women were more likely to have low individual income (OR 1.2, 95% CI: 1.0-1.5). The second study, from 2004, focused on the impact of obesity on an array of socioeconomic status variables (37). Using an OLS regression model it was found that highly educated obese women earned approximately $5,000 less annually than their normal weight peers. The negative association was stronger for women in higher SES groups, such as upper class, white collar women.

In summary, the cross-sectional studies predicted a negative effect on wage rate and income with more disadvantages attributed to obese women. Like the association between weight and employment, there appeared to be a strong influence of health status on the overall associations. Only one cross-sectional study accounted for presence of unobserved heterogeneity bias in the association between obesity and earnings. Morris used individual-level data with pooled labour force survey data to investigate the impact of BMI on labour market success in England (38). More specifically, the study looked at the outcome of occupational attainment as expressed in terms of hourly wage rate. A unique feature of this study was the use of area-level mean BMI as an instrument. The results showed a negative effect of BMI in women -- a 10% increase in BMI resulted in a 0.4% decrease in mean wage rate. The model with the total effect showed that women with a BMI over 30 were paid, on average, 4% less than women with a BMI under 30, and it was statistically non-significant.

2.4.2 Longitudinal Findings

There was only one longitudinal study that did not account for unobserved heterogeneity bias in the analysis of the impact of obesity on earnings. A 1996 longitudinal study of men and women aged 23-31 explored income, marital status and hourly pay differences due to BMI (39). The results showed that marital status and spouse’s earnings accounted for 50-95% of female income variation. Obesity-wage interaction models yielded coefficients of -0.08 and -0.04 for 1981 and 1988, respectively. Moreover, women who were obese in both 1981 and 1988 had the largest disadvantage -- their wage rate being approximately 17% lower than women of normal weight. Also, women who became obese during the study had only slightly lower wages than women who were obese prior to the study.

There were fourteen studies that analyzed the impact of obesity on earnings using longitudinal data while accounting for unobserved heterogeneity bias in their empirical framework. This type of bias was typically addressed using fixed-effects regression models or fixed-effects regression models combined with an instrumental variables method of estimation. Nine of the following studies were conducted using United States data, primarily from the National Longitudinal Survey of Youth (NLSY) (6, 7, 31, 40-42). The remaining five studies were undertaken in Europe; three used multi-national datasets while the other two focused on Germany and Denmark.

Cawley conducted two studies regarding the association between weight and log-hourly wage (6, 7). Using an IV method (weight of a woman's offspring as an instrument) he found that if two otherwise identical women differed in weight by 10 lbs, we would expect the lighter woman to have 1% higher wages (6). In terms of standard deviations, a woman at the median weight would have an approximately 7% higher wage rate than a women at the 95th percentile for weight. The hypothesis of all races being equal was rejected as white women experienced greater penalties than Hispanic women, while Black women experienced the least amount of wage penalties. Interestingly, this study failed to find statistically significant results on the impact of obesity on employment but found significance in relation to wage. In his 2004 study, Cawley estimated the effect of weight on wages using various statistical methods used to account for unobserved heterogeneity bias (7). He included a genetic IV, lagged-BMI and a fixed-effects model. In addition, three measures of weight were used: BMI, weight (lbs) and indicator variables for BMI categories. Overall, weight was found to lower wages for white females in all three methods; a difference in weight of 2 standard deviations (approximately 64 lbs) was associated with a difference in wage by 9%, which he corresponded to 1.5 years of education or 3 years of work experience.

Another American study used the National Longitudinal Survey of Youth (NLSY) to examine the impact of obesity on wage by gender (40). It found that individuals with a BMI greater than 30 had significantly lower wages (6.1% lower for obese females compared to non-obese). A fixed-effects regression model showed that a BMI of 30 or higher decreased female wages by 5.8%. Similarly, a 2010 study of the U.S. population examined the relationship between body composition and hourly wage using a bioelectrical impedance analysis (BIA) as an alternative to

BMI (43). More specifically, the study used longitudinal data with BIA measurements in which body fat (BF) and fat-free mass (FFM) were measured separately as a two-compartment model. Results showed an association between BF and lower wage rates for both sexes and among Blacks and whites. The results showed that a 1 kg increase in BF reduced wages by approximately 1%. For women the effect of BF and FFM on wage were significant for both Blacks and whites, although less robust for Black females. Overall, there was a significant impact of body composition on wages in all models, including the fixed-effects regression. Furthermore, both studies showed that the association was significant after unobserved heterogeneity bias was accounted for.

Two studies by Han and colleagues used the NLSY longitudinal survey and fixed-effects regressions. The previously discussed study by Han and others looked at the effect of high BMI on wage penalties using fixed-effects regression models (31). A wage penalty was found to be present for obese women that increased with age; moreover, a 0.81% wage penalty was present and became more robust each year after age 31. More specifically, white and Black obese women had, on average, 7.5 and 4.9% lower log hourly wages compared to their non-obese counterparts. A wage penalty also existed for obese individuals in occupations requiring more social interactions and interpersonal skills (especially for women). A more recent 2011 study by Han *et al*. used fixed-effects regressions in addition to instrumenting sibling BMI to account for unobserved heterogeneity bias (42). Women who were obese in their teen years had 3.5% lower wages than their normal weight peers. In general, obese women had wage rates 8.6% lower than their normal weight peers. However, when analyzed using a fixed-effects regression the negative association lost statistical significance.

Another NLSY study conducted in 2012 analyzed the impact of BMI on wages (41). Using quantile regression as well as same-sex sibling BMI as an instrument, the authors claimed that both unobserved heterogeneity bias and endogeneity bias were accounted for. A significant negative relationship between BMI and wage was found with coefficients ranging from -0.005 to -0.007.

A 2012 study used the Add Health survey to assess the impact of weight on wage (44). The OLS and fixed-effects regressions both yielded negative and significant associations. For example, a 1 lb increase in body weight was associated with a 0.13-0.16% decrease in wage rate. In terms of

BMI scores, a 1-point increase in BMI resulted in a 0.8-1.0% decrease in hourly wage. All of these findings were for white females who had the most significant wage impact due to obesity. Also using the Add Health survey in addition to a subset of DNA sampling, Norton and Han estimated the effect of BMI on hourly wages for women using an IV technique (31). Their IV results showed no statistically significant effect for wages. However, the use of genetics and sibling BMI as IVs proved to be strong as they were predictive of the respondent's BMI.

Looking at similar studies conducted in Europe, Brunello and D'Hombres investigated the effect of body weight on wages using data from nine nations (Denmark, Belgium, Ireland, Italy, Greece, Spain, Portugal, Austria and Finland) (8). These nine countries were divided into two groups; the "olive-belt" which consisted of the southern European nations and the "beer-belt" which included the northern European nations. The nominal wages were converted into real wages using the purchasing power parity (PPP). Similar to studies by Cawley (6, 7), a family member's BMI was used as an instrument. Overall, the estimated effect of BMI on log-hourly wages was statistically significant and negative and a 10% increase in mean BMI reduced wages by 3.27% for women. This is in agreement with Cawley (6, 7) in that there was a negative and statistically significant effect for females. They found that the effect was much greater in the "olive-belt" suggesting that the local economic and social environments matter. In agreement with other studies on labour market outcomes, the inclusion of a health indicator made the overall effect smaller.

Greve analyzed the relationship between BMI and wages using a panel study over a fifteen year period (1995-2000) in Denmark (10). This was conducted using a probit fixed-effects regression model and an IV method to control for potential unobserved heterogeneity bias. The IV utilized was an indicator for an obesity-related prescription for the mother of the participant. This IV was found to be a strong predictor of obesity for women in the study. Greve found that the only significant association was for women working in the private sector and that there was a negative linear relationship between BMI and log-hourly wages. An increase in weight by 2 standard deviations from the mean resulted in a decrease in wage by 4.4%.

Akin to the studies by Baum and Ford (40) and Wada and Tekin (43), Bozoyon looked at the impact of BMI, and BIA measurements (FFM and BF) on wages (45). Using lagged-body composition measures and fixed-effects regressions the study assessed the impact of obesity in a German sample. There were no statistically significant effects of BMI on wage in the fixed-effects model, but in the pooled OLS models BF was negatively associated with female wages compared to male wages (coefficients ranged from -0.005 to -0.007).

Two studies used the ECHP survey on multiple European countries. The study by Atella and others analyzed the relationship between obesity and wages in the same nine European countries as Brunello and D'Hombres (46). They found that heterogeneity in the association between wage and obesity existed within and between countries and that for women the negative relationship was found to be much greater than for men. In addition, the use of instrumental variable for quantile regression (IVQR) showed a negative impact (-0.021 in the 85^{th} percentile). Irrefutably, the IV and IVQR methods displayed a significant negative relationship between obesity and wage for women, although the authors encouraged caution when interpreting the IV results.

Similarly, Garcia-Villar and Quintana-Domeque looked at the association between obesity and wages for the same nine European countries (47). Three different measures of body weight were looked at in relation to log-hourly wages. All of the models showed a far greater impact for female wages, with the greatest result being in Finland where the obesity-wage gap was found to be 10% greater compared to non-obese peers. However, after controlling for health status no statistically significant relationships between obesity and wages were found.

2.5 Overall Findings

After reviewing the literature regarding the association between obesity, labour market participation, and earnings (if employed) many consistencies were discovered as well as a few limitations resulting in some gaps in the literature.

Among the studies that assessed the impact of obesity on employment without accounting for the omitted variable bias, four of the six longitudinal studies were statistically significant while all ten of the cross-sectional studies found a negative relationship. For the studies that considered the potential biases due to unobserved heterogeneity, four out of the eight longitudinal studies were significant while both of the cross-sectional studies found a significant negative association. Moreover, cross-sectional studies were more often significant as well as studies that did not consider the potential influence of unobserved heterogeneity bias.

For earnings, the single longitudinal study that did not consider the presence of unobserved heterogeneity bias had a negative association with obesity. Among the cross-sectional studies all but one of the eleven studies found a significant and negative association between weight and earnings (wage rate or income). Among the studies that accounted for unobserved heterogeneity nine of the fourteen longitudinal analyses were statistically significant while the one cross-sectional study also yielded significant results. Overall, cross-sectional studies without consideration of unobserved heterogeneity bias were more often significant which highlights the possible influence of omitted variables bias.

Although cross-sectional findings from the literature suggested a negative effect of obesity on labour maket outcomes in female populations, studies that accounted for unobserved heterogeneity bias did not always produce an unambiguous negative effect. Thus, more evidence is needed to better understand the associations between body weight and labour market participation and earnings, especially in the Canadian context. This was further exemplified by the inconsistencies in theoretical and methodological consideration of unobserved heterogeneity bias. From the conceptual framework, to the analysis and discussion, the differences in findings and conclusions when accounting for unobserved factors highlights the need for consideration of unobserved heterogeneity bias in future studies. Likewise, failure to account for unobserved heterogeneity bias may result in spurious associations. Numerous studies showed that failure to account for the omitted variable bias can lead to poor estimation of the negative effect that obesity has on labour market outcomes, especially for women.

A second finding that was commonly encountered in the relationship between obesity and the labour market was the effect of health status on the associations. As seen frequently in associations between obesity and employment or earnings, inclusion of health and lifestyle related variables substantially changed the size of the effect. More specifically, when an indicator of poor health status was included, the overall effect between obesity and labour market success was in most cases weakened and in some instances caused the association to lose statistical significance. This showed that health status was likely confounding the associations and needs to be accounted for in future research.

Some common covariates in the literature review included: age, household income, income and education to account for socioeconomic status (SES), marital status, occupation type, health indicators (including overall health, disability, or chronic conditions), mental health status, education, immigrant status, smoking status, alcohol intake, physical activity levels, area-level indicators (such as mean BMI and population density), and the presence of children in the household. These covariates can be found in Appendix A.

2.6 Gaps in the Literature

After reviewing the relevant research there was four main gaps in the literature to be considered. The first was the lack of research done from a Canadian perspective as there were only two cross-sectional studies, Klarenbach *et al*. (14) and Naimi *et al*. (13), of relevance to this topic. Moreover, there were no Canadian studies that utilized longitudinal data. Similarly, the second gap was the limited number of studies that focused solely at the association for women. During the literature search, it was apparent that many studies have focused on the effect of obesity on labour market outcomes for men. There were also various studies that compared men and women, many of which were discussed in this literature review. Rarely did studies focus solely on women and compare the impact of obesity on labour market outcomes among women.

The third gap in the literature involved the inconsistencies of acknowledging and accounting for unobserved heterogeneity bias or omitted variable bias. Moreover, the presence of unobserved individual heterogeneity in the data is highly likely and can bias the findings and in turn conceal the true effect. In particular, the existing Canadian studies did not account for unobserved heterogeneity bias. Accounting for unobserved heterogeneity bias in the association needs to be considered to gain a better understanding of the association between obesity and the labour market participation. The fourth gap that became apparent after reviewing the literature was the influence of health status on the associations and the lack of control for health indicators in many of the studies. As discussed, the health effect, when acknowledged, was influential and in some cases caused the associations to lose significance. Moreover, by failing to account for the effect of poor health, the estimated effects might have been overestimated in some studies. This suggested that health status can act as a confounder between obesity and labour market outcomes and must be accounted for in all analyses.

The next chapter, Methods, will discuss the conceptual framework, justification of models, the dataset, and statistical analysis. The analytical framework and corresponding methods will be an extension of the objectives and hypotheses laid out in Chapter 1 and links to some of the gaps presented in Chapter 2.

Chapter 3

3 Methods

The Methods chapter will begin by reviewing the conceptual framework used to explore the two objectives and guide analyses. The first section (3.1) includes an overview of the conceptual models, a discussion of variables used in the empirical analysis and a justification of why they were considered as potential confounding variables. All variables, including the primary exposure and outcomes, will be visually conceptualized using Directed Acyclic Graph's (DAG). Section 3.2 will discuss the explanatory and outcome variables further in terms of how they were asked in the NPHS household component questionnaire, any derivations, and how they were categorized for analysis. The Methods chapter will conclude by explaining the statistical methods utilized to assess the impact of obesity on employment participation, wage and income. The statistical techniques will be explained in terms of how they accounted for potential biases such as confounding within each of the models and how they assisted in fulfilling the two objectives, and to test if the associations persist after accounting for the confounding effect of the potential unobserved heterogeneity.

3.1 Conceptual Framework

The theoretical framework consisted of three distinct models used to examine the associations between the exposure, outcomes and potential confounders.

The first model controlled for common confounding variables, such as demographics and socioeconomic status (SES) expressed by education and home ownership, as considered in existing epidemiological literature. The classical criterion was used to determine the existence of a confounding variable: a confounder existed if the variable was associated with the exposure and causally associated with the outcome, although not an intermediary variable (a result of the exposure) (48). Moreover, using the classical criterion to decide if a variable is a confounder is based on the *a priori* criteria. The second model extended Model 1 by controlling for health and lifestyle-related covariates which had the potential to confound the association between obesity and labour market participation as identified in the literature review. Because current health and lifestyle variables have the potential to be influenced by the exposure and/or outcomes, lagged health and lifestyle variables were included in Model 2. The final model, Model 3, elaborated Model 2 by considering the potential influence of unobserved heterogeneity bias by adding group means of the time-varying explanatory variables, known as the Mundlak correction in the literature (49, 50).

Outcome Variables

Labour Market Participation: The first outcome, labour market participation, was used to depict the overall impact of obesity on a woman's participation in the labour market. Labour market participation is a broad determinant of employment or labour market activity. The outcome variable was dichotomized as "employed" versus "unemployed or not in labour force". This is defined by whether the participant worked or participated in the labour market at all in the past 12 months compared to non-participation as expressed through unemployment or not being in the labour force.

Wage rate: The second outcome variable, hourly real wage rate, took the outcome of labour market participation one step further and measured the success of a women if she was employed full-time. This was important as it enabled us to look at the heterogeneity within the labour market participation as expressed by log-hourly real wage rate conditional on full-time employment.

Income: The third outcome variable, income, was an extension of wage as it explored the same hypothesis but with a slightly different indicator of earnings. By assessing the impact of obesity on annual personal income the effect on overall earnings from full and part-time employment was estimated.

Exposure Variable

As explained by the WHO, overweight and obesity are due to an excessive amount of fat accumulation (51). However, a common empirical measurement of overweight and obesity is the Body Mass Index (BMI), defined as an individual's weight in kilograms (kg) divided by the square of his/her height in meters (m), denoted as: (kg/m^2). Moreover, the WHO specifies that a BMI greater than or equal to 25 is overweight and a BMI greater than or equal to 30 is obese (2).

The exposure variable of interest in this study is obesity as defined by a BMI greater than 30; dichotomized in analysis as obese versus normal weight and overweight (a BMI less than 30).

3.1.1 Model 1

In Model 1 (Fig 3.1) the exposure and outcome variables as well as the potential confounding variables are displayed. A confounding variable in this case referred to variables that had a plausible influence on both the exposure and outcomes, but could not be influenced by obesity or labour market participation. The following socioeconomic status (SES) and demographic confounders were obtained through a literature review on this topic and included in the model: age, children, immigration, rural/urban residence, marital status, spousal income, home ownership, and education (Appendix A). Fig 3.1 also expresses the influence of time on outcome variables.

Demographic Confounders

Age can affect both obesity and employment participation and was therefore deemed as a potential confounder. In terms of the classical criterion it was not plausible for age to be affected by obesity or employment status. For the outcome variables, the probability of participation in the labour market has been found to decrease with age and it has been hypothesized by some to be a result of age discrimination by employers (52, 53). Hypothetically, age could be attributed to weight gain through changes in lifestyle as well as physiological changes. The literature showed that BMI has been found to naturally increase with age for women in their post-menopausal years (1). Numerous studies have found that BMI increases with age up to a certain point then decreases (due to biological mechanisms) (54-60). Thus, suggesting the direction of the age effect reversing at a certain point. This has been attributed to an increase in fat mass which is attenuated by age in women, specifically an increase in visceral fat (61, 62).

Children, defined as whether or not a woman had children aged 5 years or less, was also considered as a potential confounding variable using the classical criterion. It is likely that having children places pressure on the mother to stay at home more often thus limiting her ability to participate in the labour market. In regards to obesity, mothers likely have less time to focus on their own healthy eating and active living, consequently resulting in weight gain. Presence of children in the household has been found to affect employment participation by decreasing the amount of hours a mother works or eliminating work entirely (63). Moreover, women who had many children and/or had children early in life were more likely to experience unemployment and chronic unemployment (55). It has also been found that mothers, especially those that were not married, experienced an overall decrease in earnings due to a decrease in labour market participation (64). The presence of children in the household was highly correlated with an increase in adipose tissue, and in turn a higher BMI (65).This is likely due to behavioural aspects that are less focused on when caring for children, such as lower levels of physical activity. Excess weight gain during pregnancies has also been found to increase the risk of obesity a decade later (65, 66). Furthermore, postpartum weight retention was negatively correlated with physical activity in mothers, especially among those with younger children (67, 68). Moreover, the presence of children under the age of five was included because they are not yet eligible for school and therefore require more care from their family or in the majority of cases, their mother.

Immigration had a confounding effect on the association between BMI and employment participation. In terms of labour market participation, immigrants were likely to have more difficulty obtaining a job due to language or culture barriers or fewer connections in the Canadian labour market. Independent of education, the labour market participation of immigrants in Canada has been decreasing and unemployment is more prevalent (69, 70). In numerous cases this was attributed to the barriers of English language acquisition (71, 72). Studies have also found that characteristics associated with one's home country are determinants of labour market participation in their country of immigration (73, 74). A British study found that white members of the population suffered less disadvantage in their employability than individuals of other ethnicities such as Africans, Carribeans, and Pakistanis (75). Labour market integration barriers for ethnic minorities were also found in a broad European study (76). These studies can be considered relevant to the situation in Canada as immigrants to Canada comprise diverse ethnic groups seeking labour market participation.

In addition, it was hypothesized that immigrants were less likely to gain weight due to the "healthy immigrant effect," meaning that recent immigration was protective for unhealthy weight gain but the effect decreased over time (77). Moreover, the effect was found to subside as immigrants began to adopt Canadian eating habits or a more sedentary lifestyle (known as the acculturation process) that is associated with developed countries (78). On average, immigrants had lower BMI scores than their Canadian-born counterparts (58, 79), and even more so for recent immigrants (78, 80). The literature has found that some ethnicities have a higher likelihood of experiencing obesity (81, 82). For example, an American study found that country of birth was associated with abdominal obesity; the greatest effect being found in the Mexican-born group (83). Longitudinal studies of immigration to North America found that unhealthy weight gain was associated with migration and this became more evident with an increase in years since immigration (77, 78, 84).

Rural/Urban Residence was the final potential demographic confounder. It was theorized that rural living had less employment prospects than urban dwelling. For Canadian women, rural labour markets were associated with lower participation rates compared to urban labour markets (85, 86). On the other hand, it was plausible that urban living was associated with more sedentary lifestyles and poor eating habits (87), as shown in studies in which living in an urban area was found to be associated with an increase in BMI (56, 58). This could have been attributed to an increase in access to and consumption of unhealthy foods (e.g., fast-foods) or sedentary jobs (87).

Socioeconomic Confounders

Marital Status was an important variable to be considered as it could act as a proxy for financial support for women. Marital status was hypothesized to affect body weight as well as labour market participation, therefore through the classical criterion it was considered to be a potential confounder. In terms of marital status as a determinant of employment participation, being married was found to reduce the probability of employment for young women (88). Although attitudes around gender roles have lessened in the last couple of decades, the idea of being a homemaker still existed and therefore decreased female participation in the labour market (89). It was also hypothesized that marital status had a bidirectional relationship with obesity in that married couples were more likely to gain weight. Alternatively, women who were obese were less likely to find a partner due to discrimination. Other studies found that marital status was a significant predictor of obesity as BMI was generally higher among married individuals compared to unmarried, widowed, divorced and separated individuals (55, 58, 90). Similarly, changes in marital status, particularly women becoming married during survey follow up, have shown a higher likelihood of gaining weight (91). On the other hand, research found that obese women were less likely to cohabitate with a partner and/or enter into marriage (92, 93).

Spousal Income was another socioeconomic variable, similar to marital status, which had the potential to confound the association. Household income was commonly controlled for in studies considering SES; however, in this study a derived variable of spousal income was created by subtracting personal income from household income. This new variable was used to control for access to non-wage income in the household. In many cases this was likely representative of financial support from a spouse or partner. A high level of non-wage financial support from a spouse was likely to cause a woman not to participate in the workforce as it was not financially necessary. Looking at the literature, it has been found that women with a higher household income are less likely to participate in the labour market or tend to participate at a lesser intensity (94). Similarly, analyses of household financial wealth through spousal income found that there was a negative impact on the probability of women being employed (95). On the other hand, metabolic syndrome as expressed through weight gain was found to be inversely related to the household income of a woman (96). Likewise, Canadian studies found that low household income was related to a high BMI in women (57, 97). In addition, spousal income or a lack thereof was influential on eating habits and the ability to afford a healthy lifestyle (98).

Home Ownership, another potential confounder, was related to permanent income and has been commonly used as a proxy for wealth or SES. It was assumed that home ownership was likely to be associated with higher employment participation. In addition, home ownership, as a representation of wealth was likely to be negatively correlated with obesity, just as a high SES was likely to result in healthier lifestyles and in turn a healthy weight. In numerous studies home ownership was found to be positively correlated with labour market participation (99-101). Moreover, studies found that obesity levels were higher for women that claimed not to own their home (102, 103). Home ownership was included as a potential confounder as it assisted in controlling for the effects of SES on employment and earnings.

Education is a commonly used proxy for SES and was hypothesized to have a potential confounding effect on the relationship between obesity and labour market participation or earnings. Hypothetically, having a higher education may encourage a healthier lifestyle through better understanding of nutrition and physical activity thus resulting in a healthy BMI. In addition, it was likely that completion of higher education directly resulted in labour market participation. For women, many studies have found an association between low SES and obesity (104, 105), as well as an association between SES and long-term employment status when education was used as a proxy for SES (105). Existing literature showed that education was directly related to labour market participation in that higher levels of education were found to increase the probability of employment and increase earnings (106, 107). On the other hand, low levels of education have been found to increase the likelihood of obesity, in that the more education a women obtained, the healthier she was, and the less likely she was to gain an unhealthy amount of weight (108, 109). Education was an important control variable in this study as women were greatly influenced by low SES in terms of unemployment, chronic unemployment, and earnings; this was especially true for single mothers (105).

3.1.2 Model 2

In addition to the variables in Model 1, Model 2 (Figure 3.2) included variables that plausibly influenced the exposure and outcome but also may be caused by them: a bidirectional association. In the majority of bidirectional cases, obesity had the potential to produce a feedback effect on the health-related behavioural variables. For example, poor health had the potential to cause unemployment through disability or discrimination while unemployment could have indirectly led to less than ideal health through economic losses. This caused the direction of association between the exposure and explanatory health and lifestyle variables to be bidirectional.

Accounting for several bidirectional associations was not feasible and therefore the associations required adjustment to plausible one direction paths. Fortunately, the availability of longitudinal data made it possible to utilize lagged health and lifestyle variables as confounders. The relationship between the exposure, outcome and bidirectional covariates is depicted in Figure 3.2.

3.1.2.1 Lagged Lifestyle and Health Variables

As discussed, reverse causation, or bi-directionality between an explanatory variable and the outcome of interest was an important consideration when developing the models and conducting analysis. Health and lifestyle variables in Model 2 had the potential of being affected by obesity while simultaneously influencing it. A simple way to control for these types of variables was through the use of lagged-variables which are variables from an earlier point in time (110, 111). Commonly, lagging explanatory variables by one or two time periods was used to control for potential simultaneity bias as it accounted for the timing of an association. By using longitudinal data, it was possible to lag the health indicators and lifestyle variables at risk of reverse causality which ensured that they fit the unidirectional assumptions under the classical confounding criteria.

Numerous studies utilized lagged health-related variables such as the presence of chronic illness or self-reported health from one or two years prior to deal with the bidirectional association (112-120). Lifestyle behaviours such as smoking and alcohol consumption have also been lagged in analyses to minimize the impact of a potential bidirectional association with obesity (118, 120). The majority of previous research yielded different results when comparing models with and without lagged variables suggesting that feedback or simultaneity effect may have been present in the data.

Health and Lifestyle Confounders

The following health indicators and lifestyle variables all had a potential bidirectional influence on the association. Furthermore, they were likely to confound the association between obesity and labour market participation or earnings in women while also being susceptible to the influence of obesity.

Smoking was considered to be a confounding lifestyle variable. Not only was it plausible that smokers faced discrimination when seeking employment, it was also likely that smoking caused weight loss through physiological occurrences. On the other hand, individuals with obesity may have initiated smoking as a means of weight loss. This behavioural association caused smoking to be bi-directionally associated with obesity. In regards to employment participation for women, heavy tobacco consumption was found to be associated with unemployment (26, 121, 122). This is likely a result of discrimination from employers or the indirect effects of smoking on health. Research has indicated that smoking is associated with a decrease in BMI (58, 79, 123). This was attributed to the physiological effects of nicotine that cause a reduced appetite and an increased energy expenditure thus resulting in weight loss or difficulty gaining weight (124). These physiological processes diminished when nicotine intake ended and in turn former smokers have been found to have an increase in BMI (79). In addition, smoking has frequently been sought by women as a means of weight loss (125).

Alcohol Consumption was another lifestyle variable controlled for as a potential confounder. Considering the effect of alcohol consumption on obesity, employment, and earnings, it was assumed that alcohol consumption was a plausible source of weight gain and that heavy alcohol consumption could have caused stereotyping and discrimination; this likely resulted in barriers to obtaining or sustaining employment. It was also plausible that alcohol consumption was influenced by obesity or loss of employment through substance use behaviors associated with depression. Alcohol intake did have an influence on labour market participation; studies have shown that a high consumption of alcohol is associated with lower rates of employment (122, 126, 127). It was hypothesized that this was due to discrimination from employers as they perceived heavy drinking as an undesirable character trait and if drinking interfered with work, it could lead to less productive workdays or in some cases workplace accidents. On the other hand, studies have found an association between a high BMI and heavy alcohol consumption (128-131). However, moderate alcohol use at one or two drinks per day had lower odds of weight gain (129).

Health Status (self-reported) was included in the analysis as the literature review commonly found it to confound the association between obesity and labour market participation. Intuitively, poor health was likely to be associated with drastic weight changes and in turn inopportune health was likely to cause little or no labour market participation. Similarly, it was hypothesized that being obese was linked to poor self-rated health status through discomfort or other obesity-related ailments. Studies found that for women, low employment participation was related to low health-related quality of life scores (132, 133). In addition, lower health-related quality of life scores were associated with having a higher BMI score (134-136). In some studies, inclusion of a health status indicator changed the magnitude of the association or the statistical significance disappeared completely, which suggested that health status needed to be controlled for in analyses.

Chronic Illness or co-morbidities (such as asthma, allergies, and back pain) were related to both variables of interest, as some chronic conditions may have led to obesity, while others may have resulted in unemployment (or even chronic unemployment). Akin to health status, chronic illness was assumed to have a bidirectional relationship with obesity in that they could have been causal of one another. It was also similar to health status in that the effect could have changed the magnitude of the association if not properly controlled for. Chronic illness such as diabetes has been linked to poor labour market participation and a risk of job loss in the literature (137-140). As explained by the WHO, obesity was linked to an array of chronic illnesses and co-morbidities (51). This was further discussed in recent Centers for Disease Control and Prevention (CDC) surveillance information as they found obesity to be caused by various co-morbidities (108). Overall, the presence of chronic illness had the potential to confound the association and in turn was controlled for in Model 2.

Health Utility Index (HUI) was included as a potential confounding variable as it had the potential to influence obesity and labour market participation while also being influenced by obesity. The HUI represented the quality of a person's vision, hearing, speech, mobility, dexterity, cognitive function, feelings and pain (141). The HUI is a commonly used indicator in studies to determine overall physical and mental health or well-being. It was postulated that a low HUI score could negatively influence BMI and labour market participation or success. It was also highly plausible that obesity influenced HUI scores. The confounding effect of health-utility was very similar to that of health status and the presence of chronic illness. It once again suggests the bidirectional association that obesity and poor health have. Previous studies that included health utility found that obese individuals were likely to have lower HUI scores than their normal weight counterparts (90, 142-144). As discussed within the justification of health status and chronic illness, physical health can be immensely influential on BMI and labour market outcomes. A major strength of the HUI was its consideration of mental health aspects in the derivation of the utility score; such as depression.

Moreover, numerous studies have found that depression and anti-depressant drug use have a negative impact on labour market participation and earnings (145, 146) and that the probability of unemployment was higher for those suffering from depression (147). In terms of bi-directionality, job loss has been attributed to the development of depression (148). Considering the relationship of obesity and depression, the literature has acknowledged that there is a bidirectional relationship (149-152). Moreover, studies assessing the effect of anti-depressants on body weight found that drugs such as amitriptyline, mirtazapine, and paroxetine increased one's risk of weight gain (153-155). In regards to obesity causing depression; the association was strong, especially for women (156, 157) and morbidly obese women (149). Furthermore, mood and anxiety disorders in general were found to have a strong effect on obesity (158). As the NPHS did not have an indicator for depression, HUI was a useful variable capturing overall health status, including mental health status.

3.1.3 Model 3

The final model, as depicted in Figure 3.3, focused on the potential influence of unobserved heterogeneity. Unobserved heterogeneity bias refers to unobservable individual factors that could influence obesity and lower labour market participation or earnings (30). An in-depth conceptual rationale and corresponding justification to deal with this potential bias was imperative before moving on to model specification and statistical analysis.

Model 3 acknowledged the potential presence of time-invariant unobserved heterogeneity bias. As illustrated in Figure 3.3, Ψ represented the presence of unobserved heterogeneity while 'e' signified the error term. These were important additions to Model 3 as when Ψ was equal to zero unobserved heterogeneity bias was not of concern. On the other hand, if Ψ was not equal to zero there was a correlation between the omitted variables and the error term suggesting the presence of unobserved heterogeneity bias. An example could be an unobserved personality trait that affected employability such as a negative influence from undesirable personality traits or a positive influence such as high motivation. These potential unobserved influences could have biased the hypothesized causal pathway of obesity to labour market participation and/or earnings, and in turn justified the need for Model 3 to successfully explore the second objective.

