Three Essays in Empirical Health Economics

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Abstract

Three Essays in Empirical Health Economics

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This thesis consists of three essays in essential public health issues. The first essay evaluates the effect of graphic cigarette warning labels on smoking prevalence and quit attempts. The Generalized Estimating Equation (GEE) model is used to examine the population-averaged (marginal) effects of tobacco graphic warnings on smoking prevalence and quit attempts. We find that graphic warnings had a statistically significant effect on smoking prevalence and quit attempts. In particular, the warnings decreased the odds of being a smoker and increased the odds of making a quit attempt. This study adds to the growing body of evidence on the effectiveness of graphic warnings as a tobacco control measure.

The second essay examines the effect of job stress on three key health risk-behaviors: smoking, alcohol consumption and body mass index (BMI), using data from the Canadian National Population Health Survey. Findings in the extant literature are inconclusive due to unobserved characteristics that previous studies have ignored. Accordingly, we use latent class, random and fixed effect models to capture heterogeneous responses to job stress and control for unobserved individual-level heterogeneity. This study provides suggestive evidence that the mixed findings in the

literature may partly be due to unobserved individual heterogeneity which is not captured in previous studies.

The third essay examines the relationship between fruits and vegetables (FV) consumption and body weight. Previous studies mostly used linear regression methods to study the correlates of the conditional mean of BMI. This approach may be less informative if the association between FV consumption and the BMI significantly varies across the BMI distribution. A quantile regression model is estimated in order to account for the potential heterogeneous association between FV intake and the BMI at different points of the conditional BMI distribution. The multivariate analyses reveal that the association between FV intake and the BMI varies across the conditional quantiles of the BMI distribution. In particular, the estimates are larger for individuals at the higher quantiles of the distribution. The OLS model overstates (understates) the association between FV intake and BMI at the lower (higher) half of the conditional BMI distribution.

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I dedicate this dissertation to God almighty for this opportunity, my wife and daughters.

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Contribution of Authors

Essay 1: Azagba & Sharaf contributed to the study design and methodology, both authors performed the data analysis, interpretation of results and wrote the manuscript.

Essay 2: Azagba conceived the study, developed the study design and methodology, conducted data management, performed the estimation, interpreted the results and wrote the manuscript. Sharaf helped with the study design and contributed to the writing of the literature review.

Essay 3: Azagba conceived the study, developed the study design and methodology, conducted data management, performed the estimation, interpreted the results and wrote the manuscript. Sharaf contributed to the writing of the literature review.

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Introduction

This thesis consists of three essays in empirical Health Economics. The first essay studies the effect of graphic cigarette warning labels on smoking behavior using longitudinal data from Canada. The second essay examines the effect of job-related stress on three health risk behaviors; smoking, alcohol consumption and body weight. The third essay investigates the relationship between fruits and vegetables (FV) consumption and body mass index (BMI) using a quantile regression approach.

The adverse effects of tobacco use are well documented. Smoking is the leading preventable cause of premature death in the world and is a risk factor for many diseases (e.g. strokes, cardiovascular disease and cancer). According to the World Health Organization (WHO), smoking is responsible for 6 million deaths and by the year 2030; this figure is expected to reach 8 million (WHO, 2011). The average life span of a smoker is reduced by 6 to 10 years. In Canada, smoking is the leading cause of premature and preventable mortality. It is responsible for more than 45,000 deaths and a total economic burden of $15 billion per year.

To address the rising smoking epidemic, the WHO Framework Convention on Tobacco Control (FCTC), requires member countries to implement measures aimed at reducing the demand for tobacco products (WHO, 2008). Article 11 of the FCTC provides guidelines for warnings messages on cigarette packages. It recommends the use of rotating, large, clear, and visible graphic warning messages and it should cover 50% or more of the principal display areas of the package (WHO, 2008). In line with the global effort to address the rising smoking epidemic, the Government of Canada implemented several measures to discourage smoking. In January 2001, Canada became the first

country in the world to enforce graphic health warning labels on cigarette packages. The warnings occupied 50% of the principal display area and appeared in English and French on both sides of the package. Since then, graphic warnings have been the subject of intensive research to determine their effectiveness as an anti-smoking measure.

Several studies have assessed the effectiveness of graphic warnings in discouraging smoking (For a recent review of the literature see Hammond, 2011), with the general finding that graphic warnings were more effective than text only messages (e.g. Hammond et al.,2006; Hammond, 2011; Borland et al., 2009; Givel 2007). Though there is substantial literature that examines the effectiveness of graphic warnings as a key tobacco control measure, evidence based on actual smoking behavior has been limited. Previous studies relied on respondents answers to questions about the graphic warnings to determine their effectiveness such as desire to quit, increased health knowledge of tobacco risks, ability to recall the messages, self reported effectiveness. The problem with these types of questions is that individuals tend to provide logical responses to questions which involve an appeal to fear. These answers may not reflect actual behavior, and hence may not provide an objective assessment of the effect of graphic warnings (Ruiter and Kok, 2005; Hastings et al., 2004). Accordingly, this study takes a different approach by using survey data that has smoking related information without any health warning questions. In particular, the effectiveness of graphic cigarette warning labels was assessed based on their effect on smoking prevalence and quit attempts. Longitudinal data from the Canadian National Population Health Survey (1998-2008) is used to conduct the multivariate regression analyses.

Three approaches are used to capture the effect of graphic warnings. In the first approach, the graphic warning is considered to be in effect starting from July, 2001. In the second approach, the warning is considered to be in effect from December, 2001. However, in the third approach, a scaled variable that takes the value of zero for up to the first six months in 2001, then increases gradually to one from December, 2001 is used. Given the longitudinal structure of the Canadian National Population Health Survey and to account for the within individuals dependency, a Generalized Estimating Equations (GEE) model is used to examine the population-averaged (marginal) effects of tobacco graphic warnings on smoking prevalence and quit attempts. The merit of this model is that it accounts for correlated responses in longitudinal data, and gives consistent estimates of the regression parameters and of their variances under weak assumptions about the joint distribution.

Three different working correlation structures; exchangeable, autoregressive and unstructured, are used to check if our main results are sensitive to the structure of covariance matrix. The main findings are that graphic warnings have a statistically significant effect on smoking prevalence and quit attempts. The warnings decrease the odds of being a smoker and increase the odds of making a quit attempt. Similar results are obtained when more time is allowed for the warnings to appear in retail outlets. The results are robust to changing the working correlation matrix

In the second essay, the effects of job-related stress on three health risk behaviors, including smoking, alcohol consumption and body weight are examined. Stress is widely cited as "the 20th century epidemic" and a "worldwide epidemic".

Substantial economic losses have been attributed to work-related stress. For example, work stress costs employers over $300 billion in the U.S (Karasek and Theorell, 1990) annually (Sainsbury Centre for Mental Health, 2007), whereas in Canada, work time lost due to stress costs $12 billion per year (Canadian Mental Health Association). A growing body of research has linked chronic stress to a wide range of adverse health outcomes such as mental disorder, cardiovascular disease, anxiety, depression, hostility, heart attack, headaches, back pain and colorectal cancer (Chandola et al., 2008; Heart and Stroke Foundation of Canada, 2000; Stansfeld and Candy, 2006). In particular, studies show that stress can exacerbate several unhealthy behaviors such as smoking, alcohol use and excessive body weight (Karasek and Theorell, 1990; Ng and Jeffery, 2003; Kouvonen et al., 2005).

Existing evidence on the effect of job stress on health risk behaviors is inconclusive (for a review see Siegrist and Rodel, 2006). Previous studies were mainly cross sectional in nature, used standard models which can model differential responses to job stress only by observed characteristics and used small samples that are not necessarily representative of the population, while other studies focus only on some stressful occupations. However, the effect of job stress on smoking and drinking may largely depend on unobserved characteristics such as: self control, stress-coping ability, personality traits and health preferences. Accordingly, in this essay, we propose that the mixed findings in the extant literature may in part be due to unobserved characteristics that are not fully captured by standard models.

To quantify the effect of job stress on smoking and alcohol consumption, a latent class model is used to capture heterogeneous responses to job stress. The effect of job stress on

BMI is examined using panel data estimation methods (fixed effects and random effects) to account for individual-level unobserved heterogeneity. Longitudinal data from the Canadian National Population Health Survey is used.

The findings of this essay are that the effects of job stress on smoking and alcohol consumption differ substantially for at least two "types" of individuals, light and heavy users. In particular, job stress has a positive and statistically significant impact on smoking intensity, but only for light smokers, while it has a positive and significant impact on alcohol consumption mainly for heavy drinkers. For the effect of job stress on BMI, the baseline ordinary least square model shows a positive effect, while the fixed effects and random effects models show no statistically significant effect. These results provide suggestive evidence that the mixed findings in previous studies may partly be due to unobserved individual heterogeneity which is not captured by standard models.

The third essay examines the relationship between fruits and vegetables (FV) consumption and body weight using a nationally representative sample from the Canadian Community Health Survey (2004). The dramatic rise in obesity prevalence and its well documented adverse effects have become a challenging issue for policy makers and academics over the last two decades. Obesity is a precursor of many chronic diseases (Hu, 2008) and may cause psychological disorders through societal prejudice and discrimination against obese individuals (Wadden et al., 2002; Cawley, 2004). In addition, the economic cost attributable to overweight and obesity is substantial (Katzmarzyk and Janssen, 2004; Finkelstein et al., 2005; Society of Actuaries, 2011). For example, a recent study estimates that the total economic cost of overweight and obesity

in the US is $270 billion yearly and the cost in Canada is $30 billion yearly (Society of Actuaries, 2011).

The World Health Organization (2003) together with empirical studies has linked individual's diet and nutrition behavior including the consumption of FV to the global rise in obesity. The health benefits of adequate consumption of FV daily (5 servings or a minimum of 400 grams) are enormous (WHO, 2003; Bazzano, 2006).

There is mixed empirical evidence about the association between FV intake and body weight in both clinical (Rolls et al., 2004) and epidemiologic studies (Tohill et al., 2004). Previous studies mostly use linear regression methods to study the correlates of the conditional mean of BMI. This approach may be less informative if the association between FV consumption and the BMI significantly varies across the BMI distribution. For example two individuals with a BMI of 40 and 30 are equally classified as being obese, notwithstanding the intensity of obesity for the first person is higher. This leads to a statistical loss of information that may be relevant for intervention measures. Individuals may respond differently to the factors causing obesity, depending on their location in the BMI distribution. Accordingly, in the third essay, a quantile regression framework is used to characterize the heterogeneous association across the different quantiles of the BMI distribution. This is relevant to the nutrition and obesity literature where attention is given to certain segments of the BMI distributions.

It is found that the association between FV intake and BMI is negative and statistically significant for both males and females; however, this association varies across the conditional quantiles of the BMI distribution. In particular, the estimates are larger for individuals at the higher quantiles of the distribution. The OLS model overstates

(understates) the association between FV intake and BMI at the lower (higher) half of the conditional BMI distribution. This implies that findings of the standard models that assume uniform responses across different quantiles of BMI distribution may be misleading. The findings of this essay suggest that increasing the intake of FV may be an effective dietary strategy to control weight and mitigate the risk of obesity.

Essay 1

The effect of graphic cigarette warning labels on smoking behavior: Evidence from the Canadian experience

Abstract

There is a substantial literature that graphic health warnings on cigarette packs are effective tobacco control measure, however, there is limited evidence based on actual smoking behavior. The objective of this paper is to assess the effect of graphic cigarette warning labels on smoking prevalence and quit attempts. A nationally representative sample of individuals aged 15 years and older from the Canadian National Population Health Survey (1998-2008) is used. The sample consists of 4,853 individuals for the smoking prevalence regression, and 1,549 smokers for quit attempts. The Generalized Estimating Equations (GEE) model was used to examine the population-averaged (marginal) effects of tobacco graphic warnings on smoking prevalence and quit attempts. To assess the effect of graphic tobacco health warnings on smoking behavior, we used a scaled variable that takes the value of zero for the first six months in 2001, then increases gradually to one starting from December, 2001. We found that graphic warnings had a statistically significant effect on smoking prevalence and quit attempts. In particular, the warnings decreased the odds of being a smoker (OR = 0.875, CI = 0.821-0.932) and increased the odds of making a quit attempt (OR = 1.330, CI = 1.187-1.490). Similar results were obtained when we allowed for more time for the warnings to appear in retail outlets. This study adds to the growing body of evidence on the effectiveness of graphic warnings. Our findings suggested that warnings had a significant effect on smoking prevalence and quit attempts in Canada.

1.1. Introduction

The adverse health effects of tobacco use are well established (Center for Disease Control and Prevention, 2008). Globally, annual smoking attributable deaths are estimated to be 6 million, with 600,000 nonsmokers exposed to environmental tobacco smoke (World Health Organization, 2011). In Canada, smoking is the leading cause of premature and preventable mortality. It is responsible for more than 45,000 deaths and a total economic burden of $15 billion per year (Health Canada, 2002). To address the rising smoking epidemic, the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC), requires member countries to implement measures aimed at reducing the demand for tobacco products (WHO, 2008). Article 11 of the FCTC provides guidelines for warning messages on cigarette packages. It recommends the use of rotating, large, clear, and visible graphic warning messages and it should cover 50% or more of the principal display areas of the package (WHO, 2008). As of June 2011, more than 40 countries have implemented similar warning messages (Tobacco Free Center, 2011).[1]

In line with the global effort to address the rising smoking epidemic, the Government of Canada implemented several measures to discourage smoking. In January 2001, Canada became the first country in the world to enforce graphic health warning labels on cigarette packages. The warnings occupied 50% of the principal display area and appeared in English and French on both sides of the package. [2]

[1] See Table 1 for a list of countries that have implemented graphic warnings as of June 2011.
[2] See Figure 1 for a comprehensive overview of the 16 graphic warnings that were implemented under the Tobacco Products Information Regulations.

Externality in the form of non-smokers exposure to tobacco smoke, lack of self control, and imperfect knowledge of the health risks of tobacco use are widely used to justify the need for intervention measures (Chaloupka and Warner, 2000). Some smokers are unaware of the health risks of tobacco use (WHO, 2011), and graphic warnings have been documented as a useful channel for informing individuals about the health hazards of smoking. A one pack per day smoker is exposed to graphic warnings up to 20 times a day (Hammond, 2011).

Several studies have assessed the effectiveness of graphic warnings in discouraging smoking (For a recent review of the literature see Hammond, 2011). Evidence from population-based surveys together with empirical research show that graphic warnings, particularly large, prominent and comprehensive warnings, are effective in discouraging smoking initiation (Vardavas et al., 2009; European Commission, 2009), and encouraging smoking cessation (Miller et al., 2009; Hammond et al., 2003). A number of Canadian studies find that pictorial cigarette health warnings are effective (e.g., Hammond et al., 2003; Hammond et al., 2004; Health Canada, 2001). Empirical evidence from other countries (e.g., Nascimento et al., 2008; Webster and Wakefield, 2008; Health Promotion Board, 2004; Vardavas et al., 2009; Miller et al., 2009; Li and Grigg, 2009) and cross-country studies (e.g., Givel, 2007; Hammond et al., 2006; Borland et al., 2009; Hammond et al., 2007) have shown that graphic health warnings are effective. For example, in Australia, Miller et al. (2009) noted that the call volume to the help quit line increased following the introduction of warning messages on cigarette packs. In Singapore, 47% of smokers reported decreased cigarette consumption after pictorial warning labels were introduced (Health Promotion Board, 2004)

Research has shown that graphic warnings were more effective than text only messages. Graphic warnings induced a greater emotional response, were more likely to retain their salience over time and increase awareness of health risks, compared to text warnings (Hammond et al., 2006; Hammond, 2011). Similarly, cross-country studies found that large and graphic health warning images were more effective in stimulating cognitive reactions (i.e., quit intentions as a result of increased knowledge of the health risks of smoking) compared to text-only warnings (Hammond et al., 2006; Borland et al., 2009; Hammond et al., 2007). Givel (2007) compared Canadian cigarette pictorial warning labels to the United States' text-only messages and found Canadian pictorial labels to be more effective in promoting smoking cessation.