3.1.3.1 Unobserved Heterogeneity

When omitted from the model, the unobserved individual heterogeneity between subjects had the potential to confound the association between obesity and employment participation or earnings.

There are many potential sources of unobserved heterogeneity and are commonly categorized as either genetic or non-genetic.

Numerous studies on the association between obesity and employment participation or earnings acknowledged time-invariant genetics as a potential source of unobserved heterogeneity (7, 11, 46, 159). Other studies acknowledged the presence of non-genetic sources of unobserved heterogeneity such as a high discount rate (6, 9, 12, 16, 22, 32, 47). A high discount rate refers to the idea that a person may hold little value to future health and as a result invest little in human capital to better his/her employment success, or they may see health as being low priority and engage in an unhealthy lifestyle. Health related issues such as chronic injuries have also been labeled as potential sources of the omitted variable bias in some studies (31, 159, 160); however, Model 2 controlled for chronic illness. Other sources of unobserved heterogeneity considered in the literature included: ability and motivation (8, 40, 46) as well as parental background, traditions, and family culture (10, 46). A wide range of personality traits that can determine obesity or labour market participation have been labeled as potential sources of heterogeneity (8, 10, 26, 30, 40); positive characteristics that cause one to easily obtain employment even if obese (such as perseverance) or negative characteristics such as a lack of self-control that may result in obesity. Another less acknowledged source of omitted variable bias is unreported earning endowment factors as mentioned by Han *et al*. (31).

Unobserved heterogeneity, as acknowledged in the study objectives, was a primary concern in the statistical analysis in order to identify the relationship between obesity, labour market participation, and earnings. If the unobserved heterogeneity and the resulting omitted variable bias were not accounted for then obesity, employment participation or earnings could have been correlated with the error term and resulted in a biased estimate of the association.

3.1.4 Summary

The impact of obesity on employment and if employed, earnings was the main focus of the hypothesis and objectives; however it could only be considered causal if individual unobserved heterogeneity bias was adequately controlled for. By conducting analyses separately for each model the difference between Model 1 and Model 2 could be detected to assess the effect of health and lifestyle-related variables. In addition, Model 3 was utilized to explore the influence of unobserved heterogeneity bias to see if there was a significant effect and if so, the magnitude. Moving forward, the data source, sampling methods and construction of variables will be discussed to explain how the three models were used to illustrate the association between obesity and labour market outcomes for Canadian women.

3.2 Data and Variable Construction

3.2.1 Data Source

The National Population Health Survey (NPHS)

The research objectives were addressed using twelve years (2000/01 – 2010/11) of longitudinal data from the Canadian National Population Health Survey to explain the relationship between obesity and labour market participation among Canadian women. The NPHS was a national, longitudinal survey conducted by Statistics Canada (141). The Household component started in 1994/1995 and was conducted every two years (141). The first three cycles (1994/1995, 1996/1997 and 1998/1999) were both cross-sectional and longitudinal and beginning in cycle 4 (2000/2001) the survey became strictly longitudinal (141). A key strength of the NPHS was the inclusion of questions regarding an array of socioeconomic and health variables asked to the respondents every two years. For the purpose of this study the NPHS was ideal in that it encompassed longitudinal information regarding labour market participation, earnings, and BMI.

This study utilized data collected from 2000/01 to 2010/11 to prospectively explore both objectives over the course of twelve years, or more specifically the changes over the last six NPHS cycles. The first three cycles were not of primary interest due to the lack of detailed information on labour market participation. Moreover, the labour market questions changed substantially from cycle 4 onwards. Using the existing dataset, an array of questions was utilized for both the exposure and outcome variables as well as the confounding covariates discussed in the conceptual framework. Opportunely, the NPHS asked near identical questions in the last six cycles which allowed for analysis of changes over time.

The confidential micro data (the master file) was used, which contained un-suppressed data that were not available in the public use NPHS micro data files (141). This allowed for use of survey responses to labour market participation, income, and wage rate. These in-depth confidential

NPHS micro data files were accessed through Statistics Canada’s Research Data Center at the University of Western Ontario.

Longitudinal Nature

A primary strength and, in turn, rationale for using NPHS data was its longitudinal nature. Having access to consistent data from the same respondents over time allowed for simple trend analysis and more complex analyses that explored associations over time with the consideration of deriving causal conclusions. Moreover, the longitudinal survey enabled the use of panel data statistical techniques such as random- and fixed-effects regression models. By using panel data, I was able to control for not only time-invariant influences, but an array of time-varying effects on the outcomes of interest. This resulted in much better insights into the resulting association than those obtained from cross-sectional studies.

Sampling Design

In terms of sampling, the NPHS utilized a technique created by the Labour Force Survey (LFS) (141). Moreover, the NPHS employed a stratified two-stage sample design for all provinces except for Quebec which used Santé Québec's sampling strategy (141). It started by stratifying the provinces according to urban cities, urban towns, and rural areas. The next step used Census Enumeration Areas (EAs) to select six clusters within the strata to represent varying socioeconomic statuses (141). Lastly, random sampling through probability proportional to size (PPS) was utilized within the strata to select the dwellings for interviews (141). From each dwelling, one representative respondent was selected for both the individual-level and household-level components (141).

The NPHS used trained interviewers to administer the survey with support from a computer assisted interview (CAI) (141). CAIs aided in efficiency by skipping irrelevant questions and by keeping the survey as controlled as possible for interviewer-bias (141). The data were collected in four quarters: starting in May, July, September and January (143). In addition, there was a follow-up period that began in April of the second year for non-respondents (143).

3.2.2 Study Population

The objectives of this study required a target population of Canadian women aged 18-65 living in private dwellings in one of the ten provinces. At baseline, the age category of 18-53 years was selected to allow for changes in labour market participation over time without a large proportion entering into retirement. The NPHS sampling frame excluded those living in the Territories, Indian reserves, Crown lands or institutions; full-time members of the Canadian Armed Forces; and persons living in remote regions (141). Due to the complex, multi-stage survey design used for the NPHS, sample weights had to be applied in all analyses to ensure that the results were representative of the respective Canadian female population in 1994/95. The NPHS longitudinal sample consisted of respondents who had completed the general component of the questionnaire at baseline which resulted in 17,276 persons in 1994/95. After the application of inclusion and exclusion criteria, the sample size in 2000/01 available for this study was 3,746, which was based on women ages 18-53.

3.2.3 Variable Construction

This section discusses variable construction. It will review the nature of the variables in the NPHS (141) and then how they were used for analysis.

Obesity (BMI): The NPHS derived BMI by calculating weight in kilograms divided by the square of height in meters, excluding pregnant women. Height and weight were originally asked in separate questions; the height question asked how tall the respondent was without shoes on and the weight variables asked the respondent how much they weighed. The interviewer then confirmed whether the response was in pounds or kilograms. As discussed in the variable justification in section 3.1, BMI was categorized into obese versus overweight and normal weight for the purpose of this study. Moreover a BMI greater than 30 was obese and a BMI greater than 18.4 and less than 30.0 was overweight or normal. In some cases, as will be discussed in section 3.3, a lagged indicator of obesity was used for analysis. As BMI is commonly influenced by measurement bias, a corrected version for women was utilized in the analysis (161):

$$BMI_{(measured)} = -0.12 + 1.05(BMI_{self\text{-}reported})$$

Labour Market Participation: In the labour force section of the survey, the question used to indicate the respondent's labour market participation asked the respondent if they had worked in the past twelve months and then categorized the responses as "employed", "unemployed" or "not in the labour force". For analysis, the variable was dichotomized as "participation" versus "non-participation", which combined unemployed and not in the labour force.

Income: Both income and wage rate were used to depict earnings. Income construction will be explained first as wage rate was derived from income. When referring to income as an outcome, it was the best estimate of the participant's annual personal income (reported continuously). Due to the personal nature of income questions, some responses did not respond to actual income but responded to income category questions. For the missing income responses, personal income was estimated based on what category their income was reported in (if actual income was missing but income category was answered). Based on the income bracket of participants with missing personal incomes, a random estimate of their personal income was obtained within the income category. After the estimated personal incomes were used to replace the missing responses, all income was adjusted to reflect inflation using the Consumer Price Index (CPI). The CPI was used to represent the cost of living given the year and province of residence (2002 as the reference year) (162). For analysis, personal income was only included if they had participated in the labour market and their main source of income was from wages or salaries. This was referred to as "real income" (i.e., inflation-adjusted income) and income from family or investments or other sources were excluded. Finally, the natural logarithm of income was used to account for the skewed nature of income variable.

Wage Rate: The hourly wage rate of women was used as another representation of earnings. As mentioned, it was derived from personal income due to the unavailability of directly reported wage rate. The variables used to derive wage rate included: real income as described above, work hours and full-time versus part-time employment status. First, hours worked was asked in terms of total hours worked per week. As a precaution, if they were unemployed or not in the labour force, their hours worked variable was set to zero to account for reporting errors. In addition, hours worked responses over 70 were excluded due to implausibility. Wage rate was then calculated using real income as the numerator and total work hours per week multiplied by 52 as the denominator (i.e., income/(total work hours × 52). This was done to reflect estimated annual total hours worked. As there would be substantial differences in wage rate between full-time and part-time workers given the multiplication by 52, only full-time employees were included in the wage rate outcome. Like income, the natural logarithmic of wage rate was utilized in the analysis to account for the skewed nature of the wage rate variable. This resulted in the outcome being the log of hourly wage rate of employed, full-time women.

Age: Age was determined by date of birth (day, month and year) and then confirmed with the respondent. In this study, age was excluded if they were under 18 years of age and over 53 years of age (at baseline).This was to allow for aging over the study period without exceeding 65 (being the typical age of retirement). Age was constructed as a continuous variable. Age squared was also included to account for its potential non-linear effect of age through a quadratic relationship (the effect could increase with age up to a certain point and then decrease).

Children: The presence of children five years old or younger in the household was determined in the survey and was recorded as how many children five or under were present during the interview. For analysis, three categories were created from the continuous variable: no children (reference group), one child five or younger, and two or more children five or younger.

Immigration: Immigrant status of the respondent was asked in the survey. This was a time-invariant question taken at the baseline which was categorized as “non-immigrant” or born in Canada (reference group), versus “immigrant” or not born in Canada.

Rural/Urban Residence: Rural or urban dwelling was determined by the Census GeoSuite which used census subdivisions and the corresponding population size to determine which population category the respondent resided in. From the categorized population densities, three groups were created: rural (less than 30,000) (reference group), urban 1 (30,000 to 500,000) and urban 2 (500,000 or more).

Marital Status: The NPHS asked if the respondents marital status was: “married”, “living with partner/common-law”, “widowed”, “separated”, “divorced” or “single, never married”. “Widowed”, “separated”, and “divorced” were combined as well as “married” and “living with partner/common-law” for ease of analysis and the reference group was “single”.

Spousal Income: Spousal (or non-wage) income was a variable created using several labour force questions. The inflation-adjusted personal income estimate and the best estimate of real household income were used to create the spousal income variable. Spousal income was derived by subtracting the estimated real personal income from the real household income in each NPHS cycle. The derived continuous income estimate was then sorted into income groups: “less than $30,000” (reference group), “$30,000 to $50,000”, “$50,000 to $80,000”, “$80,000-$100,000” , “$100,000 or more”, and “missing”. Non-wage income was categorized to allow for comparison of spousal income categories to the reference group of low non-wage income.

Home Ownership: The NPHS asked respondents whether or not a person in the household owned the dwelling; this was then dichotomized into home ownership versus not (reference group).

Education: In the education module of the survey, level of personal education was asked to all respondents. The NPHS derived education variable was available in four categories: “less than secondary school graduation” (reference group), “secondary school graduation”, “some post-secondary”, and “post-secondary graduate”.

Health Utility Index (HUI): The HUI was taken directly from the NPHS data which derived the scores from questions that evaluated the quality of a person’s vision, hearing, speech, mobility, dexterity, cognitive function, feelings, and pain (141). The combination of questions resulted in a score from -0.360 to 1, with 1 being the highest possible health utility score (perfect health). The resulting variable was useful for representing overall health (both physical and mental) and was kept continuous in analyses.

Health Status: In the general health section, the first question asked whether the individual’s health in general was: “excellent” (reference group), “very good”, “good”, “fair” or “poor”. For sufficient sample size, four groups were created by combining “fair” and “poor” into one category.

Chronic Conditions: In the chronic conditions module, multiple questions were asked in regards to chronic illness. The following chronic conditions were utilized by the NPHS to detect presence of at least one chronic illness in the population: allergies, asthma, fibromyalgia, arthritis or rheumatism, back problems, high blood pressure, migraine headaches, chronic bronchitis or emphysema, diabetes, epilepsy, heart disease, cancer, intestinal or stomach ulcers, effects of a stroke, urinary incontinence, bowel disorder, Alzheimer's disease or dementia, cataracts, glaucoma, thyroid condition and any other long-term condition. If a respondent reported any of the listed chronic conditions they were indicated as having a chronic illness. This derived variable was used to account for the presence of an indicator of chronic illness with the reference group being no chronic illness.

Smoking: Smoking status was determined using the derived smoking variable from the NPHS. The derived variable was based on whether the respondent smoked "daily", "occasionally", or "never" (reference group). "Daily" referred to 1 or more cigarettes per day for the 30 days prior to the survey date; "occasionally" referred to at least one cigarette in the last 30 days but not every day during the past 30 days, and "never" referred to zero consumption of cigarettes.

Alcohol Consumption: Drinking habits or alcohol consumption was derived using three questions from the alcohol module. The derived variable was categorized into: "regular", "occasional", "former" or "never" (reference group). "Regular" drinking was defined as the consumption of at least 1 alcoholic drink per month up to more than 1 drink per week. "Occasional" drinking was defined as less than 1 alcoholic beverage per month. "Former" drinkers were derived from whether they ever had a drink, and if so whether it was over 12 months prior to the survey date, both had to be true for the participant to be considered a "former" drinker. "Never" drinkers were those who had never consumed an alcoholic beverage.

3.3 Statistical Analysis

Analyses were done separately for each of the three outcomes (employment, wage, and income), as well as for each model in the conceptual framework. Employment, which looked at the association between obesity and labour market participation, was measured as a binary outcome; "zero" being unemployed or not participating in the labour market and "one" referred to active in the labour market or employed. Earnings, which took the employment one step further, looked at the influence of obesity on wage rate or income; both wage rate or income were measured continuously for both outcomes. The difference in the nature of the dependent variables resulted in the need for different statistical methods. In addition, earnings was conditional on being employed meaning that any "zero's" needed to be truncated in the analysis.

3.3.1 Exploratory Analyses

Descriptive Statistics

Descriptive analyses were performed for all three outcomes and the exposure and included all explanatory variables from Model 1 and Model 2 (social, demographic, health, and lifestyle). The descriptive statistics were generated to determine the frequency and distribution of each predictor and outcome, and to assess the characteristics of respondents in the dataset. Proportion was reported for categorical variables while the mean was reported for continuous variables. The descriptive/summary statistics were conducted for each year which allowed for an initial exploration of the trend.

Linear regression was used to explore the impact of obesity on earnings, and basic demographic and social variables were also included. In addition, graphs were created to visually interpret the trends of the exposure and outcome variables over the six cycles (using the mean or proportion from each survey cycle).

3.3.2 Multivariable Analyses

Methods and analysis of each outcome will be discussed in two sections; one for labour market participation and one for earnings (wage rate and income). Within each of these sections, the statistics used to examine each of the three conceptual models will be explained. The analyses required to assess the impact of obesity on employment participation will be discussed in section 3.3.2.1 and includes: pooled regression analysis, generalized estimating equation (GEE), and the inclusion of group means of the time-varying variables in the GEE to account for unobserved heterogeneity bias. The focus will then turn to the models utilized to analyze the effect of obesity on earnings (wage and income) in section 3.3.2.2; this includes: pooled regression analysis, truncated regression analysis, and the addition of group means to account for unobserved heterogeneity bias. The final section will cover other statistical considerations such as statistical software, data access, and survey sampling weights.

3.3.2.1 Employment Participation

The first set of analyses examined the effect of obesity on employment participation for Canadian women. The initial set of regression models used a pooled OLS estimation procedure while the subsequent models utilized Generalized Estimating Equation (GEE) methods and the inclusion of group means of the time-varying variables. For Model 1 (basic social and demographic confounders) and Model 2 (inclusion of health and lifestyle confounders), both pooled logistic regression and random effects regression using a GEE framework were utilized. For Model 3, the random-effects GEE was used again with the Mundlak correction procedure (i.e., inclusion of group means of the time-varying variables). Lagged-obesity was used in additional regression analyses for all three conceptual models to show the effect of obesity from previous years. Survey years or time dummies were also included in all models to account for the influence of time.

Pooled Analysis

The first analysis conducted for Models 1 and 2 was a pooled regression or running a regression after pooling all data for all cycles without consideration of the repeated nature of observations over time. The application of sampling weights, as produced by the NPHS was utilized to account for the survey design and non-response patterns over the survey cycles. Model 1 was explored first and then lagged health and lifestyle variables were included to explore Model 2. Although easy to compute and interpret, the pooled analysis was limited as it did not account for the longitudinal nature of the responses or the influence of unobserved heterogeneity bias. The pooled OLS model assumed that the correlation of the individual responses over the years have no influence on the estimated coefficients, which was quite unrealistic. Moreover, if there were time-invariant influences on the outcome variable, the pooled OLS was biased and the explanatory variables would have been correlated with the error term. In this case random or fixed-effects regression models were a better choice to account for the panel nature of the data.

Generalized Estimating Equation (GEE)

As explained, a pooled logistic regression was not sufficient given the potential correlation of individual effects over time. Therefore, a GEE model was utilized to estimate a random-effects regression for Models 1 and 2. GEE is a variation of Generalized Linear Models (GLM) and produces estimates based on a probability distribution and addresses clustering in the panel data (163). GEEs are a semi-parametric approach for regression analyses with discrete outcomes and were ideal to effectively work with correlated data. The correlation was a result of data from the same individuals over multiple time points that were no longer considered independent, but clustered. Moreover, the repeated observations from a subject are correlated over time and must be accounted for to produce valid parameter estimates.

The results from the GEEs were population averaged and interpreted as "on average" compared to "for a given subject", and did not focus on within-subject structure (164). Defining the regression model involved specification of a binomial family, a logit link and an exchangeable covariance structure (correlation is the same between each member of a cluster) (165). Other correlation options available were independence (same as the OLS logistic regression) and unrestricted (different for each correlation). Since unrestricted covariance structure is computationally complex, it was not pursued. GEEs are essentially the same as a logit model using a population averaged option, although GEEs allow for the use of population weights and a modified sandwich estimate of variance to account for possible heteroskedasticity within the cluster (164).

The GEE method worked by calculating the effect for each cluster group and then summing across groups before entering the weight matrix (165). Compared to a pooled data where we assume observations within a panel are independent, GEE created a within panel correlation matrix that was exchangeable. A strength of GEE was that with a large number of clusters (respondents) and a correctly specified link function (logit link in the analysis of employment participation), the estimates are consistent even when the correlation structure is not correctly specified (166).

Using the logit link, the exponents of the coefficients can be interpreted as odds ratios. This basic GEE model was summarized as a random-effects model that accounted for correlation within subjects and was population averaged. Random-effects models assume that the unobserved effects are uncorrelated with the explanatory variables, meaning that it did not account for bias if the unobserved effects were correlated with one or more explanatory variables (i.e., unobserved heterogeneity bias).

Generalized Estimating Equation (GEE) with Mundlak Correction

To analyze Model 3, the random-effects GEE approach was utilized with the addition of the Mundlak correction. To account for unobserved heterogeneity in panel data, a conditional fixed-effect estimator would have been ideal to condition out the fixed-effects within the panel (164). However, in the context of nonlinear panel data, the ‘incidental parameters problem’ occurs when using a logit link (167). This means that a small and fixed T (i.e., the number of cycles here) would bias the estimated parameters. Thus, to account for the potential unobserved heterogeneity bias, the Mundlak approach proposed by Mundlak (1978) was used. The Mundlak approach involves inclusion of the average over time of each variable for each individual in the random-effects models to condition out the fixed-effects. Thus, a GEE random-effects model with the inclusion of group means of the time-varying explanatory variables, was used to account for individual fixed-effects, which is widely used in the empirical literature (49, 50).

The use of GEEs with the Mundlak correction was identical in model specification to the random-effects GEEs, but Model 3 included within-individual means of time-varying predictors in addition to the lagged health and lifestyle variables. The interpretation was also the same as the logit link produced odds ratios. Overall, the GEE with group means was conceptually superior to the basic population-averaged GEE as unobserved heterogeneity bias is inevitable with micro data as unobservable individual-specific effects are typically correlated with the exposure variables of interest.

3.3.2.2 Earnings: Wage and Income

The second part of the analysis examined the effect of obesity on earnings for Canadian women. Both wage rate and income were explored to understand the impact of obesity on earnings. Wage rate and income, both continuously measured, needed appropriate statistical models to account for zeros. The first set of regression models used basic pooled regression analysis ignoring zeros as a special case while the subsequent models utilized truncated regression methods that account for zeros; including the addition of group means (Mundlak correction). Truncated regression models eliminate zeros or participants with no employment and in turn, no earnings. Furthermore, analyses were conducted for all three conceptual models, and again using lagged-obesity to show the influence of obesity status in previous years.

Pooled Analysis

The first analyses included a pooled regression model for Models 1 and 2. The application of sampling weights, as provided by the NPHS, was utilized to account for the sampling design.

The results were interpreted in terms of the marginal effects of obesity on earnings (wage rate and income) comparing obese women to normal or overweight women. As discussed before, the pooled analyses were limited as they could not account for individual effects correlated over time. Once again, random or fixed-effects regression models were appropriate to consider.

Truncated Regression

For all three models a truncated regression model was utilized. This was justified as basic linear regression models fails to account for the difference between limit observations (zeros) and non-limit observations (168). Both wage rate and income had a lower limit of zero which could have biased the association given that zero may indicate non-participation in the labour market (169). Moreover, this issue refers to the difference between limit observations (i.e., no earnings due to unemployment or not being in the labour force) versus non-limit observations (some hourly wage rate or annual income from wages or salaries) (168). As a result, non-linear methods such as truncated or Tobit regression models were necessary. This technique was followed from a study by Sepehri *et al* (2006), that utilized Tobit and truncated regression models to account for zeros in health expenditures (168).

The main difference between Tobit and truncated models is that Tobit models use censoring for women who had no earnings while the truncated regression models relies on a statistical distribution that is conditional on participating in the labour market as a full-time employee. Truncated regression models are commonly used to account for limit observations in the data. The options allowed for the truncation of no earnings, as determined by labour market participation.

The initial truncated regression models were random-effects models that used the lower limit option as zeros. Like the employment analyses, Models 1 and 2 were analyzed separately. Since unobserved heterogeneity was likely to be present in the data, a fixed-effects or group means approach was necessary.

Truncated Regression with Group Means

Akin to the analysis of the impact of obesity on labour market participation, a fixed-effects regression model was necessary to rule out the influence of unobserved individual heterogeneity bias. However, as discussed before, a fixed-effects maximum likelihood estimator may bias the estimated parameters when the length of the panel is fixed in non-linear models, known as the "incidental parameter problem" in the literature (167). Thus, an alternative method that accounted for unobserved heterogeneity bias was necessary. This is accomplished by including group means of all time-varying explanatory variables, known as the Mundlak correction factor as discussed before (21, 170). More specifically, the group average over time for each time-varying variable within each individual was included. Applying sampling weights from the NPHS was still necessary in the group means model. The truncated regression models with group means were utilized to analyze Model 3 which considered all potential predictors from Models 1 and 2 (including lagged-health and lifestyle variables) as well as any biases that could have occurred due to unmeasured individual heterogeneity. Model 3 or the Mundlak corrected models were analyzed again using a lagged indicator of obesity.

3.3.3 Other Statistical Considerations

Software and Data Access

The NPHS longitudinal data was analyzed using STATA 11.0 statistical software for employment models, while LIMDEP statistical software was utilized for both of the earnings outcomes. Data were obtained and permission was granted for use by the Research Data Centre (RDC) at The University of Western Ontario.

Survey Weights

As previously mentioned, the survey sampling weight from the NPHS was utilized and differed in each of the six cycles (141). In the initial cycle (1994/95), sampling weights were calculated for the sub-sample of 3,746 women who were 18-53 years of age in 2000/01. As a result the sampling weight was representative of the original 1994/95 sample for this cohort. For the subsequent cycles, weights were calculated for individuals that responded to all cycles and in turn were recalculated every two years. The recalculated sampling weights were updated every year to account for the attrition and non-response of the original sample. The resulting longitudinal weights provided by Statistics Canada were used in all models and assisted in accounting for the sampling design and any corresponding attrition bias.

Log-Earnings

As presented in the results, the log of both income and wage rate was utilized in the analysis to account for the skewed distribution. The logarithmic transformation brought the distribution of wage rate and income closer to the normal distribution.

Figure 3.1: Model 1 - Association between obesity and labour market participation or earnings

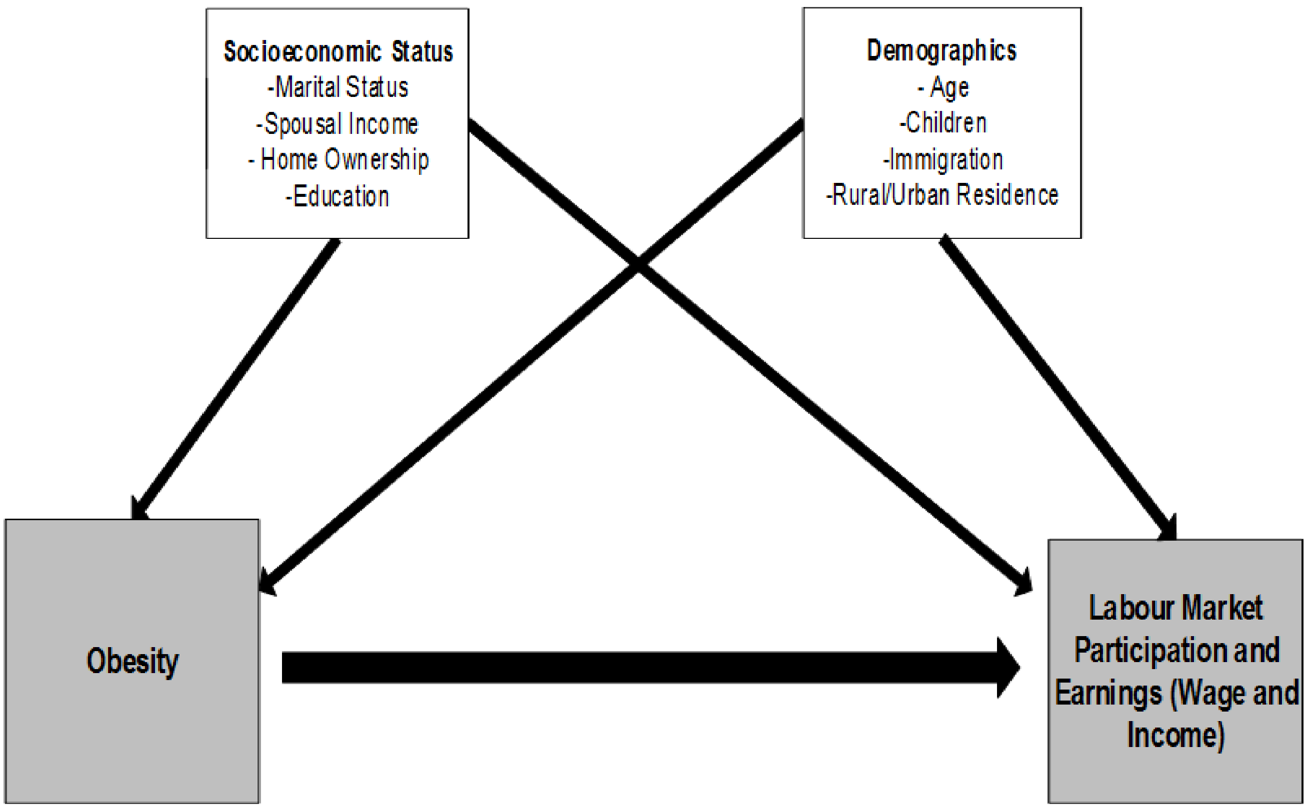


Figure 3.2: Model 2-Association between obesity and labour market participation or earnings including extended confounding variables

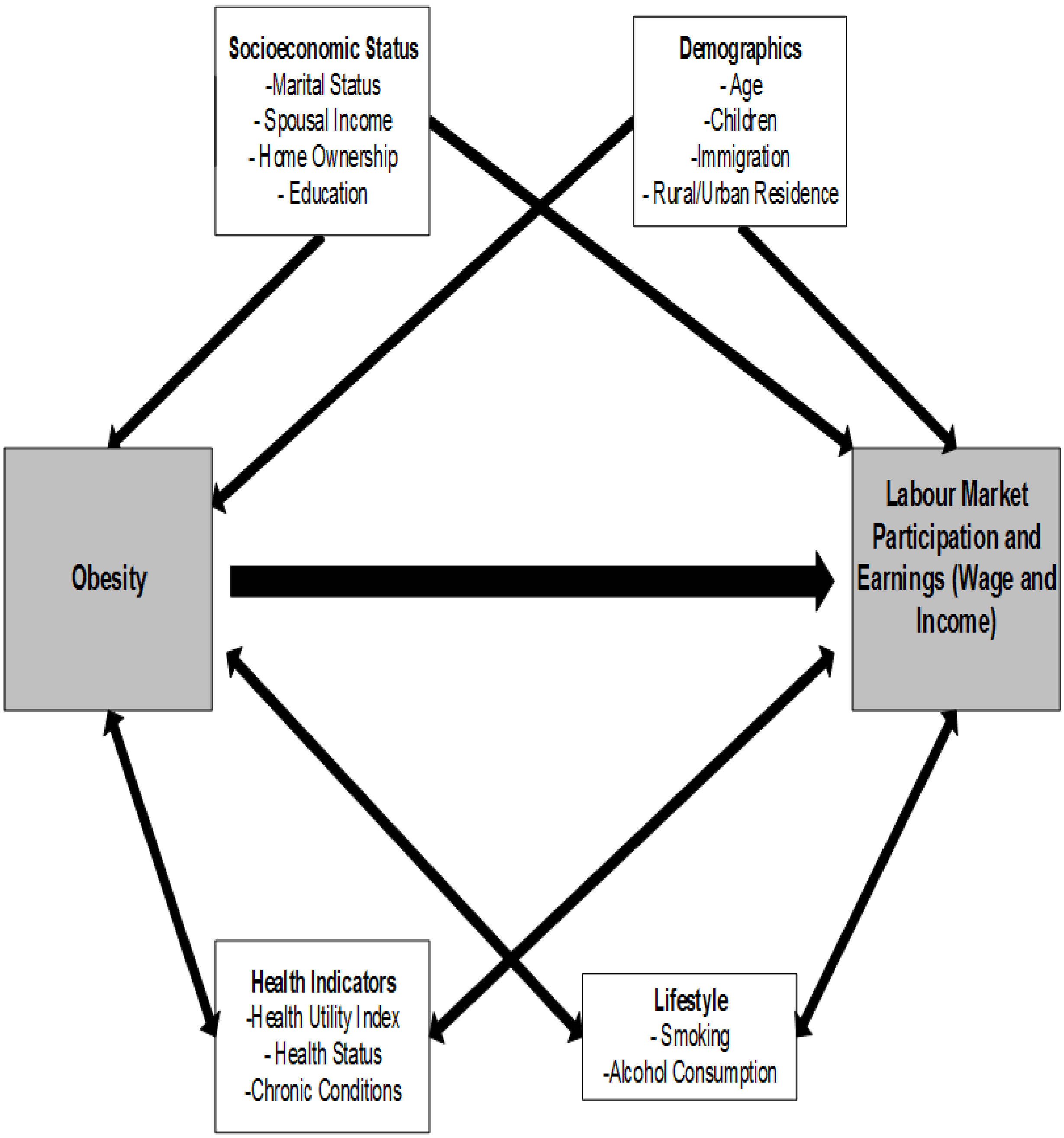
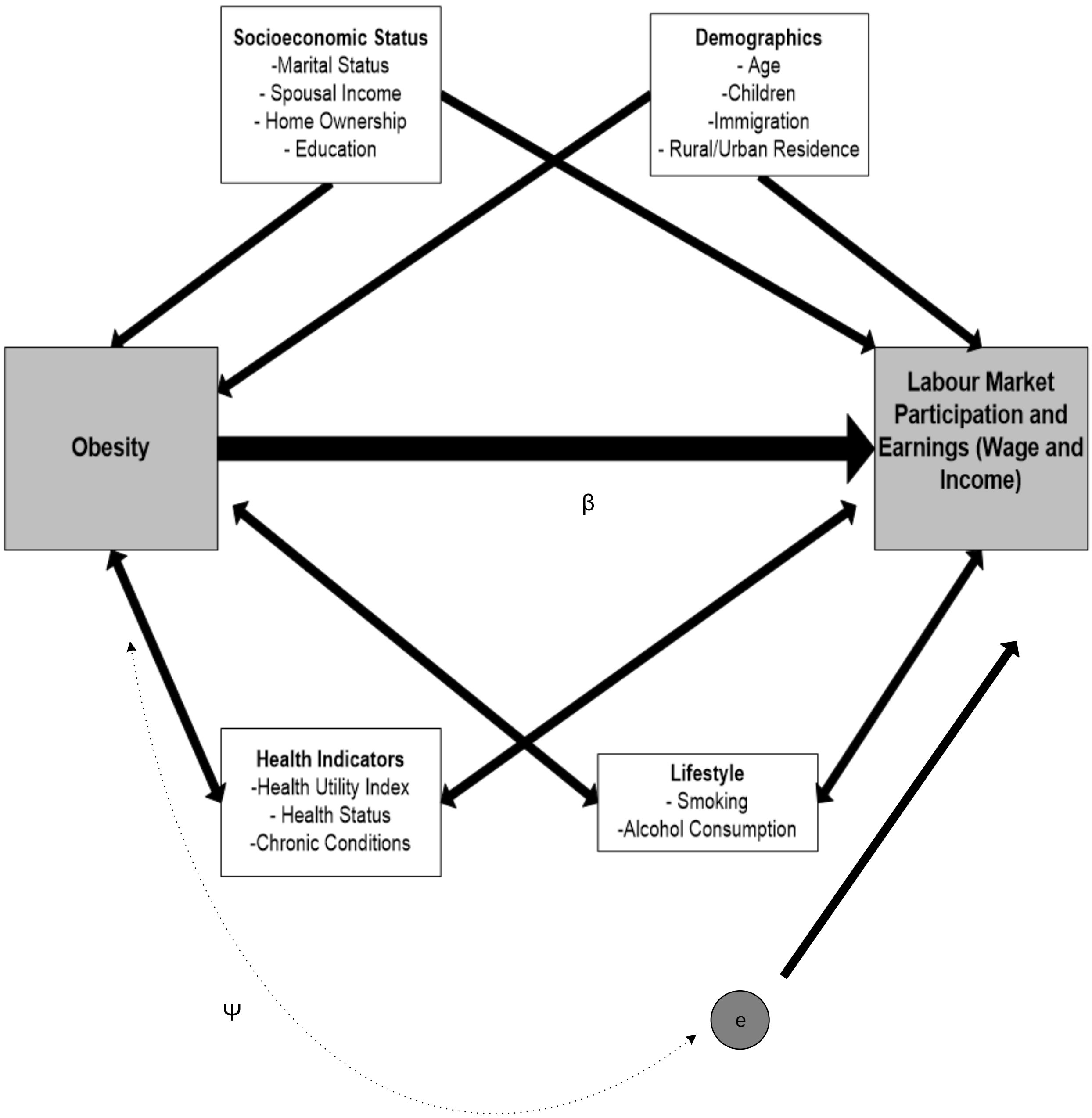


Figure 3.3: Model 3 – Association between obesity and labour market participation or earnings including potential unobserved heterogeneity bias (or omitted variable bias)



*if Ψ=0 then β is not correlated with the error term; if Ψ≠0 then β is correlated with the error term meaning that unobserved heterogeneity from omitted variables is present and must be controlled for in the analysis.