There is also evidence that graphic warnings supplement other tobacco control measures better to discourage smoking. For example, Chang et al. (2011) found that the implementation of Taiwan's graphic cigarette warning labels in combination with smoke-free laws, were effective in increasing awareness of the harmful effects of smoking and thoughts of cessation. Similarly, Brennan et al. (2011) found evidence of complementary effects between graphic warnings and television advertisement in increasing the knowledge of the health risks of smoking and motivating smoking cessation in Australia.

There is a substantial literature that graphic health warnings on cigarette packs are effective tobacco control measure, however, there is limited evidence based on actual smoking behavior. Previous studies have relied on respondents answers to questions about the graphic health warnings to determine their effectiveness. Some of the measures of effectiveness include; desire to quit, increased health knowledge of tobacco risks, ability to recall the messages and self reported effectiveness. While these measures may

predict future behavior, subjects tend to provide logical responses to questions which involve an appeal to fear. These answers may not reflect actual behavior, and hence may not provide an objective assessment of the effect of graphic warnings (Ruiter and Kok, 2005; Hastings et al., 2004).

Accordingly, this study takes a different approach by using survey data which contains smoking-related information without any health warning questions. The objective of this paper is to assess the effect of graphic cigarette warning labels on actual smoking behavior. We used longitudinal data from the Canadian National Population Health Survey (1998-2008) which covers pre- and post-policy periods.

The structure of this paper is as follows: in Section 1.2, we present a brief background on the economic rationale models for intervention and the tobacco control policy environment in Canada. Section 1.3 describes the data and methodology. Section 1.4 presents the results and conclusions are provided in Section 1.5.

1.2.1. Economic Rationale Models for Intervention

Economists have formulated models to explain the rationale for addictive consumption. The general point of reference is the rational addiction (RA) model of Becker and Murphy (BM) (1988). In this model, consumers optimally make smoking decisions with knowledge of the health consequences of tobacco use, the addictive nature of cigarette smoking and all the monetary costs. Therefore, government legislation that mandates health warnings will be of no use in the BM model. A central assumption of the RA framework is time consistency, that is to say, future preferences coincide with the current decision to smoke.

In contrast to the time consistent preferences in the RA model, the behavioral economics literature uses hyperbolic discounting to characterize consumers' preferences for addictive goods as time inconsistent[3]. Smokers in this framework place a higher value to immediate gratification, hence, significantly discount the long-term negative impact. O'Donoghue and Rabin (1999; 2002), and Gruber and Koszegi (2001) showed how time-inconsistent behavior depends on perceived future beliefs of self-control. Naive agents tend to overestimate their ability to control future behavior while sophisticated agents fully understand future self-control problems. Due to the incentive effect, sophisticated smokers are more likely to refrain from smoking than naive smokers.[4] Gruber and Koszegi suggested that government intervention in the tobacco market should not be limited to externalities (costs that smokers impose on others) but should also include smoking internalities. Self control and failure to attain a desired future level of smoking are the two key features that separate time-consistent from time-inconsistent agents. Hersh (2005) argued that smokers' support for government regulations on restricting smoking in public areas is an indication of the lack of self control among smokers. Bernheim and Rangel (2004; 2005) argued that addictive goods can sometimes interfere with the decision part of the brain, and lead to wrong "cue-conditioned" craving. The implication is that provocative counter-cue policies, like graphic cigarette health warnings, may moderate neurotic behavior but their impact is limited on smokers that are "neurologically sensitized" to nicotine.

[3] O'Donoghue and Rabin (1999) described time inconsistent preferences as 'present-biased preferences'

[4] Incentive effect here refers to a situation where sophisticated smokers refrain from current consumption in order to prevent future indulgence, see O'Donoghue and Rabin (2002) for details.

Until recently, the impact of health warnings (text only messages) on tobacco consumption was embedded in the advertising bans literature. The effect of tobacco advertising on tobacco consumption has remained a contentious public health concern. There is mixed empirical evidence from studies that examined the effects of the tobacco advertising ban on consumption. For example, Blecher (2008), and Saffer and Chaloupka (2000) used cross-country data and found that the tobacco advertising ban is effective in reducing cigarette consumption while Nelson (2003) found advertising bans to be ineffective. The mixed results in the tobacco advertising literature is largely due to the varying level of advertising ban in different countries and the difficulty in defining a ban variable that truly reflects these levels.

1.2.2. Canadian Tobacco Control Policy Environment

The Canadian health warning labels started with four rotating text messages, covering 20% of the front and back of the package, in English and French, under the federal law of 1989. Subsequently, there has been an increase in the number of messages. In 1994, a new set of eight rotating black and white text warning messages, occupying 35% of the front and back of the package were implemented (Cismaru and Lavack, 2007; Non Smokers' Right Association). In 1995, the Supreme Court of Canada removed the legal basis for imposing these warnings. It was not until 1997 when the parliament passed the Tobacco Act which gave the government the right to regulate the packaging of cigarettes. The Tobacco Act of 1997 enforced a set of regulations concerning advertising and packaging of tobacco products. In June 2000, the Tobacco Products Information Regulations (TPIR) under the Tobacco Act became a law, and tobacco companies were given a grace period until the end of December 2000 to add the new warning labels. The

new regulation mandated the display of one of 16 different colored graphic warnings on at least 50% of the principal display area. It appears in English and French on both sides of the package. The regulation also mandated the inclusion of messages inside the package about the health risks of smoking and messages to help smokers quit (Health Canada, 2000). Since then, the warning message labelling on tobacco product became an integral component of a comprehensive tobacco control strategy to discourage smoking. Parallel to the introduction of the Canadian graphic warnings, there has been a substantial increase in cigarette taxes both at the federal and provincial levels which resulted in higher cigarette prices. In April 2001, the Federal Tobacco Control Strategy (FTCS) proposed raising tobacco taxes, in addition to other measures, to reduce smoking and exposure to second hand smoke (Health Canada, 2002). This triggered a sequence of tax hikes. At the federal level, the excise tax was first raised to $10.99 per carton in May 2001, and then to $12.62 by the end of 2001. In mid 2002, the federal tax was further raised to $13.86 per carton and then to $15.85 in July 2002 (Gabler and Katz, 2010).

Canadian provinces followed the federal government and increased their taxes on cigarettes, but by different magnitudes. For example, between 2000 and 2003, real cigarette taxes almost doubled in Ontario, Alberta, New Brunswick and Nova Scotia. Taxes increased by 83% in Quebec, 70% in Manitoba and Saskatchewan, 45% in British Columbia and 37% in Newfoundland. After 2003, nominal taxes were subject to small increases to offset the impact of inflation.

In line with the Federal Tobacco Act, Canadian provinces implemented legislation to ban smoking in public places and workplaces (Health Canada, 2007). In January 1, 2005, the Saskatchewan Tobacco Control Act banned smoking in all enclosed public places

including restaurants, bars and casinos. This was followed by the Newfoundland and Labrador Smoke-Free Environmental Act in July 1, 2005. In January 1, 2006, Alberta enforced its Smoke-free Places Act. The Smoke-free Ontario Act and Quebec's Tobacco Act became effective in May 31, 2006. Nova Scotia enforced its smoke-free places act in December 1, 2006. In January 2008, British Columbia enforced legislation for banning smoking province-wide (Shields, 2007).