Chapter 4

4 Results

This chapter begins with an overview of the descriptive statistics and overall trend in BMI from 2000/1 to 2010/11. This is followed by a summary of results from the analyses of employment, wage, and income which include in-depth description of the three models followed by an overview of the relationship between each labour market outcome and all the confounders. Each subsection will describe the results with and without the use of lagged-obesity.

4.1 Descriptive Statistics

After the application of inclusion/exclusion criteria, such as being a female between the ages of 18-53, there were 3746 respondents in 2000/1, 3680 respondents in 2002/3, 3447 respondents in 2004/5, 3354 respondents in 2006/7, 3011 respondents in 2008/9, and 2922 respondents in 2010/11 were available for analysis. For the earnings models, which were conditional on the participants being employed, there were 1824 respondents in 2000/1, 1811 respondents in 2002/3, 1736 respondents in 2004/5, 1663 respondents in 2006/7, 1465 respondents in 2008/9, and 1357 respondents in 2010/11 available for analysis.

4.1.1 Overall Population

The prevalence of obesity increased by 10% among Canadian adult women aged 18 to 53 from 18% in 2000/1 to 28% in 2010/11. Comparatively, the prevalence of overweight women increased by nearly 6% over the six survey cycles, while the prevalence of normal weight women decreased by 16% (Figure 4.1, Table 4.1). It is to be noted that underweight individuals were not included in any of the descriptive statistics due to small sample size (less than 30 underweight respondents in some survey cycles).

Within the sample population the average age increased from 34.8 in 2000/1 to 46.6 in 2010/11 (Table 4.1). In regards to children, the proportion of women with no children under the age of five increased (81.13% to 88.75%). The proportion of immigrants decreased slightly from 15.9% to 15.0%. Looking at rural versus urban dwelling, the percentage of women living in rural areas (less than 30,000) increased (11.9% to 15.9%) while living in an urban area (greater than 500,000) decreased (50.0% to 45.3%). The proportion of single women decreased over time from 30.7% to 13.4% which was reflected in the increase among ‘married’ and ‘widowed, separated, or divorced’ women (13.8% and 3.5% increases, respectively). In regards to additional non-wage income, the greatest change was seen in those with non-wage income greater than $80,000, which increased from 7.7% to 12.3% over the six survey cycles. Homeownership also increased over time from 69.4% to 80.8%. Looking at the trends in education levels, proportions of those receiving less than high school, secondary school graduation and greater than high school education decreased over time, while college or university graduates increased from 40.4% to 55.0%.

Turning attention to health indicators and lifestyle variables, the average HUI score decreased from 0.91 to 0.88. For self-reported health status, excellent health decreased by 4.4% as did very good health by 1.6%. On the other hand, fair or poor health increased from 7.0% to 8.6%. The proportion of women with one or more chronic conditions increased by 15.3%; from 60.9% in 2000/1 to 76.2% in 2010/11. The proportion of occasional and daily smokers decreased as reflected in the 10.2% increase in the proportion of non-smokers. Finally, the proportion of alcohol drinkers increased from 56.7% to 63.7% among the regular drinkers, while non-drinkers decreased from 6.9% to 4.1%.

4.2 The Impact of Obesity on Labour Market Participation (Employment)

From 2000/1 to 2010/11 the overall proportion of employed women in Canada decreased from 79.3% to 72.1%, with a peak in 2004/5 at 80.5% (Figure 4.2, Table 4.1).

4.2.2 Model 1: Pooled and Random-Effects Logit

Model 1, which controlled for the potential confounding effects of socio-economic and demographic variables, found the odds of employment to be lower for obese women compared to overweight and normal weight women (Table 4.4). Moreover, in the pooled regression model the odds of being employed were 13% lower for obese women compared to non-obese women (OR 0.87, 95% CI 0.77-0.99). Using a lagged measure of obesity, the pooled regression model found that the odds of being employed were 12% lower for obese women compared to their non-obese counterparts (OR 0.88, 95% CI 0.77-1.01).

The random-effects model using GEEs showed no statistically significant impact of obesity on employment. The odds ratios depicted a lower likelihood of employment for obese women although the association failed to reach a significant level. Results remained the same with the inclusion of a lagged measure of obesity.

4.2.3 Model 2: Pooled and Random-Effects Logit

Model 2, which included lagged health and lifestyle confounders, failed to find statistically significant association between obesity and employment among Canadian women (Table 4.5). Both the pooled regression model and the GEE with random-effects models showed a lower likelihood of employment, although non-significant. With the use of lagged-obesity the odds ratios in both the pooled and GEE with random-effects, the results were not statistically significant.

4.2.4 Model 3: Random-Effect Logit with Mundlak Correction

Model 3, the GEE model with the Mundlak correction, did not result in statistically significant findings either. This remained consistent with and without the use of lagged measure of obesity.

4.2.5 Relationship between other confounders and employment

Age was significant in all three models, as well as models utilizing a lagged measure of obesity (Table 4.4, Table 4.5, Table 4.6). Moreover, an increase in age increased the odds of employment. Age^2 was also significant in all models and indicated a quadratic effect. In turn, the odds ratios showed that employment probability increased with age until a certain point in which the probability decreased. The presence of children aged five or under in the household was also found to be significant in all models. More specifically, having one child under five as well as two or more children aged five or under resulted in a lower probability of employment compared to women with no children in the household. Immigration status was only significant in Model 1 regressions and only for models that used a measurement of obesity from the same cycle. The effect, when significant, was negative on employment. Urban living (500,000 and over) was significantly associated with higher odds of employment in all models compared to rural living. In regards to marital status, married women were significantly less likely to be employed compared to single women and this was consistent in all models. Findings for additional income showed that in Model 1 (without lagged-obesity) non-wage income of $15,000-$30,000 resulted in higher odds of employment ($P<0.05$) while Models 1 and 2 found additional income greater than $80,000 to be associated with a lower odds of employment. For those who had a missing value for additional income, all three models found the association to be an indicator of lower employment probability which is further explored in a sensitivity analysis (Chapter 5). Homeownership was found to be associated with higher odds of employment in Models 1 and 2. Education was also significant in Models 1 and 2, as shown by the higher odds of employment for high school graduates, beyond high school education and college or university graduates, compared to less than high school education.

Looking at the lagged health and lifestyle variables included in Model 2, HUI was associated with higher odds of employment with each increase in the average HUI score. Self-reported health showed that women with fair or poor health were significantly less likely to be employed compared to women with excellent self-rated health. The effect of smoking was non-significant, however drinking of any sort was found to be associated with higher odds of employment compared to non-drinkers. Moreover regular drinkers were significantly more likely to be employed compared to non-drinkers, this was evident in pooled and GEE with random-effects models with and without lagged-obesity indicators.

4.3 The Impact of Obesity on Earnings (Hourly Wage Rate)

From 2000/1 to 2010/11 the mean hourly wage rate (inflation-adjusted) for Canadian women increased from $16.91 ($9.48) to $21.18 ($12.22) (Figure 4.3, Table 4.1).

4.3.1 Exploratory Analyses: Basic Linear Regression

An exploratory analysis using a basic linear regression model found obese women to be associated with a lower average hourly wage rate compared to non-obese women (Table 4.7). Including the basic socio-economic and demographic covariates in the linear regression model yielded a statistically significant negative association. Another linear regression model with both socio-economic and demographic confounders as well as health and lifestyle confounders maintained statistical significance. Although the coefficients in the linear regression models could not be described as the incremental changes for wage, the significance as well as the negative direction of the association was valuable for early exploration of the relationship.

4.3.2 Model 1: Pooled and Random-Effects

Results from Model 1 all showed a significant negative relationship regarding the effect of obesity on log hourly wage rate (Table 4.8). The pooled regression and GEE with random-effects regression found that obesity reduced the average hourly wage rate for full-time working women by 10.2% (=$e^{-0.108}$-1) and 11.0% (=$e^{-0.117}$-1) compared to non-obese women, respectively. Using lagged measures of obesity showed reductions in hourly wage rate comparing obese to non-obese women; the pooled model with lagged-obesity yielded a 3.7% (=$e^{-0.038}$-1) reduction in wage rate while the random-effect with lagged-obesity GEE estimated a 3.3% (=$e^{-0.034}$-1). Although the use of lagged-obesity diminished the wage-penalty, the effect was still statistically significant.

4.3.3 Model 2: Pooled and Random-Effects

Model 2, or the inclusion of lagged health and lifestyle confounders, differed from Model 1 in that the effect of obesity on wage rate was only significant in the random-effects regressions and not in the pooled regressions (Table 4.9). Moreover, the pooled regressions (with and without the use of lagged-obesity) yielded negative coefficients but they were not statistically significant. In regards to the random-effects GEE models, obese women experienced a 3.2% (=$e^{-0.033}$-1) reduction in average wage rate compared to non-obese women. The inclusion of lagged-obesity in the model resulted in an estimated average wage penalty for obese women of 2.5% (=$e^{-0.025}$-1) when compared to non-obese working women.

4.3.4 Model 3: Random-Effects with Mundlak Correction

Model 3, the truncated random-effects GEE model with the Mundlak correction, conditioned out the individual fixed-effects within the panel (Table 4.10). The addition of group means yielded no significant findings whether the model used a current or lagged measure of obesity. Although not significant the odds ratios suggested a negative association between obesity and log-hourly wage rate, on average, among employed Canadian women.

4.3.5 Relationship between other confounders and wage rate

Akin to the effect on employment, an increase in age was significantly associated with a higher wage rate (Table 4.8, Table 4.9, Table 4.10). Age^2 was also significant in all models and indicated a quadratic effect; at a certain point older age became associated with lower wage rates in women. Having one child aged five or under in the household was found to be significant in the pooled regression models (Models 1 and 2), showing a lower wage rate compared to women with no children under five. The presence of two or more children under the age of five resulted in significantly lower wage rates compared to women with no children in the household. This was significant in both pooled and truncated regressions and for Models 1 and 2. Immigration status was significant in all models and for pooled, truncated and Mundlak corrected regressions, showing that immigrant women had lower wage rates, on average, than Canadian-born women. Urban living (30,000 to 500,000) was significantly associated with a higher hourly wage in all of the pooled regression models compared to rural living but this was not significant in any of the truncated random-effects models. For those living in urban areas with 500,000 or more people the positive effect on wage was significant in pooled and truncated random-effects models, but not in the Mundlak corrected model.

In regards to marital status, married women had significantly lower wages in pooled models when compared to single women but this was reversed in the truncated random-effects models in which married women had significantly higher wages than single women. These findings were significant for Models 1, 2, and 3. The effect of being widowed, separated, or divorced was significant in the truncated random-effects regressions for all models and estimated a higher average wage rate compared to single women. For all models (pooled, random-effects and Mundlak corrected) it was evident that additional income of any kind was associated with a lower wage rate, on average. In Model 1, additional income over $80,000 or missing was significant in the pooled models while a truncated random effects model found significant estimates for the $15,000-30,000, $30,000-50,000, $50,000-80,000 and missing categories. The use of a lagged-obesity measure caused the missing category to lose significance in the random-effects model. In Model 2, additional income between $15,000 and $30,000 was significant in the pooled ($P<0.05$) and truncated random-effects regressions. $30,000-50,000 was only significant in the random-effects regressions while the $50,000-80,000 group was significantly associated with lower wage in all regressions. Non-wage income greater than $80,000, was only found to reduce wage in the pooled regression estimates. Missing additional income estimates were significant in all regressions, except for the random-effects regression with lagged-obesity. In Model 3, all levels of additional income were found to significantly lower wage compared to women with additional income less than $15,000, except for missing additional income in the group means corrected model with lagged-obesity. Results for those with missing values for additional income is further discussed in a sensitivity analysis (Chapter 5). Like employment, homeownership was significantly associated with higher average wage in all models. Education was also significant in Models 1 and 2 as shown by higher wage rates for high school graduates, beyond high school education and college or university graduates, compared to less than high school education. In Model 3 the only significant finding was for college or university graduates as they earned a higher wage rate on average than women who had less than high school education.

Looking at the lagged health and lifestyle variables included in Model 2, HUI was associated with a higher average hourly wage with each increase in the average HUI score although this was not significant in Model 3. Self-reported health showed that women with good and fair or poor health had significantly lower log-hourly wages compared to women with excellent self-rated health ($P<0.05$). In Model 3 only fair or poor health was significant and only in the regressions that used a current measure of obesity. The effect of smoking was significantly related to lower wage rate for daily smokers compared to non-smokers although this was only significant in pooled and random-effects models with lagged-obesity in Model 2 (not Model 3). In Model 2, drinking of any kind was significantly related to higher wage, on average, compared to non-drinkers ($P<0.05$). In Model 3 however, the effect lost significance in all except for regular drinkers. The inclusion of cycle years showed a significant increase in average hourly wage for women over the years and this remained significant across all models.

4.4 The Impact of Obesity on Earnings (Annual Income)

From 2000/1 to 2010/11 the average annual income (in real terms) for Canadian women increased from $30,328.87 ($23,719.35) to $41,272.37 ($27,194.11) (Figure 4.4, Table 4.1).

4.4.1 Exploratory Analyses: Basic Linear Regression

An exploratory analysis using linear regression found obesity among women to be associated with a lower average annual income compared to non-obese women (Table 4.11). Including the basic socio-economic and demographic covariates in a linear regression model yielded a significant negative association. A basic linear regression model with both socio-economic and demographic confounders as well as lagged-health and lifestyle confounders yielded a negative estimate; however the effect was not significant.

4.4.2 Model 1: Pooled and Random-Effects

Results from Model 1 were all significant suggesting a negative effect of obesity on the average log-income among Canadian women (Table 4.12). The pooled regression and truncated GEE with random-effects found that obesity reduced annual income by 20.2% ($=e^{-0.226}-1$) and 6.4% ($=e^{-0.066}-1$), respectively, compared to non-obese women. Using lagged measures of obesity also showed reductions in annual income comparing obese to non-obese women. Moreover, the pooled model with lagged-obesity yielded a 21.1% ($=e^{-0.237}-1$) reduction in average income, while the random-effects regression with lagged-obesity estimated a 2.1% ($=e^{-0.034}-1$). Although the truncated GEE for random-effects yielded smaller effects, the income penalty due to obesity was still statistically significant.

4.4.3 Model 2: Pooled and Random-Effects

Model 2, or the inclusion of lagged health and lifestyle confounders, differed from Model 1 in that the effect of obesity on average income was only significant in the truncated random-effects regressions without lagged-obesity (Table 4.13). The pooled regression models (with and without the use of lagged-obesity) yielded positive coefficients; however, they were not significant. In regards to the truncated random-effects GEEs, obese women experienced a 6.0% ($=e^{-0.062}-1$) reduction in average annual income compared to non-obese women. The inclusion of lagged-obesity in the model resulted in a negative estimate for the income-penalty but the effect was not statistically significant.

4.4.4 Model 3: Random-Effects with Mundlak Correction

Model 3, the truncated random-effects GEE model with the Mundlak correction, conditioned out the individual fixed-effects within the panel (Table 4.14). Inclusion of group means in the model yielded a 3.9% ($=e^{-0.040}-1$) reduction in average annual income among obese women compared to non-obese women ($P<0.05$). The same model with a lagged-obesity indicator resulted in a positive effect, although it was not significant.

4.4.5 Relationship between other confounders and annual income

The effect of age on income was analogous to the effect of age on both employment and wage rate. Moreover, an increase in age was significantly associated with a higher income in all models (Table 4.12, Table 4.13, Table 4.14). Age^2 was also significant in all models indicating a quadratic effect, or a convex association with the effect reversing and older age reducing the average income. Having any children under the age of five resulted in a significant reduction in average income compared to women with no children under five; this was consistent across all models. Immigration status was also significant in all models (pooled and truncated random-effects), showing a consistent income reduction comparing immigrants to non-immigrants ($P<0.05$). Urban living (over 500,000) was significantly associated with a higher average income compared to women in rural dwellings, and this was true for all models. Urban living (between 30,000 to 500,000 habitants) was significantly associated with a higher income in all of the pooled models as well as the truncated random-effects GEE in Model 1.

Akin to the analysis of wage, married women had a significantly lower average income in pooled models compared to single women but this was reversed in the truncated random-effects and Mundlak corrected models. In the random-effects and group means models, women who were widowed, separated, or divorced had a significantly higher income on average compared to single women. This effect was not significant in the pooled estimates. Of the additional income categories that yielded a significant effect on income, all were shown to reduce the average income when compared to non-wage support less than $15,000. Further, the presence of non-wage income $80,000 or greater and missing were found to be significant across all models. Additional income of $15,000-30,000, $30,000-50,000, and $50,000-80,000 had less consistent findings as the significance varied across pooled, random-effects and group means models. The difference between those who reported additional income versus those who had missing non-wage income estimates were explored further in a sensitivity analysis (Chapter 5). Like employment and wage, homeownership was significantly associated with higher income, on average for Models 1 and 2. Education was also significant in Models 1 and 2 as shown by a higher average income among high school graduates, beyond high school education and college or university graduates, compared to women with less than high school education. In Model 3 the only significant findings were for women who went beyond high school and post-secondary graduates (in the model without lagged-obesity). The findings showed a lower average income compared to women who did not graduate from high school.

Considering the lagged health and lifestyle variables included in Model 2, HUI was associated with a higher average income with each increase in the average HUI score although this was not significant in Model 3. In Model 2, self-rated health covariates showed that in pooled estimates fair or poor health was significantly associated with a lower average income, while in the truncated random-effects models very good, good, and fair or poor health yielded lower average incomes than women with excellent health. Model 3 on the other hand only found a significant effect in the truncated Mundlak model without lagged-obesity and showed that women with fair or poor health had a lower average income compared to women with excellent health ($P<0.05$). The presence of chronic conditions was only significant in the Mundlak corrected models and suggested a negative impact on income compared to those with no chronic conditions. The effect of smoking was only significant in the pooled and truncated random-effects models (without lagged-obesity). The pooled estimates showed that daily smokers had a lower average income compared to non-smokers ($P<0.05$) while the random-effects estimate found daily smokers to have a higher average income than non-smokers ($P<0.05$) In Model 2, regular and occasional drinkers had significantly higher incomes, on average, compared to non-drinkers and this remained in the Model 3 regression without lagged-obesity and with lagged-obesity ($P<0.05$). The effect of time, as expressed through cycle years showed an increase in average income for women over the years and this was significant for the majority of cycles.

4.5 Summary of Results

The primary hypothesis was not supported by the evidence when health and lifestyle confounders were controlled for in the analysis of employment. When lagged-obesity was used in association with health and lifestyle confounders to assess the impact of obesity on income, the models failed to support the hypothesis. However, the direction of the estimated coefficients remained negative even when the statistical significance was lost. The results regarding the association between obesity and wage supported the hypothesis and were consistently negative. The hypotheses regarding the relationship in the face of unobserved heterogeneity bias were less supported by the evidence. After accounting for unobserved heterogeneity bias using the Mudlak correction (random-effects with the addition of group means of the time-varying explanatory variable) the outcomes of employment and wage rate were not found to be statistically significant. Income, on the other hand, remained statistically significant even after accounting for unobserved heterogeneity bias, although the effect became statistically non-significant when lagged-obesity was used instead of the current obesity indicator. These findings are largely consistent with previous studies as was discussed in Chapter 2; however, the evidence is corroborated for the representative of the Canadian female population.

A summary of the results from all of the presented tables regarding the influence of obesity on the three outcomes are presented in Table 4.15. A brief summary of the results considering the evidence from the analyses in relation to the original hypotheses are presented in Table 4.16.

4.6 Justification of Log-Earnings

As the earnings results presented in this chapter were analyzed using the natural logarithmic, a justification of the transformation is needed. Looking at the difference in skewness, the use of logarithmic transformation was justified as it resulted in a better approximation to a normal distribution. The skewness quantifies the symmetry of the distribution (171). Moreover, if a skewness of zero is found, the observations are normally distributed. This means that a skewness score close to or equal to zero is desirable while a score greater than 1.0 or less than -1.0 is likely skewed or far from the normal distribution. Table 4.17 displays the skewness scores both before and after the log transformation of wage and income. The substantially smaller skewness scores after taking the log show that the use of logarithmic transformation was justified.

Figure 4.1: The prevalence of normal weight, overweight and obese among Canadian women from 2000/1 to 2010/11.

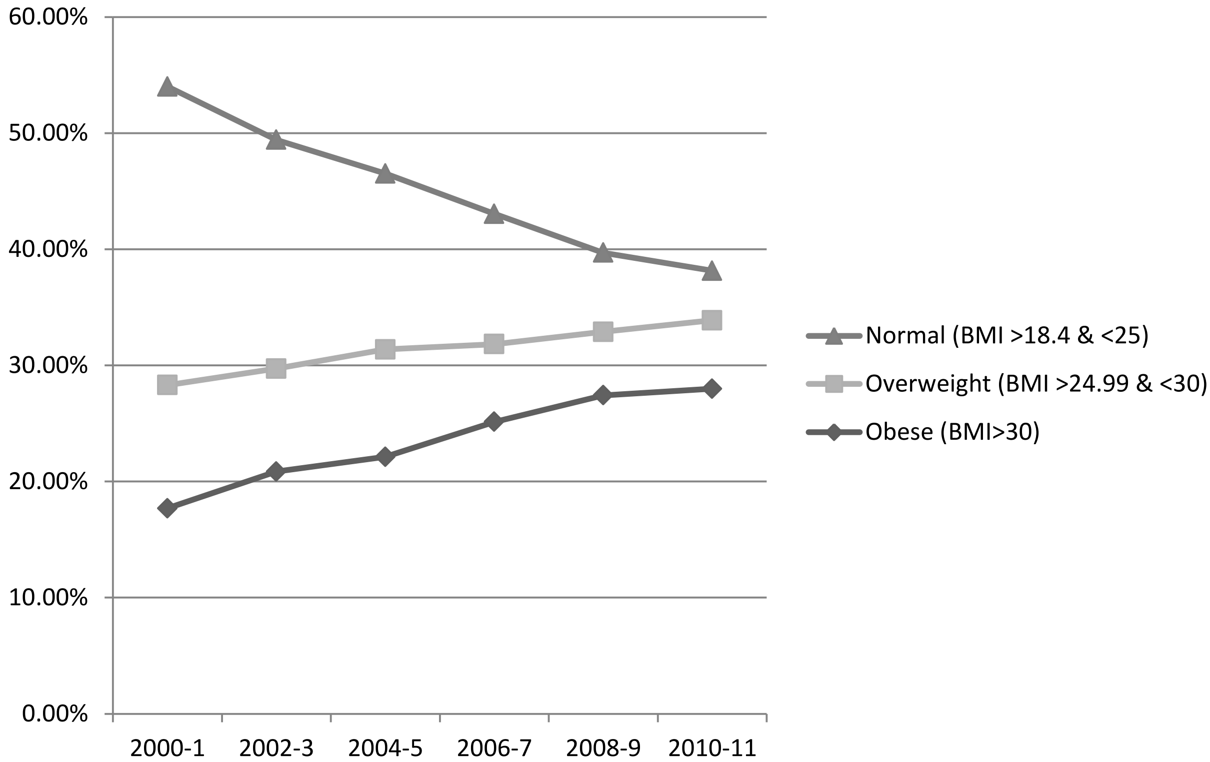


Table 4.1: Descriptive Statistics (Means or Proportions) by Year

Cycle	4		5		6		7		8		9		Total	
Years	2000-1		2002-3		2004-5		2006-7		2008-9		2010-11			
Employment														
Employed	79.31%		80.02%		80.46%		77.29%		75.70%		72.12%		77.70%	
Hourly Wage	$16.91	(9.48)	$16.96	(8.43)	$18.28	(10.66)	$19.50	(10.85)	$20.21	(11.16)	$21.18	(12.22)	$18.68	(10.54)
lnwage	$2.71	(1.31)	$2.72	(1.29)	$2.78	(1.31)	$2.85	(1.38))	$2.88	(1.42)	$2.92	(1.47)	$2.80	(1.36)
Annual Income	$30,328.87	(23719.35)	$30,666.90	(20216.93)	$34,096.66	(22535.26)	$37,114.82	(24067.77)	$39,218.22	(24787.09)	$41,272.37	(27194.11)	$34,846.52	(23932.06)
lnincome	10.05	(0.80)	10.09	(0.77)	10.23	(0.70)	10.32	(0.68)	10.38	(0.68)	10.44	(0.65)	10.23	(0.74)
Hours Worked	36.29	(12.54)	36.63	(12.93)	37.42	(12.49)	37.74	(12.40)	37.98	(12.29)	37.62	(12.64)	37.21	(12.57)
Full Time Employment	76.84%		77.99%		80.12%		80.09%		81.58%		79.35%		79.18%	
Part Time Employment	23.16%		22.01%		19.88%		19.91%		18.42%		20.65%		20.82%	
Obesity														
Obese (BMI>30)	17.69%		20.86%		22.12%		25.13%		27.42%		27.98%		23.18%	
Overweight (BMI >24.99 & <30)	28.31%		29.72%		31.37%		31.82%		32.88%		33.87%		31.15%	
Normal (BMI >18.4 & <25)	54.01%		49.41%		46.51%		43.05%		39.70%		38.15%		45.67%	
Age														
Age	34.77	(9.45)	37.96	(10.13)	40.24	(10.07)	42.28	(10.06)	44.65	(10.01)	46.63	(10.05)	40.71	(10.72)
Age^2	1298.64	(644.78)	1543.79	(757.85)	1720.83	(794.91)	1888.45	(835.05)	2094.02	(872.68)	2275.86	(916.37)	1772.48	(864.61)
Children														
No Children(ref)	81.13%		83.53%		84.55%		84.71%		85.17%		88.75%		84.45%	
1 Child 5 or under	13.40%		11.99%		11.31%		10.75%		9.63%		9.06%		11.16%	
2 or more Children 5 or under	5.47%		4.48%		4.14%		4.55%		5.20%		2.18%		4.39%	
Immigration														
Immigrant	15.93%		15.40%		15.32%		14.97%		15.19%		14.97%		15.33%	
Location														
Rural (less than 30,000)(ref)	11.89%		10.77%		10.41%		13.34%		14.71%		15.92%		12.67%	
Urban Living (30-500k)	38.10%		40.05%		40.95%		40.60%		39.65%		38.76%		39.68%	
Urban Living (500k+)	50.01%		49.17%		48.64%		46.06%		45.63%		45.32%		47.65%	
Marital Status														
Single(ref)	30.68%		23.60%		19.21%		16.68%		13.54%		13.35%		20.07%	
Married	58.17%		63.73%		66.84%		69.17%		72.14%		72.00%		66.55%	
Widowed, Separated, or Divorced	11.16%		12.68%		13.96%		14.15%		14.32%		14.65%		13.38%	
Income														
Additional Income: <$15k(ref)	26.81%		26.89%		26.52%		23.98%		23.01%		25.17%		25.51%	
Additional Income:$15-30K	13.93%		13.41%		16.64%		15.23%		12.87%		12.63%		14.17%	
Additional Income:$30-50K	23.34%		23.04%		22.17%		19.92%		20.06%		21.02%		21.70%	
Additional Income:$50-80K	17.64%		18.46%		16.56%		18.08%		19.14%		17.33%		17.85%	
Additional Income:$80k+	7.73%		10.02%		9.52%		10.94%		11.05%		12.31%		10.14%	
Additional Income: Missing	10.55%		9.19%		8.59%		11.86%		13.88%		11.53%		10.81%	
Home Ownership														
Homeowner(ref)	69.42%		72.15%		73.71%		76.96%		79.93%		80.77%		75.10%	
Education Level														
Less than High School (ref)	10.55%		9.04%		8.63%		7.93%		7.58%		7.40%		8.63%	
Secondary School Graduate	16.03%		15.19%		14.95%		14.06%		14.15%		13.04%		14.66%	
Beyond High School	33.05%		30.24%		27.05%		26.36%		24.46%		24.55%		27.93%	
College or University Graduate	40.37%		45.53%		49.37%		51.66%		53.81%		55.01%		48.77%	
Health Indicators														
Health Utility Index (HUI)	0.913	(0.16)	0.894	(0.18)	0.897	(0.17)	0.898	(0.16)	0.883	(0.18)	0.877	(0.19)	0.895	(0.17)
Health (Excellent)(ref)	23.66%		20.96%		19.95%		19.35%		18.28%		19.28%		20.39%	
Health(Very Good)	42.15%		41.40%		43.15%		42.35%		43.12%		40.54%		42.13%	
Health(Good)	27.15%		28.89%		28.51%		30.20%		30.87%		31.59%		29.40%	
Health(Fair or Poor)	7.03%		8.75%		8.38%		8.09%		7.73%		8.59%		8.08%	
Chronic Conditions														
1 or more Chronic Conditions	60.85%		68.12%		69.65%		73.29%		76.83%		76.15%		70.31%	
Smoking Status														
Occasional Smoker	6.07%		5.74%		4.03%		4.70%		3.96%		3.47%		4.75%	
Daily Smoker	24.65%		21.20%		19.98%		17.87%		17.53%		17.05%		19.98%	
Non-Smoker (ref)	69.28%		73.07%		75.98%		77.43%		78.50%		79.48%		75.27%	
Drinking Status														
Former Drinker	10.04%		9.67%		11.01%		10.02%		11.09%		11.62%		10.51%	
Occasional Drinker	26.39%		24.51%		23.51%		20.47%		20.77%		20.52%		22.93%	
Regular Drinker	56.69%		60.75%		59.94%		64.56%		64.31%		63.74%		61.40%	
Non-Drinker (ref)	6.88%		5.08%		5.54%		4.95%		3.83%		4.11%		5.16%	