Though the Tobacco Act of 1997 called for banning tobacco advertising, it continued to allow point-of-sale display of tobacco products, as well as sponsorship promotion by tobacco companies. As of October 1 2003, tobacco companies were prohibited from using the sponsorship of cultural and sports events as an avenue to advertise their tobacco products. Tobacco companies tried to get around these restrictions by using retail stores as a channel to promote tobacco products (Cohen et al., 2008). To address this challenge, the point of sale displays of tobacco products were the target of provincial policies. Saskatchewan was the first province to adopt a display restriction in 2002, but the policy was struck down after a challenge from tobacco companies. Since then, all Canadian provinces have implemented a display ban, beginning with Manitoba (2004) and followed by Saskatchewan (2005), Prince Edward Island (2006), Nova Scotia (2007), British Columbia, Ontario, Quebec and Alberta (2008), New Brunswick (2009), and Newfoundland and Labrador (2010) (The Ontario Tobacco Research Unit, 2010).

1.3. Methodology

1.3.1. Data

This study used nationally representative data from the Canadian National Population Health Survey (NPHS). A detailed description of the NPHS has been documented elsewhere (Statistics Canada, 2009). Briefly, the NPHS is a longitudinal data

set which contains information on each respondent's health-related characteristics, as well as corresponding economic and socio-demographic variables. The first cycle of the NPHS was done in 1994/95 and, since then, respondents have been re-interviewed every two years. We used balanced panel data from cycle three (1998/99) to cycle eight (2008/09) and the sample is restricted to the adult population aged 15 years and older.[5] The sample consisted of 4,853 individuals, resulting in 29,118 person-year observations for smoking prevalence. While for quit attempts, we had 1,549 smokers and 6,269 person-year observations.

1.3.2. Measures

Outcome variables: Smoking behavior. We used two self-reported measures of smoking behavior: smoking prevalence and quit attempts. Smoking prevalence is derived from participants' responses to the survey question, "At the present time do you smoke cigarettes daily, occasionally or not at all?" We created a dichotomous indicator for smoking status which takes the value of 1 if an individual reported smoking cigarettes daily or occasionally and zero otherwise. If daily and occasional smokers reported trying to quit smoking in the past six month, they were assigned the value one, indicating a quit attempt, otherwise a zero is recorded.

We did not examine the intensity of smoking. This is normally measured by the number of cigarettes consumed. Recent evidence suggested that the quantity smoked does not necessarily reflect the actual intensity of smoking (Adda and Cornaglia, 2006; Farrelly et al., 2004). Smokers may reduce the quantity of cigarettes smoked but increase the intensity with which they smoke each cigarette. Moreover, in response to higher

[5] We also restricted the sample to those aged 18 and older, the results were similar.

cigarette prices, Farrelly et al. (2004) found that some smokers increased tar and nicotine intake in order to compensate for a reduction in the quantity of cigarettes smoked. Unfortunately, the level of nicotine intake is not available in the NPHS.

Graphic warnings variable. To assess the effect of graphic tobacco health warnings on smoking behavior, we created a policy variable to capture pre and post policy periods using three approaches. First, we used a dichotomous indicator that takes the value of one starting from July, 2001 onward and zero otherwise. July, 2001 is used as the starting point so as to capture when graphic warnings were prevalent in retail shops. In the second approach, we allowed more time for the policy to take effect by creating a dummy variable that takes the value of one starting from December, 2001 onward and zero otherwise. Third, we used a scaled variable that takes the value of zero for up to the first six months in 2001, then increases gradually to one starting from December, 2001 (the following scale was used: 0.1 for July, 2001; 0.3, August; 0.5, September; 0.7, October and 0.9, November).

Control variables. We included the following standard covariates in the analyses: gender; age groups: 15-24 (reference group= ref), 25-34, 45-64 and 65 or older; educational attainment: less than secondary (ref), secondary, some post-secondary and post secondary; household income in quartiles adjusted for the household size: low income (ref), low-middle income, high-middle income and high income; marital status: single (ref), separated or widowed, married; household size; employment status, employed (ref) and unemployed; immigration status: non-immigrant (ref) and immigrant; workplace smoking bans: no ban (ref), partial ban and full ban; and province of residence. The analysis also controlled for cigarette prices. We constructed a yearly

average of cigarette prices from 1998-2009 using the monthly cigarette price index for each province from the Canadian Socioeconomic Information Management System (CANSIM) and the provincial nominal cigarette prices as of March 31, 2006 from the non-smokers' right association (Non-smokers' Rights Association, 2006). To obtain the inflation-adjusted cigarette price, the province-specific consumer price index obtained from CANSIM is used to deflate the nominal cigarette prices.

Following Fagan et al., 2007; Kahende et al., 2011 and Herrick, 2000, we used a standard set of variables including a proxy for nicotine dependence in the quit attempt analysis. For our measure of nicotine dependence among smokers, we used the time to the first cigarette after waking and the average number of cigarettes smoked per day. Previous studies using structural equation modeling have shown both as good measures for nicotine dependence (Richardson and Ratner, 2005; Nonnemaker and Homsi, 2007). We used three categories for quantity smoked: less than 11 (ref); 11 to 19; and 20 or more cigarettes per day. The time to first cigarette after waking is categorized: within 30 minutes (ref); 31 to 60 minutes; and more than 60 minutes.

1.3.3. Statistical Analysis

A Generalized estimating equation (GEE) model was used to examine the population-averaged (marginal) effects of tobacco graphic warnings on smoking prevalence and quit attempts. In an extension to generalized linear models, Liang and Zeger (1986) proposed the GEE approach to account for correlated responses in longitudinal data.[6] The estimating equations are derived from a working generalized

[6] According to Zeger et al. (1988) pg.1051 "an advantage of population-averaged models is that the population-averaged response for a given covariate, $x_{i,j,}$ is directly estimable from

linear model for the marginal distribution of $y_{i,j}$ without specifying a form for the joint distribution of individual repeated observations. Liang and Zeger showed that the GEE approach gives consistent estimates of the regression parameters and of their variances under weak assumptions about the joint distribution.[7]

Following Liang and Zeger (1986), the marginal density for of $y_{i,j}$ is represented as

$$f(y_{i,j}) = \exp\left[\{y_{i,j}\theta_{i,j} - a(\theta_{i,j}) + b(y_{i,j})\}\phi\right] \quad (1)$$

where

i denotes individuals, for $i = 1, \ldots, N$

j denotes time, for $j = 1, \ldots, t$

$\mathbf{y}_i$ are the outcome values

ϕ is the dispersion parameter

$\theta_{i,j}$ equals $h(\eta_{i,j})$

$\eta_{i,j}$ equals $x_{i,j}\beta$

$x_{i,j}$ are the explanatory variables

Under this specification, the first two moments of $y_{i,j}$ are given by

$$E(y_{i,j}) = a'(\theta_{i,j}) \quad (2)$$

$$Var(y_{i,j}) = a''(\theta_{i,j})/\phi \quad (3)$$

The GEE model for a binary outcome using logit as the link function can be expressed in the following form;

$$\text{logit } P\left(\frac{E(y_{i,j})}{1-E(y_{i,j})}\right) = \mathbf{x}_{i,j}\beta \quad (4)$$

---

observations without assumptions about the heterogeneity across individuals in the parameters. Population-averaged parameters are in the sense one step closer to the data than individual parameters".