Table 4.2: Descriptive Statistics (Means or Proportions) of Obese Women by Year

Cycle	4		5		6		7		8		9		Total	
Years	2000-1		2002-3		2004-5		2006-7		2008-9		2010-11			
Employment														
Employed	78.14%		77.92%		77.40%		76.00%		72.46%		69.21%		75.03%	
Hourly Wage	$15.15	(6.91)	$17.00	(7.48)	$18.28	(14.58)	$17.79	(8.16)	$19.24	(10.09)	$18.90	(8.59)	$17.77	(9.76)
lnwage	$1.83	(1.26)	$1.91	(1.31)	$1.92	(1.34)	$1.89	(1.35)	$1.77	(1.43)	$1.69	(1.44)	$1.83	(1.36)
Annual Income	$28,570.55	(17168.23)	$30,718.95	(18168.15)	$34,416.65	(25970.54)	$35,461.30	(19126.72)	$36,480.31	(22191.93)	$37,972.26	(21897.31)	$33,942.87	(21189.02)
lnincome	7.53	(4.40)	7.58	(4.41)	7.53	(4.55)	7.31	(4.72)	6.90	(4.88)	6.64	(5.01)	7.23	(4.69)
Hours Worked	28.66	(18.68)	29.06	(19.43)	29.79	(19.55)	30.26	(19.40)	28.03	(18.92)	27.62	(20.46)	28.89	(19.46)
Full Time Employment	79.35%		80.96%		83.70%		84.43%		83.19%		81.46%		82.23%	
Part Time Employment	20.65%		19.04%		16.30%		15.57%		16.81%		18.54%		17.77%	
Age														
Age	37.63	(8.56)	40.63	(9.94)	42.45	(9.73)	44.27	(10.05)	46.01	(10.02)	48.66	(9.78)	43.50	(10.34)
Age^2	1488.87	(611.58)	1749.83	(774.89)	1896.59	(797.41)	2060.39	(854.80)	2216.77	(885.96)	2463.54	(911.14)	1999.19	(875.26)
Children														
No Children(ref)	81.64%		82.79%		84.76%		84.58%		84.13%		90.69%		84.90%	
1 Child 5 or under	12.70%		11.38%		11.03%		9.64%		8.67%		8.42%		10.21%	
2 or more Children 5 or under	5.66%		5.84%		4.21%		5.78%		7.20%		0.89%		4.89%	
Immigration														
Immigrant	16.16%		13.82%		10.79%		13.40%		11.41%		12.53%		13.00%	
Location														
Rural (less than 30,000)(ref)	12.22%		12.89%		12.56%		12.98%		12.09%		13.86%		12.79%	
Urban Living (30-500k)	40.76%		42.26%		42.98%		42.14%		44.59%		44.13%		42.87%	
Urban Living (500k+)	47.02%		44.85%		44.46%		44.88%		43.32%		42.02%		44.34%	
Marital Status														
Single(ref)	22.77%		22.62%		17.36%		13.08%		12.88%		12.41%		16.58%	
Married	63.91%		61.40%		67.12%		70.98%		70.68%		70.82%		67.69%	
Widowed, Separated, or Divorced	13.32%		15.98%		15.51%		15.93%		16.44%		16.77%		15.73%	
Income														
Additional Income: <$15k(ref)	30.74%		33.29%		30.87%		26.50%		27.26%		28.11%		29.35%	
Additional Income:$15-30K	14.75%		13.30%		18.07%		16.05%		14.26%		16.41%		15.49%	
Additional Income:$30-50K	25.59%		21.46%		19.71%		20.57%		20.87%		18.89%		21.07%	
Additional Income:$50-80K	17.33%		17.36%		16.17%		15.90%		17.02%		14.80%		16.39%	
Additional Income:$80k+	5.02%		7.21%		7.25%		8.48%		8.18%		9.54%		7.70%	
Additional Income: Missing	6.58%		7.94%		7.92%		12.50%		12.40%		12.24%		10.09%	
Home Ownership														
Homeowner(ref)	68.15%		72.69%		73.25%		76.37%		78.13%		79.55%		74.94%	
Education Level														
Less than High School (ref)	15.75%		9.48%		10.55%		11.10%		10.07%		10.53%		11.15%	
Secondary School Graduate	18.80%		17.24%		17.87%		15.90%		15.42%		15.86%		16.78%	
Beyond High School	31.95%		33.28%		29.38%		30.53%		31.11%		26.55%		30.39%	
College or University Graduate	33.50%		40.01%		42.20%		42.47%		43.40%		47.06%		41.68%	
Health Indicators														
Health Utility Index (HUI)	0.870	(0.21)	0.836	(0.25)	0.861	(0.21)	0.879	(0.17)	0.841	(0.21)	0.858	(0.19)	0.857	(0.21)
Health (Excellent)(ref)	13.79%		12.41%		10.43%		10.11%		9.25%		9.47%		10.81%	
Health(Very Good)	37.01%		36.49%		41.01%		36.49%		37.61%		35.53%		37.32%	
Health(Good)	36.06%		34.82%		35.60%		38.91%		39.90%		41.83%		37.99%	
Health(Fair or Poor)	13.14%		16.28%		12.96%		14.50%		13.24%		13.18%		13.88%	
Chronic Conditions														
1 or more Chronic Conditions	72.42%		77.63%		78.85%		81.59%		86.51%		86.35%		80.86%	
Smoking Status														
Occasional Smoker	3.69%		4.97%		2.85%		5.11%		3.76%		2.50%		3.81%	
Daily Smoker	26.33%		22.19%		21.75%		18.94%		19.31%		15.74%		20.52%	
Non-Smoker (ref)	69.98%		72.84%		75.40%		75.95%		76.93%		81.76%		75.66%	
Drinking Status														
Former Drinker	13.55%		13.56%		14.50%		13.42%		13.05%		13.00%		13.50%	
Occasional Drinker	33.72%		32.94%		29.90%		29.00%		28.88%		26.43%		30.01%	
Regular Drinker	46.29%		48.52%		49.17%		51.83%		54.40%		56.34%		51.28%	
Non-Drinker (ref)	6.44%		4.99%		6.44%		5.75%		3.67%		4.23%		5.21%	

Table 4.3: Descriptive Statistics (Means or Proportions) for Non-Obese Women by Year

Cycle	4		5		6		7		8		9		Total	
Years	2000-1		2002-3		2004-5		2006-7		2008-9		2010-11			
Employment														
Employed	80.29%		81.37%		81.70%		79.46%		78.04%		74.07%		79.41%	
Hourly Wage	$17.67	(10.05)	$17.07	(8.62)	$18.27	(9.32)	$19.87	(11.20)	$20.37	(11.09)	$22.00	(13.00)	$18.98	(10.59)
lnwage	$1.93	(1.32)	$1.99	(1.28)	$2.06	(1.29)	$2.04	(1.36)	$2.00	(1.40)	$1.90	(1.48)	$1.99	(1.35)
Annual Income	$31,228.45	(25322.89)	$30,875.19	(20776.97)	$34,088.98	(21253.33)	$37,278.43	(24335.50)	$39,685.20	(24308.55)	$42,492.67	(28082.73)	$35,165.87	(24240.69)
lnincome	7.75	(4.31)	7.92	(4.21)	8.03	(4.25)	7.80	(4.47)	7.60	(4.65)	7.19	(4.89)	7.74	(4.44)
Hours Worked	28.94	(18.25)	29.27	(17.85)	30.38	(18.21)	30.46	(18.13)	30.95	(18.25)	28.92	(18.76)	29.76	(18.23)
Full Time Employment	76.09%		77.40%		79.99%		78.99%		81.10%		78.30%		78.45%	
Part Time Employment	23.91%		22.60%		20.01%		21.00%		18.90%		21.70%		21.55%	
Age														
Age	34.39	(9.50)	37.23	(10.21)	39.90	(10.16)	41.85	(10.17)	44.39	(10.06)	46.39	(10.08)	40.11	(10.82)
Age^2	1272.96	(643.73)	1490.52	(758.04)	1694.98	(798.29)	1855.14	(839.93)	2071.76	(875.32)	2253.60	(916.33)	1725.60	(864.42)
Children														
No Children(ref)	81.66%		83.45%		84.76%		84.35%		84.99%		87.97%		84.23%	
1 Child 5 or under	12.89%		11.85%		11.13%		10.98%		10.24%		9.88%		11.30%	
2 or more Children 5 or under	5.45%		4.70%		4.11%		4.67%		4.77%		2.16%		4.41%	
Immigration														
Immigrant	15.64%		15.89%		16.67%		14.90%		16.01%		15.31%		15.75%	
Location														
Rural (less than 30,000)(ref)	11.99%		9.95%		9.24%		13.46%		15.35%		16.69%		12.49%	
Urban Living (30-500k)	37.31%		39.10%		40.54%		40.23%		37.29%		36.24%		38.50%	
Urban Living (500k+)	50.70%		50.95%		50.22%		46.31%		47.36%		47.07%		49.00%	
Marital Status														
Single(ref)	31.93%		24.92%		19.68%		18.14%		13.65%		13.44%		21.23%	
Married	56.97%		63.44%		66.77%		68.03%		72.74%		72.74%		65.99%	
Widowed, Separated, or Divorced	11.10%		11.64%		13.56%		13.84%		13.62%		13.82%		12.78%	
Income														
Additional Income: <$15k(ref)	26.28%		25.64%		25.68%		23.78%		21.90%		23.90%		24.72%	
Additional Income:$15-30K	13.75%		12.97%		16.09%		14.65%		12.03%		11.14%		13.54%	
Additional Income:$30-50K	23.10%		24.16%		22.83%		20.38%		20.33%		21.90%		22.26%	
Additional Income:$50-80K	18.00%		19.30%		16.91%		18.85%		19.85%		17.90%		18.43%	
Additional Income:$80k+	8.59%		10.86%		10.82%		12.33%		12.51%		13.68%		11.24%	
Additional Income: Missing	10.29%		8.07%		7.67%		10.01%		13.38%		11.48%		9.98%	
Home Ownership														
Homeowner(ref)	70.40%		72.30%		74.85%		77.60%		81.26%		81.41%		75.70%	
Education Level														
Less than High School (ref)	9.26%		7.47%		6.84%		6.20%		6.01%		5.73%		7.10%	
Secondary School Graduate	15.34%		15.14%		14.19%		13.10%		13.71%		12.35%		14.12%	
Beyond High School	33.21%		29.61%		26.07%		25.20%		21.74%		22.95%		27.08%	
College or University Graduate	42.20%		47.78%		52.90%		55.50%		58.54%		58.97%		51.70%	
Health Indicators														
Health Utility Index (HUI)	0.921	(0.15)	0.915	(0.14)	0.910	(0.14)	0.909	(0.14)	0.904	(0.15)	0.891	(0.17)	0.910	(0.15)
Health (Excellent)(ref)	25.44%		24.34%		23.15%		23.03%		22.27%		23.52%		23.75%	
Health(Very Good)	43.46%		43.64%		44.82%		45.16%		45.72%		43.20%		44.27%	
Health(Good)	25.46%		25.84%		25.88%		26.87%		26.56%		26.84%		26.17%	
Health(Fair or Poor)	5.64%		6.18%		6.16%		4.94%		5.45%		6.44%		5.80%	
Chronic Conditions														
1 or more Chronic Conditions	58.88%		64.52%		65.97%		70.43%		72.72%		72.47%		66.78%	
Smoking Status														
Occasional Smoker	6.63%		6.10%		4.38%		5.00%		4.30%		3.94%		5.20%	
Daily Smoker	24.92%		20.59%		18.87%		17.05%		16.43%		17.10%		19.61%	
Non-Smoker (ref)	68.45%		73.31%		76.76%		77.95%		79.27%		78.95%		75.19%	
Drinking Status														
Former Drinker	9.00%		7.95%		9.27%		7.93%		9.84%		10.29%		8.97%	
Occasional Drinker	24.56%		22.48%		21.19%		16.92%		16.99%		18.10%		20.48%	
Regular Drinker	60.05%		65.11%		64.60%		70.71%		69.45%		67.72%		65.78%	
Non-Drinker (ref)	6.40%		4.46%		4.95%		4.45%		3.72%		3.89%		4.77%	

Figure 4.2: The proportion of employed Canadian women from 2000/1 to 2010/11.

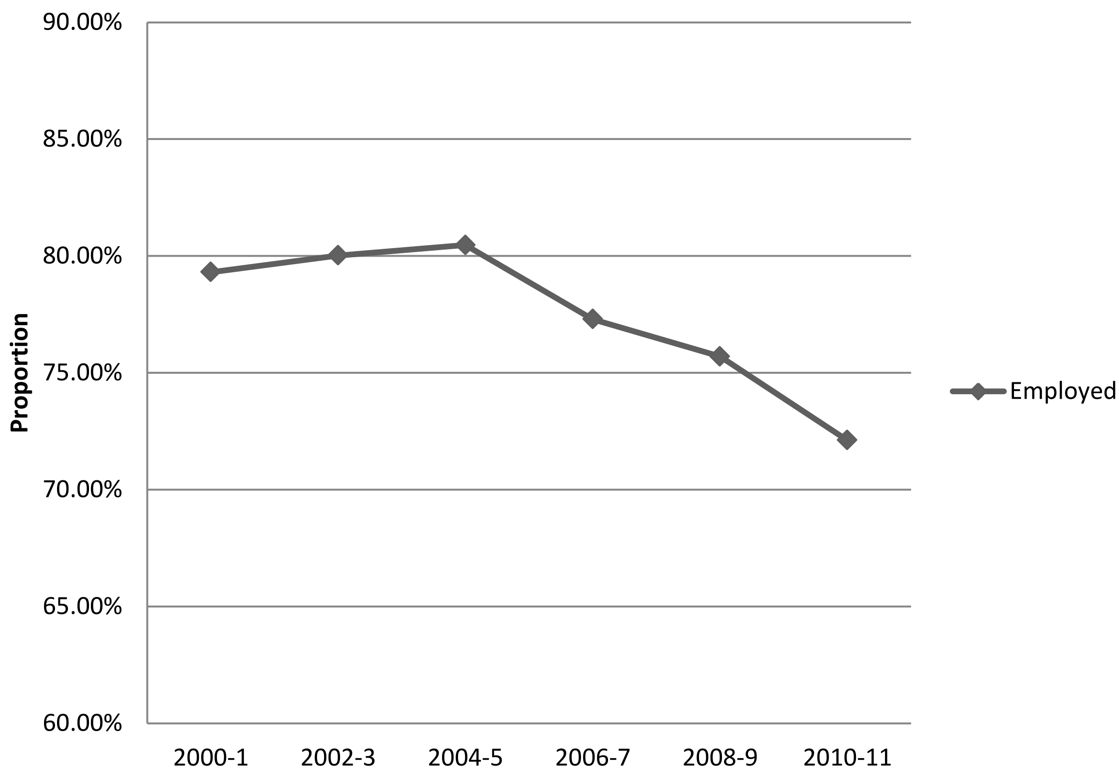


Table 4.4: Model 1 - The association between obesity and employment: pooled and random-effects regressions (using GEEs).

	Pooled OR: (95% CI)	**Pooled W/ Lagged Obesity** OR: (95% CI)	**Random-Effects GEE** OR: (95% CI)	**Random-Effects GEE W/ Lagged Obesity** OR: (95% CI)
Obese	0.869**		0.895	
	(0.766 - 0.987)		(0.763 - 1.049)	
Normal/Overweight (ref)	--	--	--	--
Obese – Lagged		0.883*		0.910
		(0.773 - 1.008)		(0.780 - 1.063)
Normal/Overweight-Lagged (ref)	--	--	--	--
Age				
Age	1.227***	1.237***	1.261***	1.287***
	(1.176 - 1.281)	(1.185 - 1.292)	(1.198 - 1.328)	(1.220 - 1.358)
Age^2	0.997***	0.997***	0.997***	0.997***

	(0.997 - 0.998)	(0.997 - 0.998)	(0.996 - 0.998)	(0.996 - 0.998)
Presence of Child(ren) in Household				
1 Child 5 or under	0.537***	0.517***	0.529***	0.501***
	(0.454 - 0.636)	(0.436 - 0.614)	(0.447 - 0.627)	(0.422 - 0.594)
2 or more Children 5 or under	0.388***	0.384***	0.405***	0.418***
	(0.310 - 0.487)	(0.302 - 0.489)	(0.320 - 0.515)	(0.321 - 0.546)
No Children 5 or under (ref)	--	--	--	--
Immigrant Status				
Immigrant	0.824**	0.867	0.754**	0.795*
	(0.686 - 0.990)	(0.720 - 1.044)	(0.585 - 0.972)	(0.610 - 1.036)
Non-immigrant (ref)	--	--	--	--
Urban vs. Rural Dwelling				
Urban Living (30-500k)	1.106	1.099	1.116	1.082
	(0.951 - 1.287)	(0.943 - 1.280)	(0.954 - 1.306)	(0.922 - 1.269)
Urban Living (500k+)	1.354***	1.327***	1.469***	1.453***
	(1.153 - 1.589)	(1.127 - 1.562)	(1.208 - 1.787)	(1.192 - 1.773)
Rural (<30k) (ref)	--	--	--	--
Marital Status				
Married	0.733***	0.799**	0.698***	0.741**
	(0.595 - 0.904)	(0.646 - 0.987)	(0.547 - 0.891)	(0.579 - 0.948)
Widowed, Separated, or Divorced	1.065	1.075	0.943	0.960
	(0.847 - 1.338)	(0.851 - 1.358)	(0.706 - 1.260)	(0.716 - 1.288)
Single (ref)	--	--	--	--
Additional/Spousal Income				
Additional Income:$15-30K	1.306**	1.164	1.284**	1.147
	(1.053 - 1.620)	(0.937 - 1.445)	(1.059 - 1.558)	(0.928 - 1.418)
Additional Income:$30-50K	1.224**	1.158	1.071	1.034
	(1.017 - 1.474)	(0.961 - 1.396)	(0.902 - 1.271)	(0.871 - 1.227)
Additional Income:$50-80K	0.984	0.939	0.930	0.935
	(0.810 - 1.196)	(0.770 - 1.144)	(0.770 - 1.123)	(0.768 - 1.138)
Additional Income:$80k+	0.576***	0.552***	0.733***	0.724***
	(0.469 - 0.708)	(0.447 - 0.681)	(0.594 - 0.906)	(0.576 - 0.909)
Additional Income: Missing	0.593***	0.565***	0.675***	0.640***
	(0.475 - 0.741)	(0.450 - 0.710)	(0.533 - 0.854)	(0.504 - 0.812)

Additional Income: <$15k (ref)	--	--	--	--
Home Ownership				
Homeowner	1.454***	1.386***	1.247**	1.200**
	(1.265 - 1.672)	(1.201 - 1.600)	(1.047 - 1.484)	(1.003 - 1.436)
Non-homeowner (ref)	--	--	--	--
Education				
Secondary School Graduate	2.016***	2.112***	2.102***	2.208***
	(1.641 - 2.476)	(1.711 - 2.606)	(1.506 - 2.933)	(1.571 - 3.102)
Beyond High School	2.070***	2.185***	1.970***	2.122***
	(1.723 - 2.486)	(1.813 - 2.633)	(1.503 - 2.583)	(1.609 - 2.800)
College or University Graduate	3.265***	3.390***	3.016***	3.162***
	(2.744 - 3.886)	(2.840 - 4.047)	(2.304 - 3.948)	(2.407 - 4.153)
Less than High School (ref)	--	--	--	--
Cycles				
2002/03 Cycle	1.023	--	1.001	--
	(0.864 - 1.212)		(0.883 - 1.134)	
2004/05 Cycle	0.992	1.067	0.948	0.979
	(0.827 - 1.190)	(0.901 - 1.265)	(0.811 - 1.108)	(0.853 - 1.123)
2006/07 Cycle	1.042	1.030	0.990	0.983
	(0.861 - 1.262)	(0.865 - 1.228)	(0.841 - 1.165)	(0.847 - 1.142)
2008/09 Cycle	1.075	1.113	1.025	1.057
	(0.889 - 1.301)	(0.933 - 1.329)	(0.863 - 1.218)	(0.902 - 1.239)
2010/11 Cycle	0.940	0.977	0.897	0.942
	(0.771 - 1.147)	(0.813 - 1.174)	(0.742 - 1.085)	(0.787 - 1.126)
2000/02 Cycle (ref)	--	N/A	--	N/A
2002/03 Cycle (ref)	N/A	--	N/A	--
Observations	16,459	16,022	16,459	16,022

Robust CI in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4.5: Model 2 - The association between obesity and employment: pooled and random-effects regressions (using GEEs).

	Pooled OR: (95% CI)	**Pooled W/ Lagged Obesity** OR: (95% CI)	**Random-Effects GEE** OR: (95% CI)	**Random-Effects GEE W/ Lagged Obesity** OR: (95% CI)
Obese	0.997		0.926	
	(0.868 - 1.144)		(0.784 - 1.095)	
Normal/Overweight (ref)	--	--	--	--
Obese – Lagged		1.052		1.013
		(0.914 - 1.211)		(0.863 - 1.188)
Normal/Overweight-Lagged (ref)	--	--	--	--
Age				
Age	1.251***	1.249***	1.283***	1.291***
	(1.195 - 1.309)	(1.194 - 1.306)	(1.215 - 1.355)	(1.224 - 1.361)
Age^2	0.997***	0.997***	0.997***	0.997***
	(0.997 - 0.998)	(0.997 - 0.998)	(0.996 - 0.998)	(0.996 - 0.998)
Presence of Child(ren) in Household				
1 Child 5 or under	0.482***	0.494***	0.485***	0.490***
	(0.403 - 0.576)	(0.414 - 0.591)	(0.407 - 0.579)	(0.412 - 0.583)
2 or more Children 5 or under	0.368***	0.377***	0.398***	0.422***
	(0.290 - 0.466)	(0.294 - 0.484)	(0.312 - 0.509)	(0.322 - 0.553)
No Children 5 or under (ref)	--	--	--	--
Immigrant Status				
Immigrant	1.043	1.079	0.871	0.920
	(0.852 - 1.277)	(0.882 - 1.321)	(0.660 - 1.150)	(0.707 - 1.195)
Non-immigrant (ref)	--	--	--	--
Urban vs. Rural Dwelling				
Urban Living (30-500k)	1.153*	1.131	1.118	1.097
	(0.983 - 1.353)	(0.967 - 1.322)	(0.954 - 1.312)	(0.933 - 1.290)
Urban Living (500k+)	1.343***	1.337***	1.429***	1.442***
	(1.133 - 1.592)	(1.131 - 1.581)	(1.170 - 1.744)	(1.181 - 1.761)
Rural (<30k) (ref)	--	--	--	--
Marital Status				
Married	0.743**	0.761**	0.732**	0.723***

	(0.591 - 0.933)	(0.608 - 0.951)	(0.562 - 0.954)	(0.567 - 0.923)
Widowed, Separated, or Divorced	1.154	1.121	1.007	0.973
	(0.899 - 1.482)	(0.877 - 1.433)	(0.739 - 1.373)	(0.729 - 1.300)
Single (ref)	--	--	--	--
Additional/Spousal Income				
Additional Income:$15-30K	1.205	1.136	1.211*	1.145
	(0.954 - 1.521)	(0.903 - 1.429)	(0.982 - 1.493)	(0.916 - 1.431)
Additional Income:$30-50K	1.073	1.048	1.005	0.986
	(0.882 - 1.306)	(0.863 - 1.273)	(0.844 - 1.197)	(0.825 - 1.179)
Additional Income:$50-80K	0.841	0.833*	0.861	0.876
	(0.684 - 1.035)	(0.678 - 1.023)	(0.707 - 1.048)	(0.715 - 1.074)
Additional Income:$80k+	0.502***	0.488***	0.674***	0.657***
	(0.403 - 0.625)	(0.392 - 0.608)	(0.539 - 0.843)	(0.520 - 0.831)
Additional Income: Missing	0.593***	0.575***	0.668***	0.636***
	(0.466 - 0.754)	(0.453 - 0.729)	(0.521 - 0.856)	(0.498 - 0.813)
Additional Income: <$15k (ref)	--	--	--	--
Home Ownership				
Homeowner	1.353***	1.345***	1.239**	1.205**
	(1.162 - 1.576)	(1.156 - 1.565)	(1.032 - 1.489)	(1.009 - 1.438)
Non-homeowner (ref)	--	--	--	--
Education				
Secondary School Graduate	1.850***	2.001***	1.950***	2.106***
	(1.484 - 2.307)	(1.610 - 2.487)	(1.395 - 2.727)	(1.508 - 2.941)
Beyond High School	1.764***	1.958***	1.746***	1.989***
	(1.444 - 2.156)	(1.608 - 2.384)	(1.321 - 2.309)	(1.515 - 2.613)
College or University Graduate	2.665***	2.875***	2.620***	2.872***
	(2.200 - 3.229)	(2.382 - 3.470)	(1.994 - 3.443)	(2.194 - 3.761)
Less than High School (ref)	--	--	--	--
Lagged Health & Lifestyle Covariates				
Health Utility Index (HUI)	5.014***	4.507***	2.385***	2.003***
	(3.510 - 7.163)	(3.154 - 6.441)	(1.670 - 3.407)	(1.326 - 3.025)
Health(Very Good)	1.046	1.047	1.054	1.056
	(0.902 - 1.214)	(0.903 - 1.215)	(0.911 - 1.221)	(0.904 - 1.233)
Health(Good)	1.072	1.066	1.025	1.017

	(0.900 - 1.276)	(0.895 - 1.270)	(0.855 - 1.227)	(0.834 - 1.241)
Health(Fair or Poor)	0.579***	0.531***	0.675***	0.618***
	(0.448 - 0.750)	(0.411 - 0.687)	(0.516 - 0.883)	(0.467 - 0.817)
Health (Excellent)(ref)	--	--	--	--
1 or more chronic condition(s)	0.943	0.930	0.958	0.926
	(0.828 - 1.073)	(0.817 - 1.059)	(0.841 - 1.092)	(0.808 - 1.060)
No Chronic Diseases (ref)	--	--	--	--
Occasional Smoker - Lagged	1.288*	1.234	1.360**	1.279*
	(0.988 - 1.680)	(0.951 - 1.601)	(1.011 - 1.830)	(0.957 - 1.710)
Daily Smoker - Lagged	0.977	1.019	0.976	1.003
	(0.851 - 1.123)	(0.887 - 1.171)	(0.822 - 1.158)	(0.837 - 1.203)
Non-Smoker-Lagged (ref)	--	--	--	--
Former Drinker - Lagged	1.512***	1.641***	1.262	1.374**
	(1.135 - 2.013)	(1.236 - 2.180)	(0.944 - 1.687)	(1.030 - 1.834)
Occasional Drinker - Lagged	1.623***	1.725***	1.335*	1.452**
	(1.244 - 2.119)	(1.324 - 2.246)	(0.992 - 1.796)	(1.090 - 1.936)
Regular Drinker - Lagged	2.047***	2.230***	1.638***	1.825***
	(1.597 - 2.625)	(1.744 - 2.851)	(1.226 - 2.189)	(1.374 - 2.424)
Non-Drinker – Lagged (ref)	--	--	--	--
Cycles				
2002/03 Cycle	0.991	1.052	0.959	0.980
	(0.835 - 1.177)	(0.885 - 1.251)	(0.834 - 1.103)	(0.851 - 1.128)
2004/05 Cycle	1.068	1.057	1.032	1.011
	(0.887 - 1.288)	(0.881 - 1.270)	(0.884 - 1.205)	(0.864 - 1.184)
2006/07 Cycle	1.135	1.125	1.096	1.067
	(0.946 - 1.361)	(0.937 - 1.351)	(0.927 - 1.296)	(0.904 - 1.260)
2008/09 Cycle	1.009	0.979	0.976	0.943
	(0.838 - 1.214)	(0.810 - 1.182)	(0.813 - 1.171)	(0.785 - 1.133)
2010/11 Cycle	0.991	1.052	0.959	0.980
	(0.835 - 1.177)	(0.885 - 1.251)	(0.834 - 1.103)	(0.851 - 1.128)
2000/02 Cycle (ref)	--	--	--	--
Observations	15,603	15,763	15,603	15,763

Robust CI in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4.6: Model 3- The association between obesity and employment: random-effects with Mundlak correction (using GEEs)

	GEE W/ Group Means OR: (95% CI)	**GEE W/ Group Means and Lagged Obesity** OR: (95% CI)
Obese	0.825	
	(0.626 - 1.087)	
Normal/Overweight (ref)	--	--
Obese – Lagged		0.944
		(0.744 - 1.198)
Normal/Overweight-Lagged (ref)	--	--
Age		
Age	1.400***	1.404***
	(1.267 - 1.547)	(1.273 - 1.549)
Age^2	0.996***	0.996***
	(0.995 - 0.997)	(0.995 - 0.997)
Presence of Child(ren) in Household		
1 Child 5 or under	0.482***	0.476***
	(0.388 - 0.599)	(0.384 - 0.590)
2 or more Children 5 or under	0.414***	0.443***
	(0.307 - 0.559)	(0.319 - 0.614)
No Children 5 or under (ref)	--	--
Immigrant Status		
Immigrant	1.007	1.046
	(0.748 - 1.355)	(0.783 - 1.398)
Non-immigrant (ref)	--	--
Urban vs. Rural Dwelling		
Urban Living (30-500k)	1.072	1.041
	(0.860 - 1.337)	(0.830 - 1.305)
Urban Living (500k+)	2.171***	2.365***
	(1.415 - 3.331)	(1.537 - 3.639)
Rural (<30k) (ref)	--	--
Marital Status		
Married	0.640**	0.589***

	(0.440 - 0.931)	(0.407 - 0.852)
Widowed, Separated, or Divorced	0.798	0.725
	(0.499 - 1.274)	(0.452 - 1.162)
Single (ref)	--	--
Additional/Spousal Income		
Additional Income:$15-30K	1.253**	1.175
	(1.006 - 1.561)	(0.928 - 1.488)
Additional Income:$30-50K	0.914	0.904
	(0.747 - 1.117)	(0.736 - 1.110)
Additional Income:$50-80K	0.839	0.864
	(0.667 - 1.056)	(0.684 - 1.092)
Additional Income:$80k+	0.834	0.824
	(0.650 - 1.070)	(0.635 - 1.069)
Additional Income: Missing	0.727**	0.693***
	(0.553 - 0.955)	(0.531 - 0.905)
Additional Income: <$15k (ref)	--	--
Home Ownership		
Homeowner	0.951	0.927
	(0.728 - 1.243)	(0.712 - 1.207)
Non-homeowner (ref)	--	--
Education		
Secondary School Graduate	1.695	1.774
	(0.547 - 5.250)	(0.557 - 5.643)
Beyond High School	0.900	1.074
	(0.320 - 2.531)	(0.392 - 2.943)
College or University Graduate	1.115	1.296
	(0.372 - 3.343)	(0.443 - 3.791)
Less than High School (ref)	--	--
Lagged Health & Lifestyle Covariates		
Health Utility Index (HUI)	1.007	0.771
	(0.667 - 1.523)	(0.465 - 1.278)
Health(Very Good)	1.109	1.122
	(0.929 - 1.325)	(0.927 - 1.357)
Health(Good)	1.061	1.078

	(0.841 - 1.339)	(0.837 - 1.389)
Health(Fair or Poor)	0.836	0.762
	(0.600 - 1.164)	(0.539 - 1.079)
Health (Excellent)(ref)	--	--
1 or more chronic condition(s)	0.994	0.968
	(0.840 - 1.177)	(0.811 - 1.155)
No Chronic Diseases (ref)	--	--
Occasional Smoker - Lagged	1.530**	1.407*
	(1.061 - 2.207)	(0.983 - 2.013)
Daily Smoker – Lagged	1.112	1.072
	(0.821 - 1.505)	(0.766 - 1.499)
Non-Smoker-Lagged (ref)	--	--
Former Drinker - Lagged	1.006	1.103
	(0.689 - 1.468)	(0.759 - 1.604)
Occasional Drinker - Lagged	0.974	1.086
	(0.636 - 1.492)	(0.718 - 1.641)
Regular Drinker - Lagged	1.107	1.274
	(0.707 - 1.732)	(0.823 - 1.971)
Non-Drinker – Lagged (ref)	--	--
Cycles		
2004/05 Cycle	0.918	0.955
	(0.738 - 1.142)	(0.769 - 1.188)
2006/07 Cycle	0.981	0.998
	(0.705 - 1.365)	(0.726 - 1.372)
2008/09 Cycle	1.042	1.071
	(0.674 - 1.611)	(0.704 - 1.629)
2010/11 Cycle	0.908	0.950
	(0.527 - 1.566)	(0.562 - 1.605)
2002/03 Cycle (ref)	--	--
Observations	15,603	15,763

Note: the full model is in Table B.1

Robust CI in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 4.3: The mean hourly wage among Canadian women from 2000/1 to 2010/11.

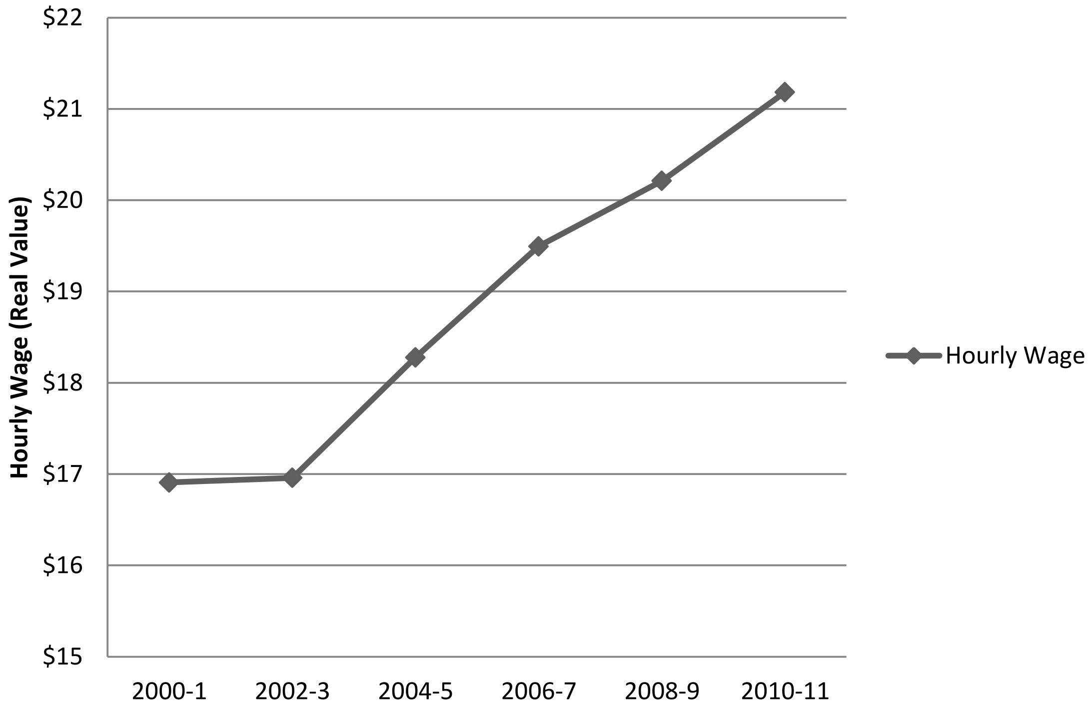


Table 4.7: The impact of obesity on wage: basic linear regressions

	W/ Basic Social and Demographic Confounders β: (95% CI)	**W/ Health and Lifestyle Confounders** β: (95% CI)
Obesity	-0.073***	-0.052***
	(-0.102, -0.044)	(-0.082, -0.021)
Observations	8,667	8,282
R^2	0.248	0.271

Robust CI in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4.8: Model 1 - The association between obesity and log-hourly wage: pooled and truncated random-effects regressions (using GEEs).

Variables	**Pooled** Estimated Coefficient: (95% CI)	**Pooled W/ Lagged Obesity** Estimated Coefficient: (95% CI)	**Truncated Random-Effects** Estimated Coefficient (95% CI)	**Truncated Random-Effects W/ Lagged Obesity** Estimated Coefficient (95% CI)
Obese	-0.108***		-0.038***	
	(-0.157, -0.059)		(-0.051, -0.025)	
Normal/Overweight (ref)	--	--	--	--
Obese – Lagged		-0.117***		-0.034***
		(-0.167, -0.066)		(-0.047, -0.020)
Normal/Overweight-Lagged (ref)	--	--	--	--
Age				
Age	0.164***	0.157***	0.066***	0.069***
	(0.146, 0.183)	(0.139, 0.176)	(0.059, 0.074)	(0.061, 0.078)
Age^2	-0.002***	-0.002***	-0.001***	-0.001***
	(-0.002, -0.002)	(-0.002, -0.002)	(-0.001, -0.001)	(-0.001, -0.001)
Presence of Child(ren) in Household				
1 Child 5 or under	-0.274***	-0.299***	-0.012	-0.022**
	(-0.346, -0.205)	(-0.368, -0.229)	(-0.029, 0.005)	(-0.039, -0.004)
2 or more Children 5 or under	-0.644***	-0.648***	-0.083***	-0.083***
	(-0.747, -0.542)	(-0.759, -0.537)	(-0.113, -0.053)	(-0.115, -0.051)
No Children 5 or under (ref)	--	--	--	--
Immigrant Status				
Immigrant	-0.202***	-0.190***	-0.133***	-0.135***
	(-0.278, -0.126)	(-0.267, -0.113)	(-0.153, -0.113)	(-0.155, -0.115)
Non-immigrant (ref)	--	--	--	--
Urban vs. Rural Dwelling				
Urban Living (30-500k)	0.162***	0.167***	-0.014*	-0.012
	(0.100, 0.225)	(0.105, 0.230)	(-0.031, 0.003)	(-0.029, 0.005)
Urban Living (500k+)	0.434***	0.436***	0.100***	0.101***
	(0.367, 0.501)	(0.369, 0.504)	(0.080, 0.119)	(0.082, 0.120)

Rural (<30k) (ref)	--	--	--	--
Marital Status				
Married	-0.144***	-0.116***	0.042***	0.036***
	(-0.212, -0.076)	(-0.185, -0.047)	(0.025, 0.058)	(0.020, 0.053)
Widowed, Separated, or Divorced	0.034	0.040	0.056***	0.052***
	(-0.043, 0 .112)	(-0.038, 0.119)	(0.037, 0.076)	(0.033, 0.071)
Single (ref)	--	--	--	--
Additional/Spousal Income				
Additional Income:$15-30K	-0.052	-0.069*	-0.090***	-0.083***
	(-0.127, 0.022)	(-0.144, 0.006)	(-0.111, -0.070)	(-0.103, -0.062)
Additional Income:$30-50K	0.026	0.0123	-0.061***	-0.051***
	(-0.045, 0.097)	(-0.059, 0.085)	(-0.078, -0.043)	(-0.068, -0.034)
Additional Income:$50-80K	-0.022	-0.030	-0.048***	-0.039***
	(-0.098, 0.055)	(-0.108, 0.047)	(-0.067, -0.030)	(-0.057, -0.020)
Additional Income:$80k+	-0.380***	-0.381***	-0.002	0.003
	(-0.471, -0.288)	(-0.474, -0.288)	(-0.020, 0.017)	(-0.015, 0.022)
Additional Income: Missing	-1.443***	-1.484***	-0.102***	-0.047
	(-1.564, -1.321)	(-1.608, -1.360)	(-0.157, -0.047)	(-0.107, 0.013)
Additional Income: <$15k (ref)	--	--	--	--
Home Ownership				
Homeowner	0.297***	0.277***	0.074***	0.073***
	(0.244, 0.351)	(0.223, 0.331)	(0.059, 0.089)	(0.058, 0.089)
Non-homeowner (ref)	--	--	--	--
Education				
Secondary School Graduate	0.495***	0.497***	0.101***	0.109***
	(0.403, 0.587)	(0.404, 0.590)	(0.073, 0.129)	(0.081, 0.138)
Beyond High School	0.677***	0.676***	0.288***	0.284***
	(0.594, 0.759)	(0.593, 0.760)	(0.251, 0.325)	(0.247, 0.320)
College or University Graduate	1.049***	1.047***	0.418***	0.425***
	(0.970, 1.128)	(0.967, 1.127)	(0.371, 0.465)	(0.377, 0.472)
Less than High School (ref)	--	--	--	--
Cycles				
2002/03 Cycle	0.019	--	-0.009	--
	(-0.049, 0.087)		(-0.027, 0.010)	

2004/05 Cycle	0.055	0.090***	0.017*	0.031***
	(-0.015, 0.125)	(0.028, 0.152)	(-0.001, 0.034)	(0.015, 0.047)
2006/07 Cycle	0.123***	0.124***	0.055***	0.069***
	(0.052, 0.195)	(0.059, 0.188)	(0.037, 0.074)	(0.052, 0.086)
2008/09 Cycle	0.147***	0.167***	0.089***	0.109***
	(0.072, 0.222)	(0.099, 0.236)	(0.070, 0.109)	(0.090, 0.127)
2010/11 Cycle	0.106***	0.147***	0.143***	0.167***
	(0.028, 0.184)	(0.075, 0.219)	(0.120, 0.165)	(0.143, 0.191)
2000/02 Cycle (ref)	--	N/A	--	N/A
2002/03 Cycle (ref)	N/A	--	N/A	--
Observations	11,909	11,611	11,909	11,611

Robust CI in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4.9: Model 2 - The association between obesity and log-hourly wage: pooled and truncated random-effects regressions (GEE's)

	Pooled Estimated Coefficient: (95% CI)	**Pooled W/ Lagged Obesity** Estimated Coefficient: (95% CI)	**Truncated Random-Effects** Estimated Coefficient: (95% CI)	**Truncated Random-Effects W/ Lagged Obesity** Estimated Coefficient: (95% CI)
Obese	-0.014		-0.033***	
	(-0.064, 0.036)		(-0.047, -0.020)	
Normal/Overweight (ref)	--	--	--	--
Obese – Lagged		-0.012		-0.025***
		(-0.063, 0.038)		(-0.039, -0.012)
Normal/Overweight-Lagged (ref)	--	--	--	--
Age				
Age	0.164***	0.158***	0.067***	0.066***
	(0.146, 0.182)	(0.140, 0.176)	(0.059, 0.075)	(0.058, 0.074)
Age^2	-0.002***	-0.002***	-0.001***	-0.001***
	(-0.002, -0.002)	(-0.002, -0.002)	(-0.001, -0.001)	(-0.001, -0.001)
Presence of Child(ren) in Household				

1 Child 5 or under	-0.286***	-0.300***	-0.003	-0.016*
	(-0.355, -0.218)	(-0.368, -0.232)	(-0.020, 0.014)	(-0.033, 0.002)
2 or more Children 5 or under	-0.633***	-0.636***	-0.078***	-0.080***
	(-0.735, -0.532)	(-0.745, -0.528)	(-0.108, -0.047)	(-0.113, -0.048)
No Children 5 or under (ref)	--	--	--	--
Immigrant Status				
Immigrant	-0.096**	-0.103***	-0.105***	-0.123***
	(-0.174, -0.018)	(-0.181, -0.026)	(-0.123, -0.086)	(-0.143, -0.103)
Non-immigrant (ref)	--	--	--	--
Urban vs. Rural Dwelling				
Urban Living (30-500k)	0.162***	0.155***	-0.016*	-0.013
	(0.100, 0.224)	(0.094, 0.216)	(-0.033, 0.001)	(-0.030, 0.003)
Urban Living (500k+)	0.410***	0.405***	0.101***	0.102***
	(0.343, 0.476)	(0.340, 0.471)	(0.081, 0.121)	(0.082, 0.122)
Rural (<30k) (ref)	--	--	--	--
Marital Status				
Married	-0.132***	-0.119***	0.038***	0.042***
	(-0.201, -0.063)	(-0.187, -0.051)	(0.021, 0.055)	(0.025, 0.058)
Widowed, Separated, or Divorced	0.084**	0.082**	0.053***	0.059***
	(0.007, 0.162)	(0.005, 0.159)	(0.033, 0.072)	(0.040, 0.078)
Single (ref)	--	--	--	--
Additional/Spousal Income				
Additional Income:$15-30K	-0.082**	-0.081**	-0.086***	-0.084***
	(-0.156, -0.008)	(-0.155, -0.008)	(-0.106, -0.065)	(-0.104, -0.063)
Additional Income:$30-50K	-0.044	-0.040	-0.054***	-0.049***
	(-0.115, 0.026)	(-0.111, 0.030)	(-0.072, -0.036)	(-0.067, -0.032)
Additional Income:$50-80K	-0.109***	-0.094**	-0.046***	-0.035***
	(-0.186, -0.033)	(-0.170, -0.018)	(-0.065, -0.028)	(-0.053, -0.017)
Additional Income:$80k+	-0.447***	-0.449***	-0.005	-0.002
	(-0.539, -0.356)	(-0.541, -0.358)	(-0.024, 0.013)	(-0.020, 0.016)
Additional Income: Missing	-1.368***	-1.381***	-0.097***	-0.046
	(-1.492, -1.244)	(-1.503, -1.258)	(-0.154, -0.041)	(-0.105, 0.014)
Additional Income: <$15k (ref)	--	--	--	--
Home Ownership				

Homeowner	0.228***	0.225***	0.069***	0.072***
	(0.175, 0.282)	(0.172, 0.278)	(0.054, 0.084)	(0.056 - 0.087)
Non-homeowner (ref)	--	--	--	--
Education				
Secondary School Graduate	0.385***	0.390***	0.100***	0.099***
	(0.292, 0.478)	(0.298, 0.481)	(0.072, 0.129)	(0.071, 0.127)
Beyond High School	0.558***	0.558***	0.293***	0.268***
	(0.474, 0.642)	(0.475, 0.641)	(0.254, 0.331)	(0.232, 0.304)
College or University Graduate	0.881***	0.880***	0.418***	0.407***
	(0.799, 0.963)	(0.799, 0.960)	(0.370, 0.466)	(0.360, 0.455)
Less than High School (ref)	--	--	--	--
Lagged Health & Lifestyle Covariates				
Health Utility Index (HUI)	1.079***	1.088***	0.042*	0.077***
	(0.928, 1.230)	(0.938, 1.238)	(-0.002, 0.087)	(0.035, 0.119)
Health(Very Good)	0.013	0.012	-0.009	-0.003
	(-0.041, 0.068)	(-0.043, 0.066)	(-0.022, 0.004)	(-0.016, 0.010)
Health(Good)	-0.082**	-0.073**	-0.030***	-0.019**
	(-0.145, -0.018)	(-0.136, -0.01)	(-0.045, -0.014)	(-0.035, -0.004)
Health(Fair or Poor)	-0.378***	-0.390***	-0.076***	-0.061***
	(-0.481, -0.274)	(-0.493, -0.288)	(-0.106, -0.046)	(-0.090, -0.032)
Health (Excellent)(ref)	--	--	--	--
1 or more chronic condition(s)	-0.051**	0.930**	-0.028***	-0.025***
	(-0.098, -0.004)	(0.817, 1.059)	(-0.040, -0.016)	(-0.037, -0.014)
No Chronic Diseases (ref)	--	--	--	--
Occasional Smoker - Lagged	0.058	0.044	-0.006	-0.014
	(-0.040, 0.156)	(-0.053, 0.141)	(-0.030, 0.018)	(-0.038, 0.009)
Daily Smoker – Lagged	-0.067**	-0.074***	-0.012*	-0.022***
	(-0.121, -0.014)	(-0.127, -0.021)	(-0.026, 0.001)	(-0.036, -0.009)
Non-Smoker-Lagged (ref)	--	--	--	--
Former Drinker – Lagged	0.133**	0.170***	0.047***	0.032**
	(0.009, 0.256)	(0.047, 0.293)	(0.015, 0.078)	(0.001, 0.063)
Occasional Drinker - Lagged	0.337***	0.357***	0.074***	0.064***
	(0.224, 0.450)	(0.245, 0.469)	(0.045, 0.104)	(0.034, 0.093)
Regular Drinker – Lagged	0.479***	0.499***	0.109***	0.096***

	(0.370, 0.588)	(0.391, 0.608)	(0.079, 0.139)	(0.067, 0.126)
Non-Drinker – Lagged (ref)	--	--	--	--
Cycles				
2004/05 Cycle	0.053*	0.076**	0.020**	0.028***
	(-0.009, 0.114)	(0.015, 0.137)	(0.005, 0.036)	(0.012, 0.044)
2006/07 Cycle	0.128***	0.123***	0.060***	0.066***
	(0.064, 0.192)	(0.060, 0.186)	(0.043, 0.077)	(0.049, 0.083)
2008/09 Cycle	0.145***	0.153***	0.095***	0.104***
	(0.078, 0.213)	(0.085, 0.220)	(0.076, 0.113)	(0.085, 0.123)
2009/10 Cycle	0.129***	0.143***	0.153***	0.163***
	(0.057, 0.201)	(0.071, 0.214)	(0.130, 0.176)	(0.139, 0.187)
2002/03 Cycle (ref)	--	--	--	--
Observations	15,603	15,763	15,603	15,763

Robust CI in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4.10: Model 3 – The association between obesity and log-hourly wage: truncated random-effects with Mundlak correction (using GEEs)

	Truncated Random-Effects W/Group Means Estimated Coefficient: (95% CI)	**Truncated Random-Effects W/ Group Means and Lagged-Obesity** Estimated Coefficient: (95% CI)
Obese	-0.004	
	(-0.032, 0.024)	
Normal/Overweight (ref)	--	--
Obese – Lagged		-0.004
		(-0.034, 0.026)
Normal/Overweight-Lagged (ref)	--	--
Age		
Age	0.065***	0.069***

	(0.054, 0.076)	(0.057, 0.080)
Age^2	-0.001***	-0.001***
	(-0.001, -0.001)	(-0.001, -0.001)
Presence of Child(ren) in Household		
1 Child 5 or under	-0.010	-0.020*
	(-0.032, 0.012)	(-0.042, 0.003)
2 or more Children 5 or under	-0.090***	-0.090***
	(-0.128, -0.053)	(-0.128, -0.051)
No Children 5 or under (ref)	--	--
Immigrant Status		
Immigrant	-0.109***	-0.118***
	(-0.129, -0.089)	(-0.138, -0.098)
Non-immigrant (ref)	--	--
Urban vs. Rural Dwelling		
Urban Living (30-500k)	-0.022*	-0.020
	(-0.048, 0.003)	(-0.044, 0.005)
Urban Living (500k+)	-0.025	-0.026
	(-0.060, 0.010)	(-0.061, 0.009)
Rural (<30k) (ref)	--	--
Marital Status		
Married	0.065***	0.058***
	(0.036 - 0.094)	(0.030, 0.086)
Widowed, Separated, or Divorced	0.059***	0.052***
	(0.021 - 0.098)	(0.014, 0.090)
Single (ref)	--	--
Additional/Spousal Income		
Additional Income:$15-30K	-0.067***	-0.064***
	(-0.090, -0.044)	(-0.087, -0.042)
Additional Income:$30-50K	-0.050***	-0.046***
	(-0.071, -0.029)	(-0.067, -0.025)
Additional Income:$50-80K	-0.064***	-0.051***
	(-0.087, -0.04)	(-0.074, -0.028)
Additional Income:$80k+	-0.055***	-0.047***
	(-0.081, -0.028)	(-0.073, -0.021)

Additional Income: Missing	-0.116***	-0.058*
	(-0.174, -0.058)	(-0.119, 0.002)
Additional Income: <$15k (ref)	--	--
Home Ownership		
Homeowner	0.031***	0.033***
	(0.009, 0.053)	(0.011, 0.055)
Non-homeowner (ref)	--	--
Education		
Secondary School Graduate	-0.024	-0.029
	(-0.128, 0.080)	(-0.129, 0.071)
Beyond High School	0.061	0.018
	(-0.017, 0.139)	(-0.054, 0.090)
College or University Graduate	0.115***	0.085**
	(0.035, 0.195)	(0.010, 0.160)
Less than High School (ref)	--	--
Lagged Health & Lifestyle Covariates		
Health Utility Index (HUI)	-0.004	0.027
	(-0.064, 0.056)	(-0.029, 0.083)
Health(Very Good)	0.005	0.010
	(-0.012, 0.023)	(-0.008, 0.027)
Health(Good)	-0.001	0.006
	(-0.023, 0.021)	(-0.015, 0.027)
Health(Fair or Poor)	-0.046**	-0.034*
	(-0.084, -0.009)	(-0.070, 0.001)
Health (Excellent)(ref)	--	--
1 or more chronic condition(s)	-0.032***	-0.028***
	(-0.050, -0.013)	(-0.046, -0.010)
No Chronic Diseases (ref)	--	--
Occasional Smoker - Lagged	0.007	-0.005
	(-0.027, 0.041)	(-0.039, 0.029)
Daily Smoker – Lagged	0.020	0.008
	(-0.009, 0.049)	(-0.021, 0.038)
Non-Smoker-Lagged (ref)	--	--
Former Drinker - Lagged	0.052**	0.023

	(0.009, 0.095)	(-0.020, 0.065)
Occasional Drinker - Lagged	0.071***	0.042*
	(0.026, 0.116)	(-0.002, 0.086)
Regular Drinker - Lagged	0.077***	0.046**
	(0.031, 0.123)	(0.001, 0.092)
Non-Drinker – Lagged (ref)	--	--
Cycles		
2004/05 Cycle	0.032**	0.027**
	(0.007, 0.057)	(0.002, 0.051)
2006/07 Cycle	0.077***	0.063***
	(0.040, 0.113)	(0.027, 0.098)
2008/09 Cycle	0.120***	0.101***
	(0.071, 0.168)	(0.054, 0.147)
2010/11 Cycle	0.183***	0.156***
	(0.120, 0.245)	(0.096, 0.216)
2002/03 Cycle (ref)	--	--
Observations	11,279	11,419

Note: the full model is in Table B.2

Robust CI in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 4.4: The average annual income among Canadian women from 2000/1 to 2010/11.

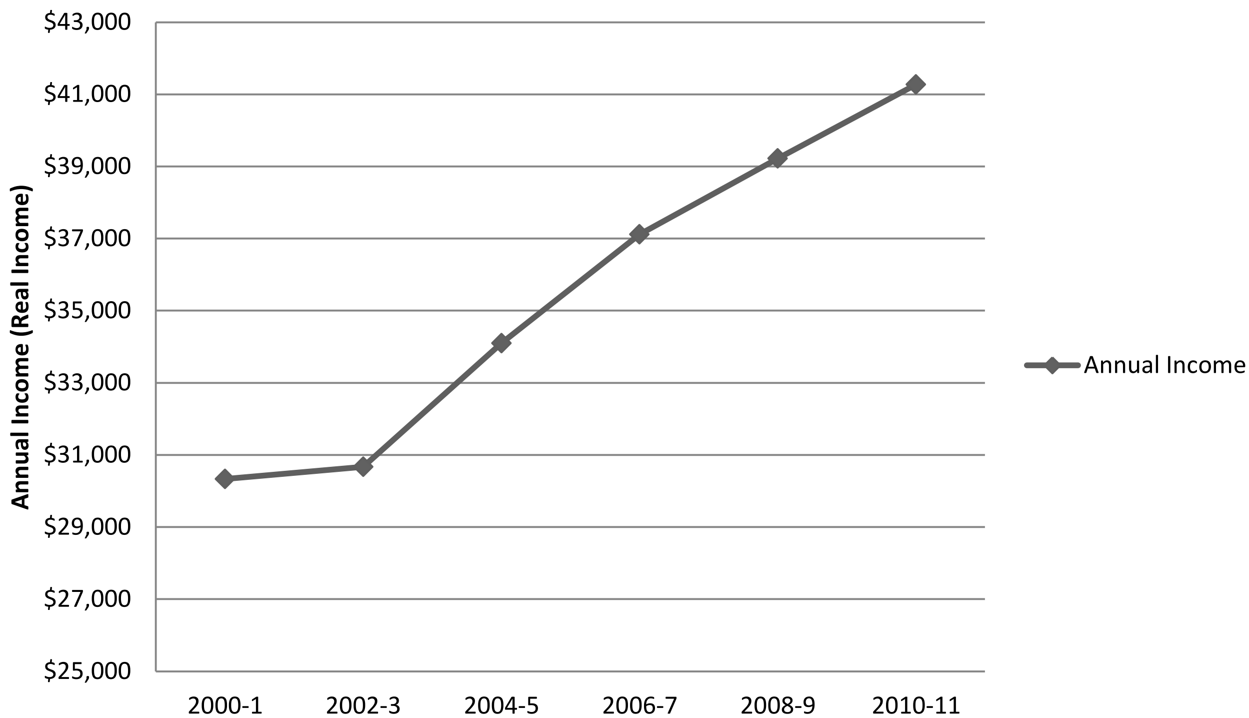


Table 4.11: The impact of obesity on income: basic linear regressions

	W/ Basic Social and Demographic Confounders β: (95% CI)	**W/ Health and Lifestyle Confounders** β: (95% CI)
Obesity	-0.067***	-0.031
	(-0.107, -0.026)	(-0.074, 0.012)
Observations	10,751	10,287
R^2	0.218	0.239

Robust CI in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4.12: Model 1 – The association between obesity and log-annual income: pooled and truncated random-effects regressions (using GEEs)

	Pooled Estimated Coefficient: (95% CI)	**Pooled W/ Lagged Obesity** Estimated Coefficient: (95% CI)	**Truncated Random-Effects** Estimated Coefficient: (95% CI)	**Truncated Random-Effects W/ Lagged Obesity** Estimated Coefficient: (95% CI)
Obese	-0.226***		-0.066***	
	(-0.382, -0.070)		(-0.088, -0.044)	
Normal/Overweight (ref)	--	--	--	--
Obese - Lagged		-0.237***		-0.021**
		(-0.399, -0.075)		(-0.04, -0.002)
Normal/Overweight-Lagged (ref)	--	--	--	--
Age				
Age	0.430***	0.410***	0.102***	0.104***
	(0.373, 0.487)	(0.352, 0.468)	(0.083, 0.121)	(0.085, 0.124)
Age^2	-0.006***	-0.005***	-0.001***	-0.001***
	(-0.006, -0.005)	(-0.006, -0.005)	(-0.001, -0.001)	(-0.001, -0.001)
Presence of Child(ren) in Household				
1 Child 5 or under	-0.917***	-0.988***	-0.057***	-0.074***
	(-1.132, -0.701)	(-1.207, -0.770)	(-0.083, -0.031)	(-0.101, -0.046)
2 or more Children 5 or under	-2.012***	-1.999***	-0.240***	-0.289***
	(-2.327, -1.698)	(-2.339, -1.660)	(-0.296, -0.183)	(-0.356, -0.222)
No Children 6 to 11 (ref)	--	--	--	--
Immigrant Status				
Immigrant	-0.555***	-0.531***	-0.091***	-0.094***
	(-0.799, -0.310)	(-0.779, -0.284)	(-0.119, -0.064)	(-0.122, -0.066)
Non-immigrant (ref)	--	--	--	--
Urban vs. Rural Dwelling				
Urban Living (30-500k)	0.502***	0.508***	-0.039***	-0.024*
	(0.304, 0.700)	(0.309, 0.706)	(-0.064, -0.013)	(-0.049, 0.001)
Urban Living (500k+)	1.095***	1.086***	0.134***	0.141***
	(0.882, 1.308)	(0.871, 1.300)	(0.100, 0.167)	(0.106, 0.176)
Rural (<30k) (ref)	--	--	--	--

Marital Status				
Married	-0.491***	-0.385***	0.079***	0.096***
	(-0.713, -0.270)	(-0.608, -0.161)	(0.051, 0.108)	(0.065, 0.126)
Widowed, Separated, or Divorced	0.067	0.101	0.125***	0.135***
	(-0.187, 0.321)	(-0.155, 0.358)	(0.088, 0.162)	(0.096, 0.174)
Single (ref)	--	--	--	--
Additional/Spousal Income				
Additional Income:$15-30K	0.2048	0.107	-0.145***	-0.137***
	(-0.034, 0.442)	(-0.133, 0.347)	(-0.185, -0.104)	(-0.176, -0.097)
Additional Income:$30-50K	0.307***	0.234**	-0.167***	-0.151***
	(0.082, 0.532)	(0.005, 0.462)	(-0.208, -0.126)	(-0.191, -0.112)
Additional Income:$50-80K	-0.012	-0.060	-0.181***	-0.164***
	(-0.256, 0.231)	(-0.306, 0.186)	(-0.225, -0.136)	(-0.206, -0.122)
Additional Income:$80k+	-1.211***	-1.202***	-0.200***	-0.192***
	(-1.5 00, -0.921)	(-1.495, -0.909)	(-0.251, -0.149)	(-0.242, -0.142)
Additional Income: Missing	-5.241***	-5.428***	-0.252***	-0.174***
	(-5.644, -4.838)	(-5.838, -5.018)	(-0.332, -0.172)	(-0.250, -0.098)
Additional Income: <$15k (ref)	--	--	--	--
Home Ownership				
Homeowner	0.814***	0.757***	0.037***	0.035***
	(0.645, 0.984)	(0.585, 0.929)	(0.018, 0.057)	(0.015, 0.054)
Non-homeowner (ref)	--	--	--	--
Education				
Secondary School Graduate	1.631***	1.670***	0.116***	0.134***
	(1.339, 1.922)	(1.374, 1.965)	(0.075, 0.158)	(0.090, 0.177)
Beyond High School	2.002***	2.020***	0.271***	0.248***
	(1.740, 2.264)	(1.755, 2.285)	(0.213, 0.329)	(0.192, 0.303)
College or University Graduate	2.865***	2.878***	0.516***	0.517***
	(2.613, 3.116)	(2.624, 3.133)	(0.418, 0.614)	(0.417, 0.617)
Less than High School (ref)	--	--	--	--
Cycles				
2002/03 Cycle	0.066	--	-0.005	--
	(-0.147, 0.280)		(-0.028, 0.018)	
2004/05 Cycle	0.132	0.246**	0.089***	0.110***