[7] See Liang & Zeger (1986) for detailed discussion on the regularity conditions.

$$E(y_{i,j}) = \mu_{i,j} \quad (5)$$

$$Var(y_{i,j}) = \mu_{i,j}(1 - \mu_{i,j}) \quad (6)$$

where $y_{i,j}$ denotes a binary measure for the two dependent variables of interest in the study;

(a) Smoking prevalence (i.e. smoking, 0 = no and 1 = yes)

(b) Quit attempt (i.e. tried to quit smoking, 0 = no and 1 = yes)

The solution to the GEE score equation can be written as

$$\mathbf{U}(\beta) = \sum_i^m \frac{\delta\mu_i}{\delta\beta} V_i^{-1}(\alpha)(y_i - \mu_i) = 0 \quad (7)$$

$$V_i(\alpha) = A_i^{1/2} R(\alpha) A_i^{1/2} \quad (8)$$

where A_i is a diagonal matrix of variance functions $v(\mu_{i,j})$, the dependency between repeated observations can be accounted for by using different within-panel correlation structure, $R(\alpha)$. This correlation structure may depend on a vector of unknown parameters, is assumed to be the same for all individuals. The GEE treats the covariance structure as a nuisance and an average dependence is assumed by specifying a "working" correlation matrix. In this study, we briefly describe the three most often used working correlation structures: exchangeable (also known as equal correlation or compound symmetry); autoregressive (AR1) and unstructured (unrestricted) correlation.[8] The GEE estimates are robust to misspecification of the within-panel correlation structure.[9]

1.3.3.1. Exchangeable Correlation

An exchangeable correlation assumes equal correlations across repeated measures. The working correlation matrix takes the following form;

[8] Other forms of working correlation structure are independent, stationary and non-stationary.
[9] See Liang & Zeger (1986); Hardin & Hilbe (2003) for detailed discussion.

$$R(\alpha) = \begin{bmatrix} 1 & \alpha & \alpha & \cdots & \alpha \\ \alpha & 1 & \alpha & \cdots & \alpha \\ \alpha & \alpha & 1 & \cdots & \alpha \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \alpha & \alpha & \alpha & \cdots & 1 \end{bmatrix} \tag{9}$$

which can be written as:

$$R_{s,t} = \begin{cases} 1 & \text{if } s = t \\ \alpha & \text{otherwise} \end{cases} \tag{10}$$

The ancillary correlation parameter, α, is estimated using model fit Pearson residuals, $\hat{r}_{i,j}$.

$$\hat{r}_{i,j} = \frac{(y_{ij} - \hat{\mu}_{i,j})}{\sqrt{V(\hat{\mu}_{i,j})}} \tag{11}$$

$$\hat{\alpha} = \frac{\left\{ \sum_{i=1}^{m} \left(\frac{\sum_{j=1}^{n_i} \sum_{k=1}^{ni} \hat{r}_{i,j} \hat{r}_{i,k} - \sum_{j=1}^{ni} \hat{r}_{i,j}^2}{n_i (n_i - 1)} \right) \right\}}{G} \tag{12}$$

$$G = \frac{\sum_{i=1}^{m} \sum_{j=1}^{ni} \hat{r}_{ij}^2}{\sum_{i=1}^{m} n_i} \tag{13}$$

1.3.3.2. Autoregressive Correlation

Autoregressive working correlation assumes that repeated observations depend on their past values in systematic order. A first-order autoregressive process is commonly used. The correlation structure requires k parameters to be estimated such that α has a vector of length $k + 1$.[10]

$$\hat{\alpha} = \frac{\left[\sum_{i=1}^{m} \left(\frac{\sum_{j=1}^{n_i} \hat{r}_{i,j}^2}{n_i}, \frac{\sum_{j=1}^{n_i - 1} \hat{r}_{i,j} \hat{r}_{i,j+1}}{n_i}, \ldots, \frac{\sum_{j=1}^{n_i - k} \hat{r}_{i,j} \hat{r}_{i,j+k}}{n_i} \right) \right]}{W} \tag{14}$$

$$W = \sum_{i=1}^{m} \frac{\sum_{j=1}^{n_i} \hat{r}_{i,j}^2}{n_i} \tag{15}$$

where the Pearson residuals is defined in equation (11).

[10] Where the first element of α is 1.

The working correlation structure is given by

$$R_{s,t} = \begin{cases} \alpha_1 |s-t| & \text{if } |s-t| \leq k \\ 0 & \text{otherwise} \end{cases} \quad (16)$$

1.3.3.3. Unstructured Correlation

Unstructured correlation uses the unconstrained correlation matrix. The working correlation model can be written as

$$R_{s,t} = \begin{cases} 1 & \text{if } s = t \\ \alpha_{s,t} & \text{otherwise} \end{cases} \quad (17)$$

$$\alpha = \frac{\begin{bmatrix} N_{1,1}^{-1}\hat{r}_{i,1}^2 & N_{1,2}^{-1}\hat{r}_{i,1}\hat{r}_{i,2} & \cdots & N_{1,n}^{-1}\hat{r}_{i,1}\hat{r}_{i,n} \\ N_{2,1}^{-1}\hat{r}_{i,2}\hat{r}_{i,1} & N_{2,2}^{-1}\hat{r}_{i,2}^2 & \cdots & N_{2,n}^{-1}\hat{r}_{i,2}\hat{r}_{i,n} \\ \vdots & \vdots & \ddots & \vdots \\ N_{n,1}^{-1}\hat{r}_{i,n_i}\hat{r}_{i,1} & N_{n,2}^{-1}\hat{r}_{i,n_i}\hat{r}_{i,2} & \cdots & N_{n,n}^{-1}\hat{r}_{i,n}^2 \end{bmatrix}}{W} \quad (18)$$

where

$$N_{p,q} = \sum_{i=1}^{m} I(i,p,q) \quad (19)$$

$$I(i,p,q) = \begin{cases} 1 & \text{if panel i has observations at indexes p and u} \\ 0 & \text{otherwise} \end{cases} \quad (20)$$

Pearson residuals and W are represented by equations (11) and (15) respectively.

$N_{i,j} = \min(N_i, N_j)$, $N_i =$ number of panels observed at time i, and $n = \max(n_1, n_2, \ldots . n_m)$

Separate analyses are performed using the three measures of graphic warnings. To determine if graphic health warnings, as a dichotomous variable, and cigarette prices in levels can be identified separately in the regression, we used a rule of thumb by estimating a variance inflation factor (VIF). A VIF of 7.64 is obtained when a graphic dummy is regressed on cigarette prices. The VIF thus confirms that there is sufficient independent price variation in the sample to identify the price effect in the analysis.

To check whether the analyses are sensitive to the inclusion of additional control variables, three model specifications are used. Model 1, the baseline specification, controlled for gender, age, educational attainment, income level, marital status, household size, employment status and immigration status. In addition to the baseline covariates in Model 1, Model 2 included workplace smoking bans and provincial fixed effects. In Model 3, we re-estimated Model 2 but restricted the sample to daily smokers.

Insert Table 1.2 here

Insert Figure 1.1 here

1.4. Results

Table 1.2 presents the characteristics of the respondents included in the study. Among the study sample, about half are male, a large percentage is 35 years and older, over 80% are non immigrants. A significant proportion of the sample is well educated with most (over 70%) having completed more than secondary education. The trend of both smoking prevalence and smokers quit attempts from 1998 to 2008 are shown in Figure 1.1. For smoking prevalence, there has been a gradual decrease in the smoking participation rate. The percentage of smokers reporting past quit attempts increased between 1998 to 2002 with a significant drop in 2004 and 2008. Although there has been a decline in smoking prevalence in Canada, the largest decrease in smoking prevalence, and the largest increase in quit attempts for our study period occurred between 2000 to 2002 (see Figure 1.1). We cannot determine from the unconditional analysis if the graphic warnings had any significant impact on smoking behavior over this period as there was also a major increase in cigarette taxes and hence prices. Tables 1.3 to 1.22 report the odds ratios (OR) and the corresponding 95% confidence intervals (CI) from the GEE regression for the smoking prevalence and quit attempt respectively. The estimates

from GEE model are interpreted as population-average (marginal) effects rather than subject-specific effects.

1.4.1. Unstructured Working Correlation

1.4.1.1. Smoking prevalence Results

The tobacco graphic cigarette warnings, represented by the scaled variable, had a statistically significant effect on smoking prevalence (see Table 1.3). The policy variable decreased the odds of being a smoker (OR = 0.875, CI = 0.821-0.932) (Model 2). The graphic warnings also decreased the odds of being a daily smoker (OR = 0.868, CI = 0.809-0.931) (Model 3). The results were similar when the policy dummy is defined to be one starting from July, 2001 and zero otherwise (OR = 0.874, CI = 0.820-0.931) (Model 2) and (OR = 0.864, CI = 0.805-0.927) (Model 3) (see Table 1.4). The results from the warnings variable defined to be one starting from December, 2001, indicated that warnings decreased the odds of being a smoker (OR = 0.875, CI = 0.821-0.932) (Model 2) and the odds of being a daily smoker (OR = 0.869, CI = 0.810-0.931) (Model 3) (see Table 1.5).

Insert Table 1.3 here

Insert Table 1.4 here

Insert Table 1.5 here

In terms of the other control variables (Table 1.3), those older (age 25-34: OR = 0.990, CI = 0.876 - 1.117; age 35-44: OR = 0.904, CI = 0.786 - 1.041; age 45-64: OR = 0.766, CI = 0.657 - 0.892; age 65+: OR = 0.587, CI = 0.493 - 0.698) and with a higher education status (except secondary)(some post secondary: OR = 0.863, CI = 0.737 - 1.010; post secondary: OR = 0.840, CI = 0.719 - 0.983) were less likely to be smokers

compared to their respective reference categories. Males were more likely to be a smoker than females (OR = 1.156, CI = 1.025-1.304). The income variable showed the standard socioeconomic gradient in smoking, where those with higher income status were less likely to be smokers (low-middle income: OR = 0.936, CI = 0.865 - 1.014; high-middle income: OR = 0.888, CI = 0.812 - 0.971; high income: OR = 0.868, CI = 0.787 - 0.957). The odds of being a smoker were found to be lower for those who were married (OR = 0.842, CI = 0.759-0.934), immigrants (OR = 0.579, CI = 0.458-0.732), and had higher household size (OR = 0.984, CI = 0.962-1.001). Those separated or widowed (OR = 1.066, CI = 0.934-1.217) were more likely to be smokers than singles and also, those employed (OR = 1.173, CI = 1.084-1.269) had higher odds of being a smoker than those unemployed. A lower odds of smoking was associated with cigarette price (OR = 0.790, CI = 0.663-0.942) and workplace smoking bans: full ban (OR = 0.916, CI = 0.857-0.979).

1.4.1.2. Quit Attempts Results

The reported results in Table 1.6 indicated that graphic warnings, using a scale variable representation, had a positive and statistically significant effect on quit attempts among smokers. Graphic warnings increased the odds of making a quit attempt (OR = 1.330, CI = 1.187-1.490) (Model 2). Among daily smokers, graphic warnings also increased the odds of making a quit attempt (OR = 1.331, CI = 1.175-1.508) (Model 3). A similar result was obtained when the policy dummy is defined to be one starting from July, 2001 and zero otherwise (OR = 1.329, CI = 1.188-1.490) (Model 2) (see Table 1.7). Using the warnings variable defined to be one starting from December, 2001, indicated that warnings increased the odds of making a quit attempt among daily smokers (OR = 1.332, CI = 1.176-1.508) (Model 3) (see Table 1.8).

Results for the other covariates revealed no statistically significant difference in the odds of attempting to quit by gender (male: OR = 0.961, CI = 0.808 - 1.143), income status; (low-middle income: OR = 1.047, CI = 0.843 - 1.300; high-middle income: OR = 0.985, CI = 0.787 - 1.234; high income: OR = 0.824, CI = 0.635 - 1.068), marital status (married: OR = 0.883, CI = 0.710 - 1.096; separated: OR = 0.922, CI = 0.720 - 1.181), household size (OR = 1.031, CI = 0.969 - 1.098), immigration status (immigrant: OR = 1.030, CI = 0.748 - 1.418), workplace smoking bans (full ban: OR = 0.943, CI = 0.762 - 1.167; partial ban: OR = 0.898, CI = 0.725 - 1.113). Older adults and those employed were less likely to make a quit attempt (age 25-34: OR = 0.572, CI = 0.431 - 0.760; age 35-44: OR = 0.541, CI = 0.400 - 0.730; age 45-64: OR = 0.491, CI = 0.357 - 0.676; age 65+: OR = 0.398, CI = 0.257 - 0.617; employed: OR = 0.824, CI = 0.660 - 1.029). Immigrants (OR = 1.030, CI = 0.748 - 1.418) and the well educated (secondary: OR = 1.120, CI = 0.846 - 1.483; some post secondary: OR = 1.164, CI = 0.912 - 1.485; post secondary: OR = 1.194, CI = 0.935 - 1.524) were more likely to have attempted quitting smoking. The measure for nicotine dependence, showed a statistically significant effect on quit attempt. Decreased odds of making a quit attempt were associated with consuming 20 or more cigarettes per day (OR = 0.561, CI = 0.478-0.658) (Model 2) and between 11 to 19 cigarettes per day (OR = 0.690, CI = 0.597-0.798) compared to those with less than 11 cigarette per day. Among daily smokers (reported in Table 1.6, Model 3), increased odds of making a quit attempt were associated with having the first cigarette after waking between 31 to 60 minutes (OR = 1.166, CI = 0.991-1.371) and more than 60 minutes (OR = 1.050, CI = 0.876-1.259).

Insert Table 1.6 here

Insert Table 1.7 here

Insert Table 1.8 here

1.4.2. Exchangeable Working Correlation

1.4.2.1. Smoking Prevalence Results

When we changed the structure of the correlation matrix to be exchangeable, results were qualitatively similar to the unstructured specification in the previous subsection. In particular, the tobacco graphic cigarette warnings, represented by the scaled variable, had a statistically significant effect on smoking prevalence (see Table 1.9). The policy variable decreased the odds of being a smoker (OR = 0.867, CI = 0.812 - 0.926) (Model 2). The graphic warnings also decreased the odds of being a daily smoker (OR = 0.852, CI = 0.792 - 0.916) (Model 3). The results were similar when the policy dummy is defined to be one starting from July, 2001 and zero otherwise (OR = 0.866, CI = 0.812 - 0.925) (Model 2) and (OR = 0.850, CI = 0.791 - 0.914) (Model 3) (see Table 1.10). The results from the warnings variable defined to be one starting from December, 2001, indicated that warnings decreased the odds of being a smoker (OR = 0.867, CI = 0.813 - 0.926) (Model 2) and the odds of being a daily smoker (OR = 0.852, CI = 0.793 - 0.916) (Model 3) (see Table 1.11).

Insert Table 1.9 here

Insert Table 1.10 here

Insert Table 1.11 here

In terms of the other control variables (Table 1.9), those older (age 35-44: OR = 0.952, CI = 0.817 - 1.109; age 45-64: OR = 0.811, CI = 0.688 - 0.957; age 65+: OR = 0.653, CI = 0.541 - 0.788) and with a higher education classes (some post secondary: OR

= 0.875, CI = 0.740 - 1.034; post secondary: OR = 0.856, CI = 0.724 - 1.012) were less likely to be smokers compared to their respective reference categories. Males were more likely to be a smoker than females (OR = 1.146, CI = 1.015 - 1.294). The income variable also confirmed the standard socioeconomic gradient in smoking, where those with higher income status were less likely to be smokers (low-middle income: OR = 0.936, CI = 0.859 - 1.020; high-middle income: OR = 0.884, CI = 0.801 - 0.974; high income: OR = 0.864, CI = 0.778 - 0.960). The odds of being a smoker were found to be lower for those who were married (OR = 0.827, CI = 0.738 - 0.926), immigrants (OR = 0.566, CI = 0.446 - 0.717), and had higher household size (OR = 0.979, CI = 0.955 - 1.005). Those separated or widowed (OR = 1.031, CI = 0.896 - 1.188) were more likely to be smokers than singles and those employed (OR = 1.189, CI = 1.091 - 1.296) had higher odds of being a smoker than those unemployed. A lower odds of smoking was associated with cigarette price (OR = 0.784, CI = 0.656 - 0.938) and workplace smoking bans: full ban (OR = 0.913, CI = 0.848 - 0.983).