	(-0.089, 0.353)	(0.049, 0.443)	(0.058, 0.120)	(0.077, 0.144)
2006/07 Cycle	0.319***	0.291***	0.135***	0.149***
	(0.092, 0.547)	(0.086, 0.496)	(0.099, 0.171)	(0.112, 0.187)
2008/09 Cycle	0.365***	0.409***	0.190***	0.212***
	(0.125, 0.606)	(0.189, 0.628)	(0.144, 0.236)	(0.162, 0.262)
2010/11 Cycle	0.181	0.293**	0.246***	0.267***
	(-0.067, 0.429)	(0.062, 0.523)	(0.193, 0.300)	(0.210, 0.324)
2000/02 Cycle (ref)	--	N/A	--	N/A
2002/03 Cycle (ref)	N/A	--	N/A	--
Observations	13,993	13,662	13,993	13,662

Robust CI in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4.13: Model 2 – The association between obesity and log-annual income: pooled and truncated random-effects regressions (using GEEs)

	Pooled Estimated Coefficient: (95% CI)	**Pooled W/ Lagged Obesity** Estimated Coefficient: (95% CI)	**Truncated Random-Effects** Estimated Coefficient: (95% CI)	**Truncated Random-Effects W/ Lagged Obesity** Estimated Coefficient: (95% CI)
Obese	0.028		-0.062***	
	(-0.131, 0.188)		(-0.084, -0.040)	
Normal/Overweight (ref)	--	--	--	--
Obese - Lagged		0.048		-0.009
		(-0.116, 0.211)		(-0.028, 0.011)
Normal/Overweight-Lagged (ref)	--	--	--	--
Age				
Age	0.425***	0.413***	0.102***	0.102***
	(0.367, 0.482)	(0.357, 0.470)	(0.082, 0.122)	(0.082, 0.122)
Age^2	-0.005***	-0.005***	-0.001***	-0.001***
	(-0.006, -0.005)	(-0.006, -0.004)	(-0.001, -0.001)	(-0.001, -0.001)
Presence of Child(ren) in Household				
1 Child 5 or under	-0.979***	-1.017***	-0.051***	-0.065***
	(-1.195, -0.764)	(-1.233, -0.802)	(-0.077, -0.025)	(-0.092, -0.038)

2 or more Children 5 or under	-2.015***	-2.003***	-0.224***	-0.278***
	(-2.327, -1.702)	(-2.337, -1.669)	(-0.280, -0.168)	(-0.344, -0.212)
No Children 6 to 11 (ref)	--	--	--	--
Immigrant Status				
Immigrant	-0.264**	-0.292**	-0.064***	-0.068***
	(-0.514, -0.013)	(-0.541, -0.043)	(-0.089, -0.038)	(-0.094, -0.042)
Non-immigrant (ref)	--	--	--	--
Urban vs. Rural Dwelling				
Urban Living (30-500k)	0.502***	0.470***	-0.024*	-0.018
	(0.305, 0.699)	(0.275, 0.665)	(-0.049, 0.001)	(-0.043, 0.007)
Urban Living (500k+)	1.031***	1.002***	0.154***	0.150***
	(0.818, 1.244)	(0.791, 1.213)	(0.117, 0.192)	(0.113, 0.187)
Rural (<30k) (ref)	--	--	--	--
Marital Status				
Married	-0.452***	-0.409***	0.082***	0.098***
	(-0.674, -0.229)	(-0.629, -0.189)	(0.053, 0.112)	(0.066, 0.129)
Widowed, Separated, or Divorced	0.252*	0.238*	0.131***	0.137***
	(-0.003, 0.507)	(-0.014, 0.491)	(0.091, 0.170)	(0.097, 0.177)
Single (ref)	--	--	--	--
Additional/Spousal Income				
Additional Income:$15-30K	0.104	0.072	-0.139***	-0.142***
	(-0.134, 0.342)	(-0.164, 0.308)	(-0.179, -0.098)	(-0.182, -0.101)
Additional Income:$30-50K	0.084	0.081	-0.162***	-0.158***
	(-0.142, 0.310)	(-0.144, 0.306)	(-0.204, -0.120)	(-0.198, -0.117)
Additional Income:$50-80K	-0.256**	-0.236*	-0.179***	-0.172***
	(-0.500, -0.012)	(-0.478, 0.006)	(-0.225, -0.134)	(-0.216, -0.128)
Additional Income:$80k+	-1.381***	-1.356***	-0.185***	-0.201***
	(-1.670, -1.091)	(-1.645, -1.067)	(-0.234, -0.135)	(-0.254, -0.149)
Additional Income: Missing	-4.975***	-5.094***	-0.242***	-0.178***
	(-5.387, -4.563)	(-5.503, -4.685)	(-0.322, -0.162)	(-0.256, -0.100)
Additional Income: <$15k (ref)	--	--	--	--
Home Ownership				
Homeowner	0.602***	0.604***	0.030***	0.037***
	(0.431, 0.773)	(0.434, 0.774)	(0.010, 0.049)	(0.017, 0.058)

Non-homeowner (ref)	--	--	--	--
Education				
Secondary School Graduate	1.310***	1.362***	0.099***	0.121***
	(1.015, 1.605)	(1.070, 1.654)	(0.058, 0.140)	(0.078, 0.164)
Beyond High School	1.642***	1.685***	0.248***	0.233***
	(1.375, 1.910)	(1.420, 1.949)	(0.191, 0.304)	(0.179, 0.287)
College or University Graduate	2.379***	2.415***	0.496***	0.504***
	(2.119, 2.639)	(2.157, 2.672)	(0.397, 0.595)	(0.404, 0.603)
Less than High School (ref)	--	--	--	--
Lagged Health & Lifestyle Covariates				
Health Utility Index (HUI)	3.655***	3.615***	0.059*	0.103***
	(3.166, 4.145)	(3.129, 4.101)	(-0.006, 0.124)	(0.037, 0.168)
Health(Very Good)	0.111	0.097	-0.029***	-0.025**
	(-0.062, 0.285)	(-0.076, 0.270)	(-0.049, -0.009)	(-0.045, -0.005)
Health(Good)	-0.148	-0.129	-0.057***	-0.037***
	(-0.350, 0.055)	(-0.330, 0.073)	(-0.082, -0.032)	(-0.060, -0.014)
Health(Fair or Poor)	-1.162***	-1.246***	-0.091***	-0.075***
	(-1.497, -0.828)	(-1.578, -0.914)	(-0.139, -0.043)	(-0.121, -0.029)
Health (Excellent)(ref)	--	--	--	--
1 or more chronic condition(s)	-0.141*	-0.143*	-0.044***	-0.043***
	(-0.290, 0.007)	(-0.291, 0.004)	(-0.063, -0.026)	(-0.061, -0.024)
No Chronic Diseases (ref)	--	--	--	--
Occasional Smoker - Lagged	0.224	0.195	0.020	0.029
	(-0.085, 0.533)	(-0.112, 0.502)	(-0.016, 0.055)	(-0.006, 0.063)
Daily Smoker - Lagged	-0.184**	-0.184**	0.023**	0.005
	(-0.354, -0.014)	(-0.352, -0.016)	(0.003, 0.043)	(-0.014, 0.025)
Non-Smoker-Lagged (ref)	--	--	--	--
Former Drinker - Lagged	0.444**	0.608***	0.002	-0.004
	(0.052, 0.836)	(0.218, 0.998)	(-0.039, 0.043)	(-0.046, 0.038)
Occasional Drinker - Lagged	1.103***	1.188***	0.109***	0.099***
	(0.745, 1.460)	(0.832, 1.544)	(0.066, 0.153)	(0.057, 0.142)
Regular Drinker - Lagged	1.315***	1.423***	0.153***	0.149***
	(0.969, 1.661)	(1.078, 1.767)	(0.106, 0.199)	(0.103, 0.195)
Non-Drinker – Lagged (ref)	--	--	--	--

Cycles				
2004/05 Cycle	0.125	0.214**	0.092***	0.108***
	(-0.070, 0.320)	(0.020, 0.408)	(0.061, 0.122)	(0.075, 0.141)
2006/07 Cycle	0.336***	0.292***	0.141***	0.150***
	(0.133, 0.539)	(0.090, 0.494)	(0.104, 0.178)	(0.112, 0.188)
2008/09 Cycle	0.365***	0.377***	0.198***	0.212***
	(0.147, 0.582)	(0.160, 0.594)	(0.149, 0.247)	(0.161, 0.262)
2010/11 Cycle	0.234**	0.274**	0.258***	0.269***
	(0.004, 0.464)	(0.045, 0.503)	(0.201, 0.315)	(0.210, 0.328)
2002/03 Cycle (ref)	--	--	--	--
Observations	13,284	13,407	13,284	13,407

Robust CI in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4.14: Model 3 – The association between obesity and log-annual income: truncated random-effects with Mundlak correction (using GEEs)

	Truncated Random-Effects W/Group Means Estimated Coefficient: (95% CI)	**Truncated Random-Effects W/ Group Means and Lagged-Obesity** Estimated Coefficient: (95% CI)
Obese	-0.040**	
	(-0.079, -0.001)	
Normal/Overweight (ref)	--	--
Obese – Lagged		0.022
		(-0.020, 0.064)
Normal/Overweight-Lagged (ref)	--	--
Age		
Age	0.116***	0.116***
	(0.090, 0.141)	(0.090, 0.141)
Age^2	-0.001***	-0.001***

	(-0.001, -0.001)	(-0.001, -0.001)
Presence of Child(ren) in Household		
1 Child 5 or under	-0.058***	-0.072***
	(-0.092, -0.025)	(-0.106, -0.039)
2 or more Children 5 or under	-0.240***	-0.295***
	(-0.305, -0.176)	(-0.369, -0.221)
No Children 5 or under (ref)	--	--
Immigrant Status		
Immigrant	-0.044***	-0.054***
	(-0.068, -0.019)	(-0.079, -0.028)
Non-immigrant (ref)	--	--
Urban vs. Rural Dwelling		
Urban Living (30-500k)	-0.036*	-0.025
	(-0.072, 0.000)	(-0.061, 0.012)
Urban Living (500k+)	0.074***	0.050**
	(0.022, 0.126)	(0.001, 0.099)
Rural (<30k) (ref)	--	--
Marital Status		
Married	0.107***	0.126***
	(0.061, 0.153)	(0.078, 0.173)
Widowed, Separated, or Divorced	0.150***	0.149***
	(0.085, 0.215)	(0.084, 0.214)
Single (ref)	--	--
Additional/Spousal Income		
Additional Income:$15-30K	-0.119***	-0.122***
	(-0.163, -0.074)	(-0.167, -0.077)
Additional Income:$30-50K	-0.156***	-0.154***
	(-0.203, -0.109)	(-0.200, -0.108)
Additional Income:$50-80K	-0.180***	-0.175***
	(-0.232, -0.128)	(-0.226, -0.125)
Additional Income:$80k+	-0.197***	-0.222***
	(-0.257, -0.137)	(-0.286, -0.158)
Additional Income: Missing	-0.219***	-0.173***
	(-0.302, -0.136)	(-0.253, -0.092)

Additional Income: <$15k (ref)	--	--
Home Ownership		
Homeowner	-0.011	-0.007
	(-0.041, 0.019)	(-0.037, 0.024)
Non-homeowner (ref)	--	--
Education		
Secondary School Graduate	-0.134**	-0.045
	(-0.263, -0.004)	(-0.174, 0.084)
Beyond High School	-0.183***	-0.154***
	(-0.286, -0.080)	(-0.258, -0.051)
College or University Graduate	0.027	0.077
	(-0.071, 0.125)	(-0.024, 0.178)
Less than High School (ref)	--	--
Lagged Health & Lifestyle Covariates		
Health Utility Index (HUI)	0.010	0.055
	(-0.074, 0.095)	(-0.029, 0.139)
Health(Very Good)	-0.016	-0.014
	(-0.042, 0.011)	(-0.040, 0.011)
Health(Good)	-0.030*	-0.019
	(-0.062, 0.002)	(-0.049, 0.012)
Health(Fair or Poor)	-0.059**	-0.050*
	(-0.117, -0.002)	(-0.105, 0.006)
Health (Excellent)(ref)	--	--
1 or more chronic condition(s)	-0.061***	-0.061***
	(-0.090, -0.031)	(-0.090, -0.031)
No Chronic Diseases (ref)	--	--
Occasional Smoker – Lagged	0.013	0.026
	(-0.041, 0.066)	(-0.026, 0.078)
Daily Smoker – Lagged	0.040*	0.028
	(-0.005, 0.085)	(-0.018, 0.073)
Non-Smoker-Lagged (ref)	--	--
Former Drinker – Lagged	-0.003	-0.019
	(-0.058, 0.052)	(-0.076, 0.038)
Occasional Drinker – Lagged	0.093***	0.069**

	(0.030, 0.155)	(0.007, 0.131)
Regular Drinker – Lagged	0.092***	0.074**
	(0.029, 0.156)	(0.011, 0.137)
Non-Drinker – Lagged (ref)	--	--
Cycles		
2004/05 Cycle	0.073***	0.081***
	(0.033, 0.114)	(0.040, 0.121)
2006/07 Cycle	0.106***	0.099***
	(0.051, 0.160)	(0.047, 0.152)
2008/09 Cycle	0.152***	0.145***
	(0.078, 0.227)	(0.073, 0.217)
2010/11 Cycle	0.198***	0.181***
	(0.107, 0.289)	(0.093, 0.269)
2002/03 Cycle (ref)	--	--
Observations	13,284	13,407

Note: the full model is in Table B.3

Robust CI in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4.15: Summary of results from all regression models

	Model 1: Basic Social and Demographic Variables				**Model 2:** Health and Lifestyle Variables				**Model 3:** Mundlak Correction using Group Means	
	Pooled	**Pooled w/ LO**	**RE**	**RE w/ LO**	**Pooled**	**Pooled w/ LO**	**RE**	**RE w/ LO**	**RE w/ Group Means**	**RE w/ Group Means & LO**
Employment	S	S	NS	NS	NS	NS	NS	NS	NS	NS
Earnings (Wage)	S	S	S	S	NS	NS	S	S	NS	NS
Earnings (Income)	S	S	S	S	NS	NS	S	NS	S	NS

NS = Not Statistically Significant, S = Statistically Significant at the 5% level, RE = Random-Effects, LO = Lagged-Obesity

Table 4.16: Summary of evidence and thesis hypotheses

	Hypothesis	**Does the evidence support the hypothesis?**
Employment	There is a negative association between obesity and labour market participation.	Does not support.
	The negative association between obesity and labour market participation persists after accounting for unobserved heterogeneity bias.	Does not support.
Earnings (Wage)	There is a negative association between obesity and hourly wage rate.	Supports.
	The negative association between obesity and hourly wage rate persists after accounting for unobserved heterogeneity bias.	Does not support.
Earnings (Income)	There is a negative association between obesity and annual income.	Supports (except for Model 2 random-effects using lagged-obesity).
	The negative association between obesity and annual income persists after accounting for unobserved heterogeneity bias.	Supports without lagged-obesity. Does not support with lagged-obesity.

Table 4.17: Skewness scores of wage and income before and after log transformation

Survey Years	Wage	Log Wage	Income	Log Income
2000-1	3.450	0.084	4.814	-0.888
2002-3	1.850	-0.025	1.776	-1.006
2004-5	5.432	0.017	2.771	-0.842
2006-7	3.625	0.030	2.461	-0.781
2008-9	2.398	-0.023	1.976	-0.848
2010-11	3.860	0.008	3.338	-0.644

Chapter 5

5 Discussion

Over the past decade the proportion of obese (BMI >30) women in Canada aged 18 to 65 increased by approximately 10%, and overweight women (24.99 < BMI < 30) by nearly 6%. The increase in obesity prevalence is not unique to the Canadian population; in fact, the global prevalence of obesity has doubled since 1980 and is associated with an array of chronic conditions and obesity related co-morbidities (51). A high BMI is a major risk factor for non-communicable diseases such as cardiovascular diseases (primarily CHD and stroke), type II diabetes, musculoskeletal disorders (like osteoarthritis) and cancers (including colon, breast and endometrial) (51). Moreover, the risk for these chronic diseases amplifies as an individual's BMI score approaches the obesity threshold (172). Although numerous studies have been published regarding the direct effect of obesity on health issues, less research has been undertaken on the indirect impact of obesity on labour market outcomes.

In regards to the labour market outcomes, employment rates decreased while the average wage and income increased over the past decade. Among Canadian women, the proportion who reported to be employed decreased by approximately 7% over the study period (79.3% in 2000/1 to 72.1% in 2010/11). However, among Canadian women who were employed, both the average hourly wage rate (for full-time workers) and average annual income increased by $4.21 per hour and $10,943.50 per year, respectively. These changes in average earnings were estimated after correcting for inflation over the six survey cycles using the Consumer Price Index (CPI) (162).

The objective of this study was to analyze the association between obesity and labour market outcomes among women in Canada. Specifically, this study aimed to describe the impact of obesity on employment and earnings (wage rate and income) in the Canadian female population while accounting for the confounding effects of numerous socio-economic, demographic, health and lifestyle variables as well as unobserved heterogeneity bias. The results provided an empirical estimate of the impact that obesity has on employment participation and earnings compared to non-obese women.

The last six cycles (or 12 years), of longitudinal data from the NPHS was utilized. Pooled, random-effects and fixed-effects regression models were considered. Model 1 consisted of socioeconomic and demographic confounders, which was analyzed using pooled and random-effects GEEs in addition to truncated models for the earnings outcomes. Model 2 utilized the same statistical techniques but differed from Model 1 due to the inclusion of lagged-health and lifestyle variables. Model 3 focused on unobserved heterogeneity bias by conditioning out the fixed-effects. However, due to the incidental parameters issue, a standard fixed-effects regression was not available in non-linear models. Therefore, the Mundlak correction approach was employed using a random-effects regression with inclusion of the group means of time-varying explanatory variables.

The empirical findings showed that there is a negative impact of obesity on employment and earnings among Canadian women, which remained statistically significant for wage rate and income in Model 2 and income in Model 3. The results also suggested that ignoring the influence of unobserved heterogeneity bias can result in markedly different findings and in turn may produce misleading conclusions. This chapter will discuss the results of all three outcomes in addition to common findings from the confounding variables across all models and outcomes, including a sensitivity analysis for additional non-wage income. Finally, the chapter will discuss the strengths and limitations of the study and then conclude by summarizing the implications and recommendations for future research.

5.1 Overview of Findings

The effect of obesity on employment participation was not significant after controlling for potential health-related confounders and unobserved heterogeneity bias. Wage rate was negatively associated with obesity in Models 1 and 2 and was statistically significant. When unobserved heterogeneity bias was controlled for, the effect of obesity on wage rate became statistically non-significant. However, income remained statistically significant in Model 3 except for when lagged-obesity was utilized.

The influence of health variables was present and significant in all models for all three outcomes. Moreover, it was quite clear that self-reported poor health, HUI score and the presence of chronic disease had a negative influence on the probability of employment and earnings as expressed by wage or income. This showed that poor health may account for some of the variation in labour market participation and earnings among women. In the employment models the inclusion of health variables had an even greater influence. When the health and lifestyle variables were added to the model the association between obesity and employment lost its statistical significance. This means that the negative influence between obesity and labour market participation can be attributed to poor health, low HUI and/or chronic conditions and not as a direct result of obesity. This was only the case when the outcome was employment as the association between obesity and earnings remained after the inclusion of health and lifestyle variables suggesting that the negative influence on earnings was directly related to being obese. Overall, the confounding effect of health status that was found in the literature review was also a consistent finding within my results.

The results of my thesis are similar to studies of other countries. The majority of studies found that there was a negative influence of obesity on the labour market outcomes of women. This is akin to my findings for earnings, but less true for the influence of obesity on the probability of employment. In regards to accounting for unobserved heterogeneity, there was great variation in results which is reflected in my findings in that the effect of obesity on wage failed to have an effect but the influence on annual income had a negative effect after consideration of unobserved individual heterogeneity. A more in-depth look at the results as well as a comparison to the findings from the literature review will be discussed in the next two sections on employment and earnings.

5.1.1 Employment

The association between employment and obesity among Canadian women was significant in the pooled regression with Model 1 confounders. However, this was the only model where the effect of obesity was found to be associated with lower odds of employment at a 5% level of significance. The inclusion of Model 2 confounders in both the random-effects and fixed-effects regressions caused the association to lose statistical significance. This implies that the inclusion of potential confounders account for some of the negative effect of obesity on employment. The use of panel data to control for time-invariant unobserved heterogeneity resulted in statistically non-significant associations suggesting that both within-subject and between-subject variations may have had an important effect on the overall association.

Considering the results from Models 1 and 2, the findings were similar to other longitudinal studies in that obese women were less likely to be employed (25) and the effect was reduced or became statistically non-significant with the inclusion of health or lifestyle related variables (27, 30). For example, Pit and Byles found a significant negative effect of obesity on employability using a GEE model which also failed to be statistically significant in a model including health and lifestyle variables (29). Notably, their population only included women aged 45-50 (29). The findings differed from those of Jusot *et al.* in that their results remained significant with the inclusion of health and smoking variables (26). In regards to the findings from Model 3 (or the models accounting for unobserved heterogeneity bias), the results of this study failed to find a statistically significance effect. This is consistent with the studies conducted by Cawley, and Norton and Han, as controlling for omitted variables caused the final model to be non-significant (6, 11). The empirical results from the employment models were very similar to the 2007 study by Garcia and Quintana-Domeque (12) in regards to both the fixed-effects methodology and the results. This study also found a negative association, but it lost statistical significance in the fixed-effects regression using lagged-BMI as an exposure measure and with the inclusion of health status. In contrast, a few studies showed statistically significant effects after controlling for unobserved heterogeneity bias using instrumental variables or fixed-effects methods (10, 31, 32). Overall, the findings of this study were consistent with several studies in that the effect of health and lifestyle variables was present in the association between obesity and employment (Model 2) and that unobserved hetereogeneity bias influenced the association as seen by the lack of statistical significance when the fixed-effects models were used (Model 3).

5.1.2 Earnings (Wage rate and Income)

The nature of the association between obesity and earnings was similar when using wage rate and income, but the results varied slightly when time-invariant unobserved heterogeneity bias was accounted for. The association between obesity and hourly wage rate among Canadian women was supportive of the first hypothesis. Moreover, the population-averaged effect on hourly wage rate due to obesity was highly significant in the truncated random-effects models. The negative association remained significant with the addition of confounders from Models 1 and 2. After accounting for unobserved heterogeneity bias, the association became statistically non-significant suggesting an influence of omitted variables bias or omitted variables correlated with the explanatory variables.

The association between obesity and annual income among Canadian women was supportive of both hypotheses. In Model 1, the association was negative and significant in the pooled regression as well as in the truncated random-effects models, however controlling for the between-subject variability using random-effects decreased the magnitude of the effect of obesity on income. The addition of Model 2 confounders (health and lifestyle variables) resulted in a statistically significant effect in the random-effects model. Also in Model 2, the use of lagged-obesity as the exposure measure caused the statistical significance to disappear. Model 3 was robust to the omitted variable bias suggesting that the negative association between obesity and income remained even after unobserved heterogeneity bias was accounted for. However, with the use of lagged-obesity as an exposure measure led to statistically non-significant findings.

Collectively, earnings as expressed by both hourly wage rate (if employed full-time) and annual income (from wages and salaries) were found to be negatively associated with obesity among women when compared to the earnings of non-obese women. The size of the effect for both earnings outcomes was influenced by the use of lagged-obesity in place of using a current obesity indicator which in many cases lessened the effect or caused the model to lose significance (as seen in Models 2 and 3 for income). Although the study by Averett did not account for unobserved heterogeneity bias, the results were similar in that the impact of obesity was explored for both income and wage rate and that obesity had a significant negative effect on overall earnings (39). The results for models assessing the effect of obesity on wage rate were consistent with previous studies by Han *et al.*, Norton and Han, Bozoyan *et al.*, and Garcia-Villar and Quintana-Domeque in that the effect was negative in the OLS models but failed to find statistical significance in the analyses controlling for unobserved heterogeneity bias (11, 12, 42, 45). The results for income were largely consistent with studies that found statistically significant effects even after accounting for unobserved heterogeneity bias via fixed-effects or instrumental variables methods (6, 8, 31, 40). However, the effects of income differed from Cawley's 2004 study (7) in that Cawley's results remained statistically significant with the use of lagged-BMI while my results did not.

5.2 Relationship between confounders and employment or earnings

The inclusion of potential confounders yielded many consistent findings across the outcomes and for pooled, random and fixed-effects models. For example age and age^2 were highly significant for employment, wage rate, and income suggesting a quadratic relationship across all models. Moreover as age increased so did the probability of employment and effect on earnings, although at a certain age the effect decreased. For the employment models the probability of employment participation increased in the neighbourhood of 37 to 54 years (depending on the model) and decreased thereafter. The wage models showed that between the ages of 33 and 41 a woman's hourly wage rate reached a turning point and started to decrease thereafter, while for income the point in which income stopped increasing with age and began to decline ranged in models in the neighbourhood of 36 to 51 years. This is consistent with the literature suggesting a non-linear effect of age on labour market outcomes (15, 25, 45). An indicator for the presence of children under the age of five was included as it accounted for children before they were eligible to attend school and therefore required more care from their family or mother. The presence of children under the age of five was found to be negatively associated with a woman's employment and earnings in this study. This became especially apparent when there were two or more children under the age of five in the household compared to women with no children. This is in agreement with several previous studies on the effect of the number of biological children (15) and children under twelve (8, 46) on the association between obesity and earnings; however, my results differed from other studies that found no association between the presence of children in the family and employment outcomes (4, 28, 30).

Immigration or non-Canadian born women were found to be negatively associated with the earnings outcomes, which is in agreement with previous literature (23). Urban living (cities with 500,000 populations and over) was significantly associated with higher odds of employment as well as higher average wage rate and income which were similarly hypothesized in previous studies (40, 41, 47). This implied that large Canadian cities are positively linked to better rates of employment as well as higher earnings. In regards to marital status, the effect was less consistent between models although the findings largely showed that married women have lower odds of employment and lower earnings (if employed). However, the relationship between marriage and earnings became positive in the truncated random-effects models. This is similar to Greve's findings that the effect of being married was negative for employment but positive for wage (10), which is also comparable to Averett and Korenman's finding that being married had a positive effect on the influence between obesity and earnings (in the final model)(39).

Findings for additional income or non-wage income were fairly consistent among all outcomes and models. Akin to the 1996 study by Averett and Korenman, spousal earnings were found to be significant in a model exploring the effect of obesity on earnings (39). In regards to employment participation, women who had access to large spousal income (non-wage income greater than $80,000) were less likely to work, while women with access to lower non-wage income ($15,000 to 30,000 and $30,000 to 50,000) were more likely to be employed compared to women with access to less than $15,000 non-wage income. For all models (pooled, random-effects and Mundlak corrected) it was found that additional spousal income was associated with a lower wage rate but the effect was particularly evident for women with spousal income between $50,000 and 80,000 and even more so with spousal incomes greater than $80,000. The findings for both participation and earnings align with the idea that women who have financially successful partners do not need to participate in the workforce and if they do it is seldom in high paying jobs. These findings are comparable to studies that found that higher household incomes result in lower employment participation (24), lower earnings (44), or both (6, 12).

Interestingly, the inclusion of a missing category for additional income was found to be significant in many of the models. A sensitivity analysis was conducted to assess the difference between women who reported their additional income versus the missing sub-sample. Comparing the proportions of various socio-economic, demographic and lifestyle variables there were a few inherent differences between the two groups. Pooling years, women who reported additional non-wage income were less often immigrants (14.4% compared to 20.3%), were less likely to have not completed a high school education (7.8% compared to 17.4%), were more likely to be college or university graduates (49.8% compared to 37.1%) and were more likely to be regular drinkers (62.3%compared to 51.3%). In regards to labour market variables, women who reported additional income compared to those who did not were found to have higher participation rate in the workforce (80.1% compared to 55.6%), had a higher hourly wage rate

($18.73 compared to $13.77) and a higher level of annual personal income ($34,980 compared to $21,435). Overall the direction of the effect on employment and earnings was negative for the missing income category.

Homeownership was found to be associated with higher odds of employment in addition to a higher average income and/or hourly wage. Education was also significant as shown by the higher odds of employment and higher average earnings for high school graduates, women who went beyond high school education and college or university graduates. This was particularly true for university or college graduates when compared to women with less than high school education. Many studies also controlled for education as a means of accounting for SES and my results were consistent with the vast majority of studies in the literature (5, 8, 10, 25, 30, 42).

As expected, poor health was found to negatively impact the odds of employment and earnings. HUI was associated with higher odds of employment and higher earnings with each increase in the average HUI score. This was highly significant across the outcomes and models ($P<0.01$). Likewise, poor self-rated health compared to excellent self-reported health showed significantly lower odds of employment, lower hourly wage rate and annual income. This was a common finding in the literature regarding the effect of obesity on employment and earnings (4, 5, 16, 17, 19, 23, 26). This shows that poor health does lower a woman's probability of being employed and wage rate and annual income if employed. In the case of employment, poor health accounts for the negative association between obesity and probability of employment as when it was added to the model the significant association between the primary variables of interest was lost. Consideration of lifestyle variables found that smoking was associated with lower earnings when compared to non-smoking; although this was unclear across models and not significant with employment probability. Regular drinking on the other hand was found to be consistently associated with higher odds of employment and if employed, higher earnings compared to non-drinkers. This implies that regular drinking, as defined in the survey as at least one drink a month up to one drink a day, may be a socially acceptable behaviour among women in Canada.

Lastly, the effect of time as expressed through the inclusion of cycle dummy variables showed that earnings (wage rate and income) were increasing over time but this effect was not statistically significant in the employment models.

5.3 Strengths

This is the first study in Canada to examine the association between obesity and labour market participation among women. By focusing on women, the explanatory variables and overall association resulted in empirical findings more representative of the female working population over time. The longitudinal study design was another key strength of this study. It not only assisted in controlling the temporality of the study (173) but it allowed for the use of panel data statistical techniques such as the random- and fixed-effects models. As cross-sectionals models would have failed to show the true causal effect of obesity, the ability to use longitudinal analyses was a major strength of this study. Although panel data analysis does not guarantee the results to be causal, the ability to control for within and between-subject variation in addition to time-invariant unobserved hetereogeneity bias allowed to better capture some unknown confounders.

The NPHS was also an inherent strength to the study mainly because the NPHS household questionnaire allowed for longitudinal analyses (141). In addition, the computer assisted interviewing minimized interview errors (141) while the labour force survey sampling strategy created a nationally representative sample of the Canadian female population. The large sample size and six cycles of data provided adequate power to the study.

5.4 Limitations

One major limitation of this study was the use of the Body Mass Index greater than 30 to indicate obesity. The BMI is a commonly criticized measure of body composition. Although it is useful in that it is easy to obtain and inexpensive to collect, it is notorious for errors due to self-reporting (161). Moreover, the BMI tends to be underestimated and in many cases women who are obese are categorized as being overweight (174). A correction factor was used in analyses to minimize such bias; however, it is likely that the corrected-BMI is not completely free of self-reporting biases.

Another limitation was that this study did not take into account the heterogeneous effect within obesity groups. Specifically, the effect of obesity on labour market participation and earnings could differ across Class I, II and III obesity groups.

Other confounding variables were subject to measurement error thus resulting in a limitation of this study. Moreover, labour market indicators such as personal income (175) or employment status are likely subject to misreporting as they can be considered sensitive topics. Hypothetically, this could have resulted in overestimated annual income or incorrectly claiming to be employed. Similarly, self-reported health is highly subjective. It has been found that individuals that are unemployed are more likely to report poor health; even if it is not the case (176).

Another limitation was the inability to control for reverse causality. Although time-invariant unobserved heterogeneity bias was accounted for and lagged-obesity was controlled for in the final models, the nature of the association between obesity and labour market outcomes was susceptible to endogeneity bias. This study did not account for the potential bi-directional associations between obesity and labour market outcomes. Moreover, there was a chance that loss of employment or reduced earnings may be causally responsible for obesity. Unfortunately the NPHS did not have any suitable instrumental variables that could be utilized for all six cycles. Lastly, this study only accounted for the time-invariant nature of unobserved heterogeneity bias. This means that the time-variant nature of unobserved heterogeneity bias was not considered.

5.5 Conclusions – Implications and Future Research

This longitudinal study revealed that obese Canadian women, between the ages of 18 and 65, are subject to a 3.9% reduction in annual income compared to their non-obese counterparts. A woman's employment probability and earnings (if employed) were found to be negatively impacted by the presence of obesity. Earnings, in particular, were negatively associated with obesity (6.0% reduction in income and a 3.2% reduction in wage rate in Model 2) and this association remained robust with the inclusion of socio-economic, demographic, health and lifestyle controls. In all models, poor health was found to be significantly associated with a lower probability of employment and when employed, lower earnings.

Other notable results were found among the control variables in models for employment and earnings. Age and age^2 were highly significant suggesting a non-linear influence of age on labour market variables. Moreover, age increased employment probability and earnings until women were in their 40's and 50's and then the effect became negative. The presence of children aged five and under was found to negatively influence employment and earnings. A negative effect was also evident among immigrants compared to non-immigrants. Urban living, compared to rural living, was found to have a positive influence on all outcomes. Marital status had a positive influence on employment, however the effect was less clear in earnings as pooled models suggested a negative influence while random-effects models revealed a positive effect. As discussed, additional non-wage income such as spousal income was associated with a lower probability of employment and a decrease in earnings and this was especially true for women having access to non-wage income greater than $50,000. Other SES related controls found that a higher education (post-secondary) and homeownership compared to less than high school education and non-home owners had higher employment probabilities and greater earnings.

Considering the influence of all controls, the lagged health-related variables appeared to be most influential and this was consistent across all models and outcomes. HUI, in particular was positively associated with employment and earnings suggesting that overall health related quality of life has considerable influence on the labour market participation and earnings. Similarly, fair or poor health compared to excellent health was consistently associated with poor labour market outcomes. Lastly, smoking was negatively associated with employment and earnings while alcohol consumption was interesting in that it showed that regular drinkers are more likely to be employed and have higher wages and incomes compared to non-drinkers.

It has been hypothesized that obese women face discrimination in the workforce (177-180). One study assessed weight bias in simulated interviews and found that overweight and obese applicants were less likely to be hired and that the discrimination was much more prevalent among women (181). Given that discrimination could not be empirically measured using the NPHS data and that perceived measures were not considered in this study, it would be beneficial to empirically assess the presence of discrimination and whether anti-obese attitudes are a primary source of unobserved heterogeneity in the association.

The increasing proportion of obese women in Canada combined with the growing rates of unemployment make these findings timely and relevant to the current Canadian context. Given that the results showed penalties in job attainment, wage rate and income due to obesity it is likely that the penalties will continue as obesity rises. As obesity is of primary concern in this association, it has been suggested that adopting a preventative “up-stream” approach through programs regarding healthy eating and active living may help with reducing obesity and maintaining a healthy weight (182, 183). Needless to say, obesity reduction strategies are likely to be the most effective way at controlling obesity and addressing the possible negative association between obesity and labour market outcomes in women. Given the challenges of the obesogenic environment found in developed countries, a lifestyle-modification program is associated with the greatest success in fighting obesity (184). This approach involves adopting a balanced diet, increasing physical activity levels and building knowledge about the adverse consequences of obesity.

At a broader level, the public health approach via policy interventions has been suggested to combat obesity in Canada. Moreover, Canada could utilize legislative interventions such as taxing junk food, making labels on food more informative and comprehensible, regulating consumption of food with high amounts of sodium, improving the built environment, implementing restaurant-based interventions and controlling junk-food advertising (185). It is unclear as to whether or not these obesity-reduction strategies are effective or would be effective if implemented. Therefore more research and evaluation is needed. It is clear, however, that a combination of legislative practice, environmental modification, education, and cooperation between the government, corporations and the public health system is the best way to combat the rising prevalence of obesity in Canada (185).

Future research is needed to explore the endogeneity of the association and examine the effect using accurate measures of adiposity. The influence of discrimination or anti-obese attitudes among potential employers in Canada is another topic for future research. In conclusion, implementing evidence-based policies and programs aimed at reducing obesity among Canadian women may in turn eliminate the potential adverse effects of obesity on labour market participation and earnings.

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Glossary of Terms

Endogeneity – A bias that occurs when the explanatory variable is correlated with the error term, in epidemiology this typically occurs when the outcome simultaneously causes the exposure.

Instrumental Variable (IV) – An IV is an exogenous variable or a variable not correlated with the error term but correlated with the endogenous variable. IVs are commonly used method in regression analyses to account for endogeneity bias in observational studies.

Omitted Variable Bias – The bias that occurs when a relevant variable or variables that should be controlled for in analyses are not present (or omitted).

Reverse Causality – Occurs when the outcome variable (y) can also determine the exposure variable (x) of interest resulting in endogeneity bias. Reverse causality is synonymous with simultaneity bias in the epidemiology literature.

Unobserved Heterogeneity Bias –Refers to the individual-specific unobserved factors that could not be measured or were left out but correlated with the explanatory variables (see omitted variable bias). The exclusion of the unobserved individual effects can cause the association between the exposure (x) and outcome (y) to be biased.

Appendices

Appendix A

Author	Title	Objectives/Exposure /Outcome	Design/Methods	Results	Comments/Gaps	Key Words
EMPLOYMENT & WAGE RATE/INCOME						
Cawley *et al*. (2009)	Obesity and labor market outcomes among legal immigrants to the United States from developing countries	Examine the association between weight and labour market outcomes among legal immigrants in the US who originated from developing countries. Exposure: BMI >25 & >30 Outcome: Employment (binary)	Cross-sectional study using the New Immigrant Survey (NIS) from 2003 (n=2321 women). Ages 18-62 Logistic regression Covariates: age, age squared, height, children, race, education, marital status, drinking and smoking habits, English proficiency, duration of stay in US.	Main finding is that for women, higher weight is associated with a lower probability of employment for immigrants who had been in the US for both less than 1 year and less than 5 years. Marginal effect of -0.1831 (0.0415) for the effect of being obese (relative to normal weight) on employment for women who had only been the US a short time.	Also looked at occupation class, work limitations and wage (if employed).	Employment, Cross-Sectional, US, Negative
Han *et al.* (2009)	Weight and Wages: Fat Versus Lean Paychecks	Investigates the effect that obesity has on labour market outcomes (employment and wages) in the US. Exposure: BMI Outcome: Employment (probability) and log hourly wage	A seventeen year longitudinal study of American men and women (n=12686). 57172 person-years for women were in analysis. Age 20-27 at baseline in 1985 Logistic regression, individual fixed-effects models and Heckman test for IVs.	A penalty for employment probability is experienced by overweight and obese women (except for Black women). Obese white and Hispanic women were 1.5 and 4.5 percent less likely to be employed. A wage penalty is present for obesity and increases with age, as a .81% wage penalty increases each year after age 31 for obese women. White and Black obese women had	The study considers the unobserved heterogeneity and endogeneity. They argue that strong IVs were not available. They also caution that time-varying individual heterogeneity is uncontrolled.	Employment, Longitudinal, US, Fixed-Effects, IV, Negative

			Covariates: Interpersonal skills, race, age, marital status, human capital, and regional variables.	7.5 and 4.9% lower log hourly wages. A wage penalty also exists for obese individuals in occupations requiring more social interactions and interpersonal skills (especially for obese women). There was also significant difference between races.		
Johansson *et al*. (2009)	Obesity and labour market success in Finland: The difference between having a high BMI and being fat	An examination of the relationship between obesity and labour market success in Finland. Exposure: BMI, fat mass, waist circumference (measured by health professionals). Outcome: employment (probability) ands wage	Cross-sectional survey of Finish workers (n=3500). Age 30-54 Probit regression models (multiple body weight measures). Covariates: Age, education, health	All measures of obesity had a negative impact on employment probability for women. A 1 kilo increase in weight resulted in a 0.3% decrease in employment probability while 1 kilo increase in fat mass resulted in a 0.5% decrease in employment probability. Overall, the use of better measures of body composition helps reduce measurement bias (specifically the inclusion of waist circumference). For all models, it was shown that height was an important predictor of labour market success. The inclusion of self-reported health reduced the size of the marginal effects because obesity and good health are negatively correlated.	Overall, the use of better measures of body composition helps reduce measurement bias (specifically the inclusion of waist circumference).	Employment, Cross-sectional, Finland, Negative
Greve (2008)	Obesity and labour market	An analysis of the relationship between BMI and employment	A fifteen year panel study of public and private sector	For women, once a BMI of 22-25 has been reached,	All three models used in this study	Employment, Longitudinal,

	outcomes in Denmark	status and wages. Exposure: BMI Outcome: Employment (probability) and wages	employees in Denmark (1995-2000) (n=3666 women). Probit (probability) models, fixed-effects logit model and IV models (IV being whether the respondent's mother was prescribed medication for obesity-related health problems). Covariates: age, race, marital status, children, education, region,	probability of employment begins to decrease. Obese women are 8.5% less likely to have employment compared to normal weight women**.** Interestingly, taller women have a higher probability of employment. The fixed-effect model showed a negative correlation for women. The IV approach turned out to be relatively weak for women, but using the mother's prescription to anti-obesity meds was a more valid IV (t-stat = 2.93). In terms of wages, the only significant association was for women working in the private sector; they had log negative wages in relation to BMI and taller women had overall higher wages. Increase in weight by 2SD = decrease in annual wage by 4.4%	were strong. IVs were good for endogeneity. Considered mother and father hypertension and diabetes as well as maternal anti-obesity prescriptions.	Denmark, Fixed-Effects, IV, Negative
Norton & Han (2008)	Genetic Information, Obesity, And Labor Market Outcomes	To estimate the marginal effect of BMI on the probability of employment and wages for American women. Exposure: BMI>30 Outcome: Employment (probability of at least 10 hours/week) and wages.	Longitudinal study using Adolescent Health (ADD) data as well as a subset of DNA sampling (n=769 women). Age 21> at wave 3 Linear probability models, 2SLS regression (lagged BMI) and IV models for endogeneity (genotype as an	Using lagged obesity, the results showed no significant effect on the probability of employment or wages. However, the use of genetics and sibling BMI as IV's proved to be strong predictors as they were predictive of lagged BMI (both exceed the minimum of 10 for F-statistics: 14.83 and 18.38).	Main finding was that the genetic IV's are highly predictive of BMI which can be helpful for endogeneity control in future research. Standard errors are fairly tight	Employment, Longitudinal, US, IV, Negative/NS

			IV to predict variation in phenotype (obesity) as well as sibling BMI) Covariates: age, race, marital status, education, health, risk behaviours, region, and genetics.	The models including all IV's and lagged BMI showed no significant effect for probability of employment and wages. The coefficients did show that probability of employment is higher for older, white, unmarried women with higher education. Overall, a one-unit increase in lagged-BMI for women is barely as a large as a 1% increase in employment or 1% increase in wages.	and they claim this rules out large effects.	
Sarlio-Lahteenkorva & Lahelma (1999)	The association of body mass index with social and economic disadvantage in women and men	Examine the association of BMI with social and economic disadvantage (such as employment and income) in Finland. Exposure: BMI Outcome: unemployment (short and long-term) and income (household and personal).	Cross-sectional survey (nationwide living conditions survey linked to taxation register) of Finnish subjects (n=8650). Age 25-64. Multivariable Logistic Regression (separate analyses for women and men). Covariates: age, region, education and health status.	The majority of disadvantages were more likely to be experienced by women. Overweight was associated with current unemployment (OR = 1.4, 95% CI: 1.0-1.8), while obese was associated more with long-term unemployment (OR=2.5, 95% CI: 1.5-4.2). Obese women were associated with lower household and individual income (OR=1.5-1.7) and overweight women were more likely to have low individual income (OR=1.2, 95% CI: 1.0-1.5).	They acknowledge that the direction of causality remains as an open question.	Unemployment, Cross-sectional, Finland, Positive (unemployed and lower income).
Garcia & Quintana-Domeque (2007)	Obesity, Employment and Wages in Europe	Examine the associations between obesity, employment status and wages for nine European countries.	A cross-national panel study of Austria, Belgium, Denmark, Finland, Greece, Ireland, Italy, Portugal and Spain (n=48,743 women)	Although findings showed a greater impact for women (for unemployment and wages), such as a 10% obesity wage gap for women in Finland,	The authors did conclude that the associations are heterogeneous across the	Employment & Wage, Longitudinal, Europe, NS

		Exposure: BMI, weight Outcome: Employment, hourly wage	Age 25-64. Multinomial Logit (RRRs). Covariates: age, age squared, education, household income, country, year, marital status, children.	after adjusting (i.e., controlling for health status) and trimming the data no significant results were found for obesity's effect on employment status and wages.	countries which are likely attributed to differing labour market institutions. Recommend more research at the country-level. Great paper for methodology and an interesting section on the role of cultural factors and labour market institutions (may be helpful for discussion purposes).	
Caliendo & Lee (2012)	Fat Chance! Obesity and the transition from unemployment to employment.	Estimate the magnitude of weight discrimination between obese/overweight and normal weight individuals using labour market outcomes in Germany. Exposure: BM Outcome: gap between obese/overweight and normal individuals considering wage, # of job applications, and participation in training. Employment variables looked at in 2 waves of the survey.	Longitudinal survey using IZA evaluation Interviews of those unemployed from late 2007 to early 2008 in Germany (n=673 women). Blinder-Oaxaca (BO) Decomposition through OLS regression and Propensity Score Matching (PSM). Covariates: education, labour market history, health, and other demographics.	The most significant gaps were for women while men did not have significant gaps after controlling for other variables. For women, the difference between obese and normal individuals has the most significant gap even after controlling for the multiple covariates (raw gap = -0.165) Obese women earned 0.102 less per log hourly wage relative to normal weight women.	Focus on discrimination as being the "missing key" more than other papers. The use of an identical starting point looking at unemployment to employment for obese individuals contains useful information.	Employment(gaps) & Wage, Longitudinal, Germany, Negative.

Heineck (2007)	Fatness and labor market outcomes in the UK – First evidence from the BHPS.	Estimate the relationship between weight and labour market outcomes using BHPS (Britain) data for the first time. Exposure: Fatness, estimated through total body fat (TBF), fat free mass (FFM), BF % and adiposity. Outcome: Employment (probability), earnings (wage).	A cross-sectional study using the British Household Panel Study (BHPS) (n=7764). Age 16-64. Multinomial logit models (economic activity) and Mincer-type regressions (earnings). Covariates: height, age, age squared, education, marriage, number of children, partner has a job, smoking, regional dummies and employment characteristics.	Overall, there were only a few differing results using BMI versus the other alternative measures of fatness. Females with high body fat had a lower probability of employment (being obese results in a 0.02 % reduction in probability). The threshold at which earnings decrease is estimated to be around a BMI of 26.6 or a BF% of 37. Regression analysis for earnings showed no obesity penalty although there is a convex relationship between fatness and earnings. BF% and labour market status formed a u-shaped relationship.	Overall, the results are mixed and there are no main findings. Use more accurate measures of body composition/fatne ss.	Employment, Cross-sectional, Britain, Negative.
Cawley (2000)	Body Weight and Women's Labor Market Outcomes	To estimate the effect of weight on labour market outcomes for American women (hourly wages, employment and sector of occupation). Exposure: BMI and Weight (lbs). Outcome: Employed (binary), log hourly wage and occupation type.	A longitudinal study of American women using the National Longitudinal Survey of Youth (n=21391). Age 14-22 in 1979. OLS and probit regression models and Instrumental variable probit (IV=weight of the woman's child). Covariates: race, job type, intelligence, education, experience, tenure, age, local unemployment rate, region,	OLS results showed that both BMI and weight in pounds had coefficients that were e both negative and statistically significant. If two otherwise identical women differed in weight by 10 lbs, we would expect the lighter woman to have 1% higher wages.In terms of standard deviations, a woman at the median weight would have an approximately 7% higher wage than a women at the 95th percentile for weight.	IV of a woman's offspring's BMI was used.	Employment, Wage & Sector, Longitudinal, US, Positive/NS(Employ ment), Negative (Wage)

			year, marital status, children, age of children, family income.	The hypothesis of all races being equal was rejected as white women experienced greater penalties than Hispanic women and black women experienced the least amount of loss (not significant at all). Employment status showed a 1% increase in probability of employment per 10lbs weight gain but this was not significant.		
Lundborg *et al*. (2007)	Obesity and Occupational Attainment among the 50+ of Europe	Explore the relationship between obesity and labour market outcomes (employment, hours worked, and wages) in 10 European countries. Exposure: BMI >30. Outcome: Employment, hours worked (past month) and hourly wage rate.	Cross-sectional survey of Europeans over 50 which included Northern Europe (Denmark and Sweden), Central Europe (Austria, France, Germany, Switzerland, and the Netherlands) and Southern Europe (Spain, Italy and Greece). (n= between 4,189-4,330 employed individuals). Age 50 + Probit regression models and IV models (3 IV's: presence of obese person in household, being the oldest child and having only sisters). Covariates: Health status	Being obese was associated with a lower probability of being employed (-0.053, $p<0.01$) However, there was no significant effect found for obesity on hours worked β=-0.090 (0.036). Regressions by country-groups showed that the influence of obesity varied across Europe. In addition, all 3 outcomes appeared to be influenced by reduced health status. Pooling all countries, obese women earned 10% less than their non-obese counterparts and when including health status in the model, it only dropped to 9%. Further analysis of European regions showed that central European	The only situation in which the hypothesis of exogeneity was rejected was for employment among obese women and the overall predictive power of the IVs was weak.	Employment & Hours Worked & Wage, Cross-sectional, Europe, Negative (Employment & Wage), Positive/NS (Hours),

				women faced the greatest wage penalty.		
EMPLOYMENT						
Pit & Byles (2012)	The association of health and employment in mature women: a longitudinal study	Identify which health problems are associated with employment among middle-aged Australian women over time. Exposure: Obesity (BMI>30) Outcome: Employment (compared to unemployed or not in the labour force)	Longitudinal data from the Australian Longitudinal Study on Women's Health (ALSWH) (n=13,715 at baseline). 45-50 years-old in 1996 Generalized Estimating Equations (GEE) for nested multivariable longitudinal analyses. Covariates: Socio-demographics, health problems, quality of life, time, residence, marital status	Compared with employed women, women who were not employed were significantly more likely to have a BMI in the obese range (OR:0.85, CI: 0.77-0.94) Not significant in the fully-adjusted model with quality of life.	Quality of life caused the association to lose significance.	Employment, Longitudinal, Australia, Negative/NS
Asgeirsdottir (2011)	Do body weight and gender shape the workforce? The case of Iceland	Examine weight-related differences in employment controlling for traditional employment-related characteristics in Iceland. Exposure: BMI >25 & >30 Outcome: Probability of unemployment	Cross-sectional survey of the Icelandic population (n=1062). Ages 20-80 in 2002 Probit regression models. BMI modeled both categorically and continuously (the probability of unemployment given BMI). Covariates: age, marital status, children, education, health status.	Inverse correlation between body mass and employment for women. Marginal effect of BMI on employment: -0.0509 (0.0289) significant at 10% level. Associated with discrimination and health effects (as when health was excluded the differences were much greater).	Iceland has high level of gender equality which controls for gender differences. Limitations and gaps in the literature that were mentioned included small sample size.	Employment (Probability), Cross-sectional, Iceland, Negative
Lindeboom et al. (2010)	Assessing the impact of obesity on labour market	Study the effect of obesity on employment in Great Britain using instrumental variables.	Longitudinal panel study (NCDS data) of individuals born in Great Britain	The baseline OLS results showed a 4.9% reduction in employment probability for	The authors claim that the lack of significance when	Employment, (Probability), Longitudinal, GB,

	outcomes	Exposure: BMI>30 Outcome: Probability of Employment	(n=17,000). Born in 1958 and followed until 46 years of age or 2004 Basic OLS regression and then IV models (biological parents BMI) to account for potential endogeneity using genetic indicators.	obese women at age 42 and a 20% penalty for obese women at age 33. Substantial differences were found in the probability of being obese by the obesity status of one's parents (thus giving strong predictive power to the instrument used). The instrument predicted obesity well for women; however the coefficients became positive and non-significant.	using the IV may mean something else was at work other than pure genetics (same as Cawley (2000) results but different than Morris (2007)).	Endogeneity, IV, Negative/NS
Renna & Thakur (2010)	Direct and indirect effects of obesity on U.S. labor market outcomes of older working age adults	Examine the impact of obesity on labour market outcomes for older adults still of working age in the US. Exposure: BMI>30 (3 classes) Outcome: Employment (working, not working due to disability, or not working due to an early retirement).	A longitudinal study of pre-retirement adults using BMI in 1992 in relation to labour market outcomes in 2002 (n=1776). Ages 55 to 64 in 2002. Multinomial logit was used for the trichotomous outcome and marginal effects were interpreted. Two estimation methods were used (random and fixed-effects): first, employment in 2002 was modeled as a function of BMI in 1992, second, the model controlled for time-invariant individual heterogeneity. Covariates: Demographics	The results for women (which were greater than the results of men) showed that obesity (class 2 and 3) increases the probability of early retirement by 2.5% and disability in the older adults by 1.7%. Evidence that both physical impairments and chronic illness due to obesity affect employment outcomes and there is a causal relationship between body weight and labour market outcomes.	They hypothesized that obesity can impact labour market decisions later in life both directly and indirectly. The models cannot control for time-variant effects.	Employment (retirement), Longitudinal, US, Fixed-Effects, Negative

			(sex, race, age, marital status etc.), Health insurance, health variables (status, behaviours distress etc.)			
Jusot *et al*. (2008)	Job loss from poor health, smoking and obesity: a national prospective survey in France	Examine the combined effects of obesity and health-related behaviors on unemployment to distinguish direct from indirect effects in France. Exposure: BMI>30 Outcome: employment (4 years later)	A longitudinal survey of 10 years was used to look at 2420 time transitions (employment status transitions) for French women. Age 30-54 at baseline Logistic regression Covariates: non-optimal self-rated health, smoking	Overall, women were more likely to be unemployed four years later compared to men. In addition, individuals who reported poor self-rated health and obese women were more likely to be unemployed after 4 years (OR: 2.0 (CI: 1.2-3.4) compared to normal weight women. Obese women were also more likely to report non-optimal self-reported health. After controlling for self-rated health and smoking, obesity was a significant risk factor for unemployment only for women.	They distinguish between direct effects (such as unemployment due to diseases) and indirect effects (such as employability or work behaviors). Direct vs. Indirect effects were defined and explored and discrimination was considered as a hypothesis. Also found that poor health at baseline was a risk factor for unemployment (mediator?)	Employment, Longitudinal, France, Negative
Tunceli *et al*. (2006)	Long-Term Effects of Obesity on Employment and Work Limitations Among U.S. Adults, 1986-1999	Determine relationship between BMI and workforce participation or limitations in the working population (U.S). Exposure: BMI>30 at baseline Outcome: Employment and work limitations	Prospective cohort panel study was used to estimate the effect of obesity in 1986 for employment and work limitations in 1999 (n=4,290, 2395 women). Age: >18 in 1986 and <65 in 1999 Multivariable probit models (stratified by sex and BMI	Obesity in women was associated with reduced employment at follow up by a ME (marginal effect) of -5.8 pp (percentage points). Work limitations were more associated with women at follow-up. In terms of self-reported work limitations, overweight women experienced a ME of 3.9 pp	The authors mention the possibility of discrimination. The ME is interpreted as the increase or decrease in probability due to a one unit change in the variable.	Employment, Longitudinal, US, Negative

			was categorical) Covariates: smoking status, exercise frequency and health status (as baseline).	and obese women had an ME of 12.6pp.	They claim that endogenous variables may still exist in the relationship between obesity and workforce participation.	
Klarenbach *et al*. (2006)	Population-Based Analysis of Obesity and Workforce Participation	A description of the relationship between obesity and workforce participation of Canadians. Exposure: BMI >30 Outcome: Employment status and attendance at work (week prior).	A cross-sectional study of 73,531 adults using the CCHS (2000-2001). Age 20-59. Logistic regression (full adjusted considered BMI classes). Covariates: age, gender, ethnic origin, region, marital status, education, obesity-related co morbidities, and depression.	As obesity increased, the odds of workforce participation decreased (0.94 (CI: 0.89-0.99), 0.86 (0.77-0.94) and 0.64 (0.57-0.78) for Class I, II and III, respectively). Class II and III were the only significant findings. The results also showed that obese individuals were less likely to be employed and more likely to be absent from work. Odds of absenteeism for those with a BMI >35 was 1.17. Findings were more robust for women.	Not causal due to cross-sectional data. They mention discrimination. Concludes that the impact of indirect costs of obesity effect workplace participation.	Employment & Absenteeism, Cross-sectional, Canada, Negative (Employment), Positive (Absenteeism).
Paraponaris *et al.* (2005)	Obesity, weight status and employability : Empirical evidence from a French national survey	An investigation of the relationship between obesity (and other BMI categories) and employability) in France. Exposure: BMI (lagged) Outcome: Employability (how many years spent unemployed and the ability to regain employment).	Longitudinal face-to-face and self-administered survey for 2003 (Decennial Health Survey) (n=15,642). Age 18-64. Probit estimation and Cox proportional hazard regression analysis to look at average time spent unemployed.	They found that the percentage of time spent unemployed increases with each kg/m^2 deviation from the mean BMI (measured at age 20), with a sharp increase occurring when a BMI is $>5kg/m^2$ over the median. For women $>5kg/m^2$ over the median, 15% of their working years are spent unemployed (for those who	Overweight and obese prevalence is much lower in France than other western countries but still shows an association between weight and employability. The effects are all larger for women.	Unemployment (years unemployed and probability), Longitudinal, France, Positive (unemployed).

			Covariates: age, age squared, nationality, education, occupation, family, housing.	have experienced at least 1 period of unemployment). The probability of remaining unemployed for 6-12 months is 13% higher for obese people (and probability of unemployment stays higher for women).	Use of BMI at age 20 (lagged-BMI) was an attempt to control for direct endogeneity bias of BMI on employment status. Hypothesize the effects of discrimination or self-esteem issues of obese individuals.	
Laitinen *et al.* (2002)	Unemployment and obesity among young adults in northern Finland 1966 birth cohort.	Establish whether obesity in adolescence predicts unemployment and unemployment is a risk for obesity in Finland. Exposure: BMI at 14 and 31 & Unemployment. Outcome: Same (both directions explored).	Longitudinal study using national registries (n=9754). Age 14 at baseline, 31 at follow-up. Binary Logistic Regression Covariates: family social class, residence, school performance, marital status, children.	Overweight or obese BMIs at 14did not predict long term unemployment at 31 but marital status and education were significant. Long term unemployment was significant for obesity in women at 31 (OR: 1.64, CI: 1.07-2.50).	Exposures measured as adolescents.	Unemployment, Longitudinal, Finland, Positive (unemployed).
Alavinia & Burdorf (2008)	Unemployment and retirement and ill-health: a cross-sectional analysis across European countries	Explore the associations between different measures of health (such as BMI) and labour market position in 10 European nations. Exposure: BMI (and other health variables). Outcome: Unemployment (retired, employed, or homemaker).	Cross-sectional survey (Survey on Health and Ageing in Europe – SHARE). (n=11,462). Age 50-65. Logistic regression. Covariates: Health status, education, marital status, smoking, drinking, physical	Overweight women were more likely to be retired, or a homemaker compared to normal weight women (ORs: 1.15(2.00-1.31) and 1.23(1.05-1.43)). Obese women were more likely to be retired, unemployed and homemakers compared to normal weight women (ORs: 1.43(1.20-1.70),	Analysis for older age group, but still relevant.	Unemployment, Cross-sectional, Europe, Positive (unemployed, retired, homemaker).

			activity.	1.31(1.01-1.68), and 1.34(1.10-1.64)).		
Mora (2010)	BMI and Spanish labour status: evidence by gender from the city of Barcelona.	Explore the consequence that BMI has on employment in Barcelona, Spain. Exposure: BMI >30 Outcome: Employment.	Cross-sectional study using data from the Public Health Agency in Barcelona (N=6000+). Age 16-64. IV probit models by gender (IVs: average BMI level from individuals with same education and area of residence). Covariates: age, marital status, housing deprivation, health coverage, caregiver, education, health status, place of birth.	BMI effects on labour status, especially for obese women over 45. IV probit with education and district IVs: -0.01524 Baseline probit corrected: -0.01934.	Focus on discrimination as being the underlying cause of obesity effecting employment in women.	Employment, Cross-sectional, IV, Spain, Negative.
Glass *et al.* (2010)	The Skinny on Success: Body Mass, Gender and Occupational Standing Across the Life Course.	Estimate the influence of body mass on occupational attainment over three decades of career potential in the US. Exposure: gender and adolescent body mass. Outcome: occupational attainment over the life course.	Longitudinal study over 3 decades in Wisconsin (n=10,317). Age: high school to retirement age Considered 3 mechanisms – 1. Employment-based discrimination 2. Educational attainment 3. Marriage market processes. Covariance structure analysis and an MLR estimation. Covariates: family SES and cognitive ability of the	Limited evidence for employment-based discrimination but found that heavier women received less post-secondary schooling (0.3 fewer years) than their thinner peers adversely affecting their careers at each point. Overweight adolescents delayed family formation by 1.18 years on average which actually had a beneficial influence on initial and mid-career attainment. The effect of lower education was however 4x larger than the indirect effect of delayed family formation.	Study shows good evidence for the effect of obesity on both education attainment and in turn occupational success. Highlights the effect of mediators. Could have been even stronger if health measures and employer discrimination were better measured/ accounted for.	Employment, Longitudinal, US, Negative (through 3 mediating mechanisms).

			respondent.	Overall, the association of overweight women investing less in educational attainment is most influential on occupational attainment even with the benefits of delayed marriage/family.		
Naimi *et al.* (2009)	Associations between Area-Level Unemployment, Body Mass Index, and Risk Factors for Cardiovascular Disease in an Urban Area.	Determine whether area-level unemployment is associated with CVD and BMI in Montreal, Canada. Exposure: BMI Outcome: Area-level unemployment (ALU).	Cross-sectional study using the Montreal Neighbourhood Survey of Lifestyle and Health (MNSLH) (n=342). Age 18-55 Generalized Estimating Equation (exchangeable with logit link) and a Poisson regression model. Covariates: age, smoking status, area-level education, income, education, employment status, diet, fast food consumption, physical activity, alcohol consumption. (DAG defined confounders).	Area-level unemployment in relation to BMI for women in Montreal ranged from 1.71-2.7(prevalence ratios) controlling for all covariates. Area-level unemployment for each area was compared to lowest area-level unemployment group. There a was a positive gradient with BMI.	Small sample size, but positive association was till clear.	Employment (area-level unemployment), Cross-sectional, Canada, Negative.
Morris (2007)	The impact of obesity on employment	Investigate the impact of obesity on employment in England. Exposure: BMI >30 Outcome: Employment (binary).	Cross-sectional survey of individual-level data from the Health Survey for England (HSE) and area-level data from the Allocation of Resources to English Area (AREA)(n=8,643 females). Age 18-60 for females. Three methods were used: a	For both males and females there was a significant, negative effect of obesity on employment. In the IV model, the direct effect showed that obese females have a 0.213 lower probability of employment compared to non-obese females.	Heavy focus on the endogeneity bias and a helpful layout covering four reasons why obesity and employment may be correlated.	Employment, Cross-sectional, IV, England, Negative.