1.4.2.2. Quit Attempts Results

The reported results in Table 1.12 showed that graphic warnings, using a scale variable representation, had a positive and statistically significant effect on quit attempts among smokers. Graphic warnings increased the odds of making a quit attempt (OR = 1.313, CI = 1.172 - 1.472) (Model 2). Among daily smokers, graphic warnings also increased the odds of making a quit attempt (OR = 1.314, CI = 1.161 - 1.488) (Model 3). A similar result was obtained when the policy dummy is defined to be one starting from July, 2001 and zero otherwise (OR = 1.313, CI = 1.172 - 1.472) (Model 2) (see Table 1.13). Using the warnings variable defined to be one starting from December, 2001,

indicated that warnings increased the odds of making a quit attempt among daily smokers (OR = 1.315, CI = 1.161 - 1.489) (Model 3) (see Table 1.14).

Results for the other covariates revealed no statistically significant relationship between gender, income status, marital status, household size, immigration, workplace smoking ban and the odds of attempting to quit. Older adults and those employed were less likely to make a quit attempt. Immigrants and the well educated were more likely to have attempted quitting smoking. The measure for nicotine dependence, showed a statistically significant effect on quit attempt. Decreased odds of making a quit attempt were associated with consuming 20 or more cigarettes per day (OR = 0.614, CI = 0.509 - 0.741) (Model 3) and between 11 to 19 cigarettes per day (OR = 0.726, CI = 0.618 - 0.854) compared to those with less than 11 cigarette per day. Among daily smokers (reported in Table 1.12, Model 3), increased odds of making a quit attempt were associated with having the first cigarette after waking between 31 to 60 minutes (OR = 1.163, CI = 0.986 - 1.372) and more than 60 minutes (OR = 1.038, CI = 0.865 - 1.246).

Insert Table 1.12 here

Insert Table 1.13 here

Insert Table 1.14 here

1.4.3. Autoregressive Correlation (AR1)

1.4.3.1. Smoking Prevalence Results

Results based on the AR (1) working correlation structure revealed similar pattern to the previous two specifications, and hence confirm the robustness of the results to changing the structure of the working correlation matrix. The tobacco graphic cigarette

warnings, represented by the scaled variable, had a statistically significant effect on smoking prevalence (see Table 1.15). In particular, warnings decreased the odds of being a smoker (OR = 0.885, CI = 0.827 - 0.948) (Model 2). The graphic warnings also decreased the odds of being a daily smoker (OR = 0.860, CI = 0.797 - 0.927) (Model 3). The results were similar when the policy dummy is defined to be one starting from July, 2001 and zero otherwise (OR = 0.884, CI = 0.827 - 0.946) (Model 2) and (OR = 0.857, CI = 0.794 - 0.924) (Model 3) (see Table 1.16). The results from the warnings variable defined to be one starting from December, 2001, indicated that warnings decreased the odds of being a smoker (OR = 0.886, CI = 0.827 - 0.948) (Model 2) and the odds of being a daily smoker (OR = 0.860, CI = 0.798 - 0.928) (Model 3) (see Table 1.17).

Insert Table 1.15 here

Insert Table 1.16 here

Insert Table 1.17 here

In terms of the other control variables (Table 1.15), the results were qualitatively similar to the previous two specifications. For example, those older (age 25-34: OR = 0.964, CI = 0.847 - 1.098; age 35-44: OR = 0.858, CI = 0.737 - 0.998; age 45-64: OR = 0.703, CI = 0.598 - 0.828; Age 65+: OR = 0.477, CI = 0.394 - 0.576) and with a higher education classes (secondary: OR = 0.959, CI = 0.793 - 1.159; some post secondary: OR = 0.820, CI = 0.698 - 0.963; post secondary: OR = 0.778, CI = 0.663 - 0.912) were less likely to be smokers compared to their respective reference categories. Males were more likely to be a smoker than females (OR = 1.168, CI = 1.035 - 1.319). The income variable revealed the standard socioeconomic gradient in smoking, where those with higher income status were less likely to be smokers (low-middle income: OR = 0.934, CI =

0.857 - 1.018; high-middle income: OR = 0.877, CI = 0.798 - 0.964; high income: OR = 0.850, CI = 0.766 - 0.942). The odds of being a smoker were found to be lower for those who were married (OR = 0.847, CI = 0.760 - 0.944), immigrants (OR = 0.600, CI = 0.473 - 0.761), and had higher household size (OR = 0.988, CI = 0.964 - 1.013). Those separated or widowed (OR = 1.118, CI = 0.973 - 1.286) were more likely to be smokers than singles and also, those employed (OR = 1.177, CI = 1.082 - 1.280) had higher odds of being a smoker than those unemployed. A lower odds of smoking was associated with cigarette price (OR = 0.820, CI = 0.677 - 0.994) and workplace smoking bans: full ban (OR = 0.909, CI = 0.848 - 0.975).

4.3.2. Quit Attempts Results

The reported results in Table 1.18 indicated that graphic warnings, using a scale variable representation, had a positive and statistically significant effect on quit attempts among smokers. Graphic warnings increased the odds of making a quit attempt (OR = 1.333, CI = 1.163 - 1.528) (Model 2). Among daily smokers, graphic warnings also increased the odds of making a quit attempt (OR = 1.398, CI = 1.200 - 1.629) (Model 3). A similar result was obtained when the policy dummy is defined to be one starting from July, 2001 and zero otherwise (OR = 1.332, CI = 1.162 - 1.527) (Model 2) (see Table 1.19). Using the warnings variable defined to be one starting from December, 2001, indicated that warnings increased the odds of making a quit attempt among daily smokers (OR = 1.398, CI = 1.201-1.629) (Model 3) (see Table 1.20).

Results for the other covariates revealed no statistically significant relationship between gender, income status, marital status, household size, immigration, workplace smoking ban and the odds of attempting to quit. Older adults and those employed were

less likely to make a quit attempt. Immigrants and the well educated were more likely to have attempted quitting smoking. The measure for nicotine dependence, showed a statistically significant effect on quit attempt. Decreased odds of making a quit attempt were associated with consuming 20 or more cigarettes per day (OR = 0.512, CI = 0.423 - 0.621) (Model 2) and between 11 to 19 cigarettes per day (OR = 0.679, CI = 0.571 - 0.806) compared to those with less than 11 cigarette per day. Among daily smokers (reported in Table 1.18, Model 3), increased odds of making a quit attempt were associated with having the first cigarette after waking between 31 to 60 minutes (OR = 1.179, CI = 0.969 - 1.433) and more than 60 minutes (OR = 1.144, CI = 0.901 - 1.453).

Insert Table 1.18 here

Insert Table 1.19 here

Insert Table 1.20 here

1.5. Discussion

In January 2001, Canada became the first county in the world to introduce pictorial warning messages on cigarette packs. As of June 2011, more than 40 countries have implemented similar warning messages (Tobacco Free Center, 2011). Since then, a growing body of research has been conducted to assess the effectiveness of this policy in discouraging smoking. Previous studies mostly agree that graphic cigarette warnings appear effective, however, there is limited evidence based on actual smoking behavior.