			univariate probit model, propensity score matching and IV regression (the instrument being area-level prevalence of obesity in which the participant resides). Covariates: Four groups of explanatory variables were considered - education, health, home and family (marriage, family size), and additional control variables that may affect employment (gender, age, ethnicity, rurality, region, HSE year.	Failure to account for endogeneity leads to underestimation of the negative effect of obesity on a female's employment. The hypothesis that p=0 was rejected showing that univariate probit models underestimate the effect.		
Harkonen (2007)	Labour force dynamics and the obesity gap in female unemployment in Finland.	An analysis of the obesity gap for female unemployment in Finland. Exposure: BMI>30. Outcome: Unemployment.	Longitudinal data from the European Community Household Panel (ECHP) for Finland (n=2373 women). Age 25-54. First decomposed the obesity gap into transition periods (from unemployment to employment).Then conducted an event-history analysis (Cox-regression) and multivariable analyses. Covariates: age, education, marital status, number or presence of children, health status and regional variables.	The obesity gap transitions from unemployment to employment are still present after controlling for demographics and human capital variables. Non-obese women were approximately three times more likely to move from inactivity to employment than obese women, while obese women were twice as likely to move from employment to inactivity as non-obese women, and from unemployment to employment, non-obese women were 1.6 times more likely to make the transition. The transition from employment to inactivity	Harkonen concludes that employer discrimination is an explanation regarding the obesity gap for females. Discuss 3 explanations of female obesity and labour market outcomes: 1) a common factor that predicts both variables (heterogeneity), 2) poor labour market success as an obesity predictor (endogeneity), 3)	Employment (transitions), Longitudinal, Finland, Negative.

				becomes non-significant after controlling for other variables. Event-history analysis showed that obese women had a 25% lower chance of moving from unemployment to employment than non-obese women (although this was at a significance level of 10% with adjustment).	factors that lead obese women to poor labour market outcomes (causality).	
Au *et al.* (2012)	Employment, work hours and weight gain among middle-aged women	Investigate the influence of employment and work hours on weight gain among middle-aged Australian women. Exposure: Employment status and work hours/week. Outcome: Body weight % gain over 2 years.	Longitudinal study using the Australian Longitudinal Survey of Women's Health (n=9276). Women aged 45-50 years Quantile regression techniques for both outcomes.	Women that were out of the labour force or unemployed were less likely to gain weight compared to employed women. The median weight gain was 1.4% while the 0.95 quantile was 11.7%. Weight change for employment status ranged from -5.26 to 11.76. Meaning a 1kg-8kg increase in weight for an average 69kg woman. The model for employment status became non-significant when health status was controlled for. In terms of work hours; regular, long and very long we more association with weight gain than working part-time hours. The median and 0.95 quantile percentage weight gains were the same as for the employment model. The longer the hours worked, the	Part-time =1-34 h/week, regular full-time = 35-40 h/week, long hours = 41-48h/week, very long hours = >49 h/week. Just classifying someone as employed vs. unemployed hides the relationship between weight gain and hours worked/intensity of work.	Employment & Hours Worked, Longitudinal, Australia, Positive

				larger the weight gain.		
WAGE RATE/INCOME						
Morris (2006)	Body mass index and occupational attainment	Investigate the impact of BMI on occupational attainment at the individual-level in England. Exposure: BMI (measured by nurse). Outcome: occupational attainment as expressed by mean hourly wage.	Cross-sectional survey of individual-level data from the Health Survey for England (HSE) and pooled data from the UK Quarterly Labour Force Survey (QLFS). (n=5658 women). Age 18-60. Pooled and IV regression models (IVs: mean regional BMI from health authority and obesity prevalence). Covariates: health, job characteristics, home and family, non-bmi related affects on occupational attainment.	The OLS results showed a negative, significant effect for BMI in women for occupational attainment or a 10% increase in BMI results in a 0.4% decrease in mean occupation wage. Moreover, the model with the total effect showed that women over a BMI of 30 are on average paid 4% lower wages than women with a BMI less than 30. IV coefficients were not significant in any of the models so they were unable to identify any endogenity issues with BMI.	Further, there was no difference detected between OLS and IV methods so the OLS method should be preferred. Area-level IVs were used.	Hourly Wage, Cross-sectional, IV, England, Negative.
Haskins & Ransford (1999)	The Relationship Between Weight and Career Payoffs Among Women	Explore the relationship between weight and occupational standing and wages in American women. Exposure: Weight as classified using the Metropolitan Table Outcome: Personal income and occupation type.	Cross-sectional questionnaire done in the U.S. in 1988 (n=306). Multiple regression techniques controlling for human capital factors. Covariates: education, entry occupation, length of service, age, father's occupation, contact outside the firm, male-dominated organizations and human capital control variables.	It was found that weight is related to income, but only for entry-level positions in professional and managerial occupations (B= -.18, p<0.5). In the first model the human capital control variables explained over 40% of the income variation. Weight had no effect for blue-collar, clerical workers or upper-level professional/managerial positions. Weight was also significantly related to occupational	Focused on the effects of discrimination, SES and primarily white collar women. Acknowledge a glass-ceiling effect for women in entry-level jobs which are enhanced by higher weight ranges. Hypothesized that	Income & Occupation Type, Cross-sectional, US, Negative.

				positions in male-dominated industries. No significant relationship between weight and positions with a high amount of outside contact. Entry weight and subjective weight were not significantly different (except for the subjective weight being positively related to income in blue-collar positions).	overweight women will have lower career payoffs (income and position) with most consequences occurring in male-dominated or outside contact positions.	
Pagan & Davila (1997)	Obesity, Occupational Attainment, and Earnings	Study the relationship between obesity, occupational attainment and earnings in the US. Exposure: BMI>30. Outcome: occupational attainment (distribution) and earnings.	Cross-sectional study using the National Longitudinal Survey of Youth (NLSY) of Americans. (n=3486 women). Age 24-39 in 1989. Multinomial logit to first look at occupational selection of the obese and then to estimate the earnings of overweight individual (wage-obesity link). An Occupational Distribution Differences Index (ODDI) was used to predict occupation segregation. Covariates: experience, marital status, race, region, and education.	For women, it was found that obesity results in a labour market penalty. Using the ODDI, they found that obese women face far greater occupational segregation than men (19.5% of obese women would have to change occupation to equalize the distributions compared to only 8.4% of men). The log wage model yielded a significant, negative coefficient (-0.202, p=0.001) meaning that obese women face a greater wage penalty. Hausman specification test was used to test for exogeneity which they failed to reject therefore endogeneity was not of concern.	The authors argue that the occupational disadvantages for women may be due to discrimination and that men partake in weight-related occupational sorting.	Wage & Occupation, Cross-sectional, US, Negative.
Atella *et al.*	Are employers	Investigate the relationship	Longitudinal survey	Heterogeneity of wage and	Use of IVQR’s	Wage, Longitudinal,

(2008)	discriminatin1g with respect to weight? European Evidence using Quantile Regression?	between obesity and wages in 9 European countries. Exposure: BMI. Outcome: Wage.	(European Community Household Panel (ECHP)) from 1998-2001 of Denmark, Belgium, Ireland, Italy, Greece, Spain, Portugal, Austria, Finland (n=77687). Age 25-64. Ordinary Least Squares, Quantile Regression, and Instrumental Variable Quantile Regression (IVQR). IV = biological BMI from family member. Covariates: insurance, training, productivity, health, age, marital status, children, smoking, occupation type, and education.	obesity found between and within countries. Negative relationship between wage and obesity was found and was stronger for women. IV regression for obese women (-0.065). IVQR for obese women (-0.0206 at the 85th percentile). Minimal changes including the numerous IV's and the authors conclude that unmeasured discrimination may cause wage disparity.	may show causal effects if used properly. Complex model used for the IVQR analyses. However, it appears to be strong method for dealing with the endogeneity bias. Quantile regression is also beneficial as the assumption of linearity does not apply to wage/BMI.	IV, Europe, Negative.
Barkin *et al.* (2010)	Millennials and the World of Work: The Impact of Obesity on Health and Productivity	Predict the impact of obesity for lifetime earnings and employee/employer consequences for the Millennial generation in the US. Exposure: Obesity. Outcome: aggregate lifetime earnings.	Economic model using evidence from existing literature regarding aggregate lifetime earnings. Predictive Economic Model.	Millennial generation American women that are obese will earn on average $956 billion less (compared to obese men who will earn on average $43 billion less).	Economic model perspectives predict in a different way than the common logistic models. Shows empirical evidence of the negative effect of obesity on the labour market.	Lifetime Earnings, Economic Model, US, Negative.
Baum & Ford (2004)	The wage effects of obesity: a longitudinal study	Examine the effects of obesity on wages by gender in the US. Exposure: BMI>30. Outcome: Wage (log wage).	A longitudinal study in the US using the National longitudinal survey of youth (NLSY) (n=6283 females). Age 18+.	The person-year model showed that individuals with a BMI greater than 30 have significantly lower wages (6.1% for obese females compared to non-obese).	Hypothesized presence of discrimination by employer, obesity causing less productive habits	Wage, Longitudinal, Fixed-effects, US, Negative.

			Person-year observations were used to make a wage model, multivariable and fixed-effects regression models. Covariates: race, age, education, marital status, children, experience, urban, area employment, industry type.	Fixed-effects model showed that a BMI of 30 or more continue to decrease wages (female wages by 5.8%). The model using sibling difference did not yield significant results, however an additional model using individual and sibling differences showed a significant decrease in wages for obese women (4.8%).	and discrimination by customers.	
Brunello & D'Hombres (2007)	Does body weight affect wages? Evidence from Europe	Investigate the impact of body weight on wages in nine European Countries. Exposure: BMI. Outcome: Wage (log wage).	A cross-national longitudinal survey of Spain, Greece, Italy, Portugal, Austria, Ireland, Denmark, Belgium and Finland (17,767 female observations). Age 18-65. Converted nominal into real wages using the time-varying purchasing power parity (PPP) as per a conversion index. Probit and IV regression models. IV = family member BMI. Covariates: occupation, industry, education, marital status, health status, smoking, presence of children.	The estimated effect of BMI on log wages was always statistically significant and negative. The study found that a 10% increase in mean BMI reduced wages by 3.27% for women. Controls such as occupation, industry and health make the effect smaller suggesting them as mediators. With two identical females, the one living in an area with a higher than average BMI will be paid 7% less than the one living in an area with a lower than average BMI.	The authors also divide the countries into Northern and Southern Europe (or the beer versus olive belts). They found that the effect is much greater in the "olive-belt" suggesting that the local economic and social environments matter.	Wage, Longitudinal, IV, Europe, Negative.
Garcia Villar & Quintana-Domeque (2009)	Income and body mass index in Europe.	Explore the relationship between household income and BMI in nine European countries.	Cross-sectional survey using the European Community Household Panel (1998-2001) looking at data from	Findings suggest a significant overall negative relationship for women. OLS showed a negative statistically	Study looked at BMI as a dependent variable unlike	Income (own and other), Cross-sectional, Europe, Negative.

		Exposure: Household income (own and other). Outcome: BMI.	Austria, Belgium, Denmark, Finland, Greece, Ireland, Italy, Portugal and Spain. (n=1670-5910 women depending on country). Age 21-75. Multinomial logit and quantile regression estimates (separate for each nation and gender). Covariates: age, age squared, marital status, children, region, year, food prices, urbanization, risky behaviours, physical activity, smoking, hours worked, social activities, education.	significant effect for women in five countries. Relationship for women is driven by their "own labour earnings". For example, BMI and "own labour earnings" range from -0.115 and the 1st quantile to -0.300 at the 3rd quantile in Denmark. In four countries, high income women are less likely to be obese. Quantile regression showed that negative BMI-income relationships become stronger with the BMI gradient in 5 countries.	the majority of similar studies.	
Cawley (2004)	The Impact of Obesity on Wages.	Estimate the effect of weight on wages in the US using several regression strategies. Exposure: BMI, weight in lbs. Outcome: Wage (log wage)	A longitudinal study of Americans using the National Longitudinal Survey of Youth (n=45,120 women). Age 14-22 at baseline (1979). OLS and three strategies were used to account for the endogeneity of weight: lagged-weight method, fixed effect) and IV model. IV = BMI of a sibling. Covariates: race, children, intelligence, education,	Overall, weight lowers wages for white females. A difference in weight of 2 SD (approx. 64 lbs) is associated with a difference in wage by 9%, which is 1.5 years of education or 3 years of work experience. Negative correlations between weight and wages for other gender-ethnic combinations all appear to be a result of unobserved heterogeneity (black and Hispanic females). The findings for white females	3 methods to account for the endogeneity of weight were used.	Wage, Longitudinal, IV, US, Negative.

			parent's education, experience, age, year, marital status, county unemployment, type of job, region.	are consistent for OLS (current and lagged weight), fixed-effect and IV methods.		
Wada & Tekin (2010)	Body composition and wages	Examine the relationship between body composition and wages (hourly) in Americans using a bioelectrical impedance analysis (BIA) as an alternative to BMI. Exposure: body composition - measured using the BIA in which body fat (BF) and fat-free mass (FFM) as a two-compartment model. Outcome: Wage	A longitudinal study using the National Health and Nutrition Examination Survey III (for BIA) and the NLSY of 1979 for a U.S. population. Age 14-21 in 1979. 2-stage least squares (2SLS) regression, fixed-effects regression and IV (IV= sibling body composition). Covariates: health, parents' education, children, education, marital status, age, tenure, experience, unemployment rates, urban, region, occupation type, year.	Results showed an association between BF and a decrease in wages for both sexes and among blacks and whites. A 1 kg increase in BF reduced wages by approximately 1%. Alternatively, the authors found that FFM was associated with an increase in wage (a 1kg decrease increased wages by about 1.2% for white females). Further, for women the effect of BF and FFM were significant for both blacks and whites. The 2SLS with the instrument of sibling body composition showed the effect of FFM to be twice as large.	Overall, there were significant effects of body composition on wages even after controlling for individual fixed-effects and the analysis showed that the outcomes were not a result of unobserved heterogeneity.	Wage, Longitudinal, IV, US, Negative.
Averett & Korenman (1996)	The Economic Reality of The Beauty Myth	To investigate income, marital status and hourly pay differences due to BMI in Americans. Exposure: BMI (categorized by the Metropolitan Life Insurance Company tables;	Longitudinal survey using American data from the 1988 National Longitudinal Survey of Youth (NLSY) of men and women (n=5090 women). Age 23-31 at baseline.	Obese women in both 1981 and 1988 had the largest disadvantage: approximately 17% lower than women of normal weight ($p < 0.01$). Marital status and spouses earnings account for 50-95%	More of a focus on SES, but still uses hourly wage as an outcome. They argue that there is evidence for labour market	Wage, Longitudinal, US, Negative.

		obesity still defined as a BMI > 30). Outcome: Various labour market (hourly wage) and marriage market outcomes.	OLS and multivariable regression models (using lagged BMI in some models). Covariates: sibling BMI, health limitations, self-esteem, academic ability test, marital status, age and children were used.	of a females income differences. Differences also increase when using an earlier BMI measure. The models used to analyze obesity-wage interactions showed coefficients to be -0.08, -0.04, and -0.05, for 1981, 1988 and the interaction term, respectively. Also, women who became obese during the study had only slightly lower wages.	discrimination for women. Results were similar when comparing same-sex siblings as controls and in general there seemed to be an importance of marriage market success on a woman's overall labour market success.	
Johar & Katayama (2012)	Quantile Regression Analysis of Body Mass and Wages	To explore the relationship between body mass and wages among American workers. Exposure: BMI Outcome: hourly wage rate (adjusted using CPI) (ln).	Longitudinal study using the National Longitudinal Survey of Youth 1979 (NLSY) (n=8787 or 77 375 person-years). Age 14-22 at baseline. Quantile and IV quantile regression (IV= BMI of same-sex sibling). Covariates: race, age, age squared, job tenure, mother/father grade level, marital status, area unemployment rate, education, work type, region, urban/rural, health insurance, birth country, health limitations.	Significant negative relationship between wage and BMI for women with stronger associations with higher wages (ranged from -0.0053 to -0.0071 for all women). In the IV model the relationship stayed significant for white women and was once again stronger at higher wage quantiles. The association was also stronger for social jobs.	Use of both quantiles for wage and IVs for endogeneity.	Wage, Longitudinal, IV, US, Negative.

DeBeaumont (2009)	Occupational differences in the wage penalty for obese women	To explore the connection between weight and wages for American women in different types of occupations. Exposure: BMI Outcome: hourly wage (ln).	Cross-sectional study using the National Longitudinal Survey of Youth 1979 (NLSY) from 1990 (n=3079 women). Age 26-33. OLS regression estimates. Covariates: school, tenure, age, race, region and type of occupation.	OLS results found that obese women in sales and service jobs had lower log wages (-.11(1.84)) at the 10% level. Obese and severely obese women receive wage penalties of 11% and 25%, respectively.	Focus of the study was on the effect of obesity on wage for different occupations but still showed the overall effect.	Wage, Cross-sectional, US, Negative.
Sabia & Rees (2012)	Body weight and wages: Evidence from Add Health	To examine the relationship between weight and wages for Americans. Exposure: BMI (lag) Outcome: Wage	Longitudinal study using the Add Health dataset in the US. Age 24-32. OLS and fixed effect regression with confirmation using 2SLS (IV) estimation (IVs = sibling and mother's BMI) Covariates: age, age squared, marital status, children, education, tenure, household income, occupation type, urbanicity.	1lb increase in body weight is associated with a 0.13-0.16% decrease in wage while a one-unit increase in BMI score is related to a 0.8-1% decrease in wage. This was all for white females (whom had the most significant impact). The association was significant in the OLS, OLS with lag weight and FE models. In the IV models, maternal BMU as a instrument resulted in a 1.9% decrease in wage given a 1-unit increase in BMI for white women.	Used FE and IV models.	Wage, Longitudinal, US, Negative.
Han *et al.* (2011)	Direct and indirect effects of body weight on adult wages.	To examine the relationship between BMI (obesity) on wage for young Americans. Exposure: BMI. Outcome: Hourly Wage	Longitudinal study using the National Longitudinal Survey of Youth 1979 (NLSY)(n= 12,686). Age 14-22 at baseline. Direct and indirect OLS nd FE (using sibling BMI)	Women who were obese as late teens had 3.5% lower wages (indirect). Direct obesity effect on wage was 8.6% less. However when controlling for sibling fixed-effects the relationship loses significance.	Direct and indirect analyses (using late-teen BMI).	Wage, Longitudinal, US, Negative.

			regression. Covariates: occupation type, race, parental education, marital status, children, year employed, pregnant, regional unemployment, CPI, and highest grade completed.			
Bozoyan & Wolbring (2011).	Fat, muscles, and wages.	To analyze the effect of body mass on wages in Germany using fat-free mass (FFM) and body fat (BF) and BMI. Exposure: BMI, FFM, and BF. Outcome: Log-hourly wage.	Longitudinal analysis using the German Socioeconomic Panel (GSOEP) and the BIAdata Base Project Data. (n=1169 females). Age 22-60. OLS, lagged body composition models, and fixed-effect regressions. Covariates: age, age squared, marital status, children, region, interviewer present, health-status, education, work experience and other human capital variables.	No significant findings between BMI and wage. For OLS (linear and lagged) models, FFM/BF show a negative significant relationship for female wages compared to male (-0.005 to -0.007 for BF). Fixed-effects models were no significant except for the association between job changers and hourly wage.	BIA measures used in addition to BMI due to the criticism of BMI.	Wage, Longitudinal, Germany, Negative.
Sarlio-Lahteenkorva *et al.* (2004)	Relative Weight and Income at Different Levels of Socioeconomic Status.	To examine the association between body weight (relative) and income among different levels of SES in Finland. Exposure: BMI Outcome: Annual income (and other SES variables).	Cross-sectional study using the Finnish Survey on Living Conditions (n=2068 women). Age 25-64. Ordinary regression analysis. Covariates: age, education, occupation.	Obesity was associated with income disadvantage among women with higher socioeconomic status (higher education/occupational class). Especially upper, white collar women. For highly educated obese women, income was approx. $5000 less annually than normal weight counterparts.	Heavy focus on discrimination at different SES levels.	Income, Cross-sectional, Finland, Negative.

Appendix B

Table B-1: Employment - Group Means of Explanatory Variables from Mundlak Corrected Model

Variables	Pooled OR: (95% CI)	Pooled W/ Lagged Obesity OR: (95% CI)
Obese	1.363* (0.947 - 1.963)	
Normal/Overweight (ref)	--	--
Obese - Lagged		1.211 (0.859 - 1.705)
Normal/Overweight-Lagged (ref)	--	--
Age		
Age	0.869** (0.762 - 0.990)	0.866** (0.761 - 0.986)
Age^2	1.002** (1.000 - 1.003)	1.002** (1.000 - 1.003)
Presence of Child(ren) in Household		
1 Child 5 or under	0.862 (0.543 - 1.368)	0.989 (0.626 - 1.561)
2 or more Children 5 or under	0.707 (0.328 - 1.526)	0.637 (0.294 - 1.380)
No Children 5 or under (ref)	--	--
Urban vs. Rural Dwelling		
Urban Living (30-500k)	1.111 (0.762 - 1.618)	1.159 (0.793 - 1.695)
Urban Living (500k+)	0.615* (0.362 - 1.044)	0.574** (0.337 - 0.978)
Rural (<30k) (ref)	--	--
Marital Status		
Married	1.225 (0.714 - 2.104)	1.404 (0.851 - 2.318)
Widowed, Separated, or Divorced	1.640 (0.904 - 2.976)	1.832** (1.015 - 3.307)
Single (ref)	--	--
Additional/Spousal Income		
Additional Income:$15-30K	0.664 (0.357 - 1.235)	0.702 (0.393 - 1.252)
Additional Income:$30-50K	1.451 (0.844 - 2.493)	1.395 (0.821 - 2.368)
Additional Income:$50-80K	0.927 (0.510 - 1.685)	0.893 (0.501 - 1.589)
Additional Income:$80k+	0.298*** (0.163 - 0.543)	0.300*** (0.166 - 0.541)
Additional Income: Missing	0.567** (0.331 - 0.971)	0.581** (0.353 - 0.957)
Additional Income: <$15k (ref)	--	--
Home Ownership		
Homeowner	1.763*** (1.227 - 2.532)	1.739*** (1.226 - 2.465)

Non-homeowner (ref)	--	--
Education		
Secondary School Graduate	1.048 (0.319 - 3.437)	1.104 (0.327 - 3.720)
Beyond High School	1.913 (0.645 - 5.674)	1.876 (0.650 - 5.414)
College or University Graduate	2.437 (0.773 - 7.682)	2.349 (0.762 - 7.236)
Less than High School (ref)	--	--
Lagged Health & Lifestyle Covariates		
Health Utility Index (HUI)	14.988*** (5.735 - 39.165)	19.270*** (7.188 - 51.657)
Health(Very Good)	0.772 (0.527 - 1.131)	0.774 (0.525 - 1.143)
Health(Good)	1.182 (0.767 - 1.822)	1.133 (0.728 - 1.762)
Health(Fair or Poor)	0.455** (0.224 - 0.926)	0.513* (0.254 - 1.038)
Health (Excellent)(ref)	--	--
1 or more chronic condition(s)	1.083 (0.825 - 1.424)	1.052 (0.794 - 1.393)
No Chronic Diseases (ref)	--	--
Occasional Smoker - Lagged	0.816 (0.448 - 1.485)	0.813 (0.453 - 1.461)
Daily Smoker - Lagged	0.935 (0.635 - 1.377)	1.042 (0.690 - 1.574)
Non-Smoker-Lagged (ref)	--	--
Former Drinker - Lagged	1.447 (0.706 - 2.963)	1.439 (0.707 - 2.930)
Occasional Drinker - Lagged	1.657 (0.885 - 3.105)	1.561 (0.835 - 2.918)
Regular Drinker - Lagged	1.849* (0.983 - 3.478)	1.692* (0.907 - 3.157)
Non-Drinker – Lagged (ref)	--	--
Observations	15,603	15,763

Robust CI in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-2: Wage - Group Means of Explanatory Variables from Mundlak Corrected Model

Variables	**Pooled** OR: (95% CI)	**Pooled W/ Lagged Obesity** OR: (95% CI)
Obese	-0.053*** (-0.085, -0.021)	
Normal/Overweight (ref)	--	--
Obese - Lagged		-0.037** (-0.070 - -0.004)
Normal/Overweight-Lagged (ref)	--	--
Age		
Age	0.005 (-0.006, 0.016)	0.000 (-0.011 - 0.01)
Age^2	-0.000 (-0.000, 0.000)	-0.000 (-0.000 – 0.000)
Presence of Child(ren) in Household		
1 Child 5 or under	0.035* (-0.002, 0.071)	0.029 (-0.006 - 0.065)
2 or more Children 5 or under	0.131*** (0.067, 0.196)	0.086*** (0.025 - 0.146)
No Children 5 or under (ref)	--	--
Urban vs. Rural Dwelling		
Urban Living (30-500k)	0.080*** (0.044, 0.115)	0.085*** (0.051 - 0.12)
Urban Living (500k+)	0.22352*** (0.176, 0.271)	0.2359 (0.188 - 0.284)
Rural (<30k) (ref)	--	--
Marital Status		
Married	-0.143*** (-0.183, -0.103)	-0.088*** (-0.124 - -0.051)
Widowed, Separated, or Divorced	-0.02144 (-0.066, 0.023)	0.01624 (-0.028 - 0.061)
Single (ref)	--	--
Additional/Spousal Income		
Additional Income:$15-30K	-0.144*** (-0.187, -0.101)	-0.185*** (-0.229 - -0.141)
Additional Income:$30-50K	-0.047** (-0.084, -0.011)	-0.082*** (-0.118 - -0.046)
Additional Income:$50-80K	0.103*** (0.062, 0.144)	0.065*** (0.026 - 0.104)
Additional Income:$80k+	0.267*** (0.211, 0.323)	0.207*** (0.155 - 0.258)
Additional Income: Missing	-0.019 (-0.059, 0.021)	-0.062*** (-0.1 - -0.023)
Additional Income: <$15k (ref)	--	--
Home Ownership		
Homeowner	0.111*** (0.081, 0.141)	0.125*** (0.096 - 0.155)
Non-homeowner (ref)	--	--

Education		
Secondary School Graduate	0.155***	0.155***
	(0.046, 0.264)	(0.051 - 0.26)
Beyond High School	0.203***	0.222***
	(0.120, 0.287)	(0.142 - 0.301)
College or University Graduate	0.325***	0.348***
	(0.236, 0.413)	(0.262 - 0.433)
Less than High School (ref)	--	--
Lagged Health & Lifestyle Covariates		
Health Utility Index (HUI)	0.250***	0.285***
	(0.153, 0.347)	(0.19 - 0.379)
Health(Very Good)	-0.037***	-0.029**
	(-0.064, -0.009)	(-0.056 - -0.002)
Health(Good)	-0.114***	-0.118***
	(-0.147, -0.081)	(-0.15 - -0.085)
Health(Fair or Poor)	-0.022	-0.009
	(-0.081, 0.038)	(-0.067 - 0.048)
Health (Excellent)(ref)	--	--
1 or more chronic condition(s)	0.031**	0.028**
	(0.007, 0.055)	(0.005 - 0.052)
No Chronic Diseases (ref)	--	--
Occasional Smoker - Lagged	0.001	-0.001
	(-0.051, 0.052)	(-0.052 - 0.05)
Daily Smoker - Lagged	-0.038**	-0.034**
	(-0.071, -0.004)	(-0.067 - -0.001)
Non-Smoker-Lagged (ref)	--	--
Former Drinker - Lagged	-0.067**	0.002
	(-0.130, -0.004)	(-0.06 - 0.064)
Occasional Drinker - Lagged	-0.091***	-0.037
	(-0.151, -0.031)	(-0.095 - 0.021)
Regular Drinker - Lagged	0.027	0.088***
	(-0.031, 0.085)	(0.03 - 0.147)
Non-Drinker – Lagged (ref)	--	--
Observations	11,279	11,419

Robust CI in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-3: Income - Group Means of Explanatory Variables from Mundlak Corrected Model

Variables	**Pooled** OR: (95% CI)	**Pooled W/ Lagged Obesity** OR: (95% CI)
Obese	-0.022 (-0.066, 0.021)	
Normal/Overweight (ref)	--	--
Obese - Lagged		-0.042* (-0.090, 0.006)
Normal/Overweight-Lagged (ref)	--	--
Age		
Age	-0.024*** (-0.039, -0.008)	-0.016** (-0.030, -0.001)
Age^2	0.000*** (0.000, 0.000)	0.000 (0.000, 0.000)
Presence of Child(ren) in Household		
1 Child 5 or under	0.054** (0.001, 0.108)	0.044* (-0.008, 0.096)
2 or more Children 5 or under	0.071* (-0.012, 0.154)	0.112** (0.027, 0.197)
No Children 5 or under (ref)	--	--
Urban vs. Rural Dwelling		
Urban Living (30-500k)	0.096*** (0.043, 0.148)	0.069*** (0.018, 0.119)
Urban Living (500k+)	0.162*** (0.095, 0.229)	0.178*** (0.111, 0.246)
Rural (<30k) (ref)	--	--
Marital Status		
Married	-0.100*** (-0.155, -0.044)	-0.118*** (-0.174, -0.061)
Widowed, Separated, or Divorced	-0.074** (-0.141, -0.007)	-0.057*** (-0.123, 0.010)
Single (ref)	--	--
Additional/Spousal Income		
Additional Income:$15-30K	-0.236*** (-0.313, -0.16)	-0.230*** (-0.304, -0.155)
Additional Income:$30-50K	-0.081*** (-0.136, -0.027)	-0.054** (-0.107, -0.001)
Additional Income:$50-80K	-0.082*** (-0.139, -0.026)	-0.084*** (-0.140, -0.028)
Additional Income:$80k+	-0.087*** (-0.151, -0.023)	-0.030 (-0.092, 0.032)
Additional Income: Missing	-0.141*** (-0.204, -0.078)	-0.088*** (-0.147, -0.029)
Additional Income: <$15k (ref)	--	--
Home Ownership		
Homeowner	0.157*** (0.108, 0.207)	0.172*** (0.121, 0.223)
Non-homeowner (ref)	--	--

Education		
Secondary School Graduate	0.287***	0.202***
	(0.143, 0.431)	(0.061, 0.342)
Beyond High School	0.500***	0.443***
	(0.355, 0.646)	(0.303, 0.582)
College or University Graduate	0.537***	0.477***
	(0.385, 0.688)	(0.332, 0.622)
Less than High School (ref)	--	--
Lagged Health & Lifestyle Covariates		
Health Utility Index (HUI)	0.263***	0.252***
	(0.122, 0.403)	(0.113, 0.391)
Health(Very Good)	-0.056***	-0.048**
	(-0.096, -0.015)	(-0.088, -0.008)
Health(Good)	-0.119***	-0.075***
	(-0.169, -0.070)	(-0.121, -0.028)
Health(Fair or Poor)	-0.091**	-0.082*
	(-0.182, -0.001)	(-0.170, 0.007)
Health (Excellent)(ref)	--	--
1 or more chronic condition(s)	0.116***	0.117***
	(0.074, 0.159)	(0.074, 0.159)
No Chronic Diseases (ref)	--	--
Occasional Smoker - Lagged	0.074*	0.015
	(-0.004, 0.152)	(-0.059, 0.089)
Daily Smoker - Lagged	0.003	-0.008
	(-0.047, 0.053)	(-0.059, 0.042)
Non-Smoker-Lagged (ref)	--	--
Former Drinker - Lagged	-0.033	0.020
	(-0.119, 0.053)	(-0.067, 0.106)
Occasional Drinker - Lagged	-0.131***	-0.074*
	(-0.217, -0.046)	(-0.156, 0.008)
Regular Drinker - Lagged	0.089**	0.148***
	(0.006, 0.171)	(0.062, 0.235)
Non-Drinker – Lagged (ref)	--	--
Observations	13,284	13,407

Robust CI in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Curriculum Vitae

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EDUCATION

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PRESENTATIONS

Samantha Larose, Dr. Karen Campbell, Dr. Gregory Zaric, Dr. Sisira Sarma. *The Impact of Obesity on Employment Participation and Earnings among Working-Age Women in Canada: Evidence from the NPHS Longitudinal Data***.** London Health Research Day, London Convention Centre, London, Ontario. March 19, 2013. Poster Presentation.