This study adds to the existing literature by using longitudinal data from the Canadian National Population Health Survey (1998-2008) which covers pre- and post-policy periods to assess the effect of graphic warning labels on actual smoking behavior. The multivariate analysis showed that graphic warnings had a statistically significantly

association with lower smoking prevalence and increased quit attempts (for a summary of the results, see Tables 1.21 and 1.22).

The positive effect of the graphic warning on quit attempts is in line with the finding of several previous studies (e.g., Hammond et al, 2003; Borland et al., 2009). For example, in a Canadian study, Hammond et al (2003) found that smokers who noticed, thought about and discussed the new graphic labels at baseline were more likely to quit or to make a quit attempt. Borland et al (2009) found that forgoing cigarettes and cognitive reactions as a result of warnings, consistently predict quit attempts. Though not directly comparable, our results are consistent with projection based studies that have assessed the potential effect of warning labels on smoking prevalence within the context of a tobacco control simulation framework, "SimSmoke" (e.g., Levy et al., 2008; Nagelhout et al., 2011). The findings of an early study by Gospodinov and Irvine (2004), runs contrary to our results. The authors used cross-sectional data collected six months before the graphic warnings policy was introduced and five months after to evaluate the immediate effect of the policy on smoking behavior. They found that pictorial warnings had no significant impact on smoking prevalence. However, in this current study, we used a longer time period and longitudinal data. Also, the warnings variable was captured in ways that allow the messages to diffuse throughout the retail shops.

Some potential limitations of this study warrants discussion. First, the outcome measures, smoking participation and quit attempts were self reported. However, this is standard in the literature. Second, due to data limitations, there may be other relevant confounding factors that we did not control for. For example, there is no information in the survey about participation in the black market or about the type of cigarettes (discount

or premium) smokers consumed. Also, there is no information about compensatory behaviors. As a result, our estimates of the effect of graphic warnings on smoking prevalence and quit attempts may be biased. The smuggling of cigarettes and the existence of a considerable black market (estimated to satisfy about 30% of demand in Canada), may partially offset the effects of the graphic warnings on smoking behavior (Gabler and Katz, 2010). For example, cigarette packs smuggled from the US into Canada do not currently contain graphic warnings. Nonetheless, the inclusion of provincial dummies may help capture some of the smuggling effect in Canadian border provinces. The scope of the contraband cigarette market in Canada has been steadily expanding. According to estimates by Physicians for a Smoke-Free Canada (2010), contraband cigarettes sales as a percentage of the total cigarette sales has increased from 7% in 2002 to 10% (2003), 20% (2006), 27% (2007) and 31% (2008).

Graphic warnings may also be prone to wear out (Hammond et al., 2007). In response to the wear out effect, in September, 2011 Canada introduced new tobacco graphic warning regulations which increased the size of the graphic warnings to 75% along with other modifications. The new regulations allow for a transition period of up to six months for industry to introduce the new labels on packages, and an additional three months for retailers to clear up their inventory with the old warning labels (Health Canada, 2011). Despite these limitations, we believe that this study is timely and relevant for policy makers to understand the Canadian experience, especially for countries that are in the process of implementing graphic cigarette warnings. For example, from September 2012 the United States of America will implement graphic warning labels on cigarette packs.

In summary, existing evidence on the effectiveness of graphic warnings were mainly based on emotional responses and projections from simulation models. The current study is among the first to provide longitudinal evidence at the population level that graphic tobacco warnings had a statistically significant impact on smoking prevalence. Given the differences in the anti-smoking policy environment across countries, further empirical evidence from other countries will be needed before reaching a generalized conclusion.

Appendix

Table 1.1
Countries and jurisdictions that require pictures or images on cigarette packs

1- Canada	23- Mauritius
2- Brazil	24- India
3- Singapore	25- Latvia
4- Thailand	26- Pakistan
5- Venezuela	27- Switzerland
6- Jordan	28- Mongolia
7- Australia	29- Colombia
8- Uruguay	30- Turkey
9- Panama	31- Mexico
10- Belgium	32- Philippines
11- Chile	33- Norway
12- Hong Kong	34- Malta
13- New Zealand	35- France
14- Romania	36- Guernsey
15- United Kingdom	37- Spain
16- Egypt	38- Honduras
17- Brunei	39- Ukraine
18- Iran	40- Nepal
19- Malaysia	41- Argentina
20- Taiwan	42- Bolivia
21- Peru	43- Israel
22- Djibouti	44- United States

Source**:** http://www.tobaccofreekids.org/research/factsheets/pdf/0325.pdf and http://www.smoke-free.ca/warnings

Table 1.2
Selected characteristics of the respondents included in the study analyses

	Percentage(standard deviation)			
	Smoking prevalence		Quit attempts	
Male	50.5	(0.500)	50.9	(0.500)
Female	49.5	(0.500)	49.1	(0.500)
Age 15-24	7.1	(0.257)	10.2	(0.302)
Age 25-34	17.7	(0.381)	23.1	(0.422)
Age 35-44	24.8	(0.432)	28	(0.449)
Age 45-64	38.7	(0.487)	33.4	(0.472)
Age above 64	11.7	(0.321)	5.3	(0.224)
Less secondary	12.6	(0.332)	13.6	(0.342)
Secondary	14.3	(0.350)	17.8	(0.383)
Some post secondary	27.4	(0.446)	29.3	(0.455)
Post secondary	45.7	(0.498)	39.2	(0.488)
Low income	6.1	(0.240)	10.4	(0.305)
Low middle income	15.7	(0.364)	16.8	(0.374)
High middle income	35.9	(0.480)	37.6	(0.484)
High income	42.3	(0.494)	35.3	(0.478)
Married	67.4	(0.469)	56.7	(0.495)
Separated	13.8	(0.345)	18.2	(0.386)
Single	18.9	(0.391)	25.1	(0.433)
Employed	74.3	(0.437)	79.4	(0.404)
Unemployed	25.7	(0.437)	20.6	(0.404)
Immigrant	16.6	(0.372)	11.1	(0.314)
Non immigrant	83.4	(0.372)	88.9	(0.314)
Full ban	47.0	(0.500)	36.2	(0.481)
Partial ban	20.0	(0.400)	27.1	(0.445)
No ban	32.6	(0.468)	36.6	(0.482)
Newfoundland	1.8	(0.134)	1.8	(0.134)
Prince Edward	0.6	(0.074)	0.9	(0.095)
Nova Scotia	3.4	(0.182)	3.7	(0.189)
New Brunswick	2.6	(0.158)	2.5	(0.155)
Quebec	24.8	(0.432)	25.6	(0.437)
Ontario	40.2	(0.490)	39	(0.488)
Manitoba	3.3	(0.178)	3.5	(0.184)
Saskatchewan	2.8	(0.164)	3.5	(0.184)
Alberta	9.8	(0.298)	11	(0.312)
British Columbia	10.8	(0.310)	8.5	(0.279)
Observations	29118		6269	

The statistics are weighted using the NPHS sampling weights.

Table 1.3
Odd ratios (95% confidence intervals) for the smoking prevalence regression using warning scale (unstructured working correlation)

	Model 1	Model 2	Model 3
Graphic warnings	0.874***	0.875***	0.868***
	(0.821 - 0.930)	(0.821 - 0.932)	(0.809 - 0.931)
Male	1.167**	1.156**	1.153**
	(1.035 - 1.315)	(1.025 - 1.304)	(1.014 - 1.311)
Age 25-34	0.989	0.990	1.102
	(0.876 - 1.116)	(0.876 - 1.117)	(0.958 - 1.268)
Age 35-44	0.901	0.904	1.011
	(0.783 - 1.038)	(0.786 - 1.041)	(0.860 - 1.188)
Age 45-64	0.763***	0.766***	0.896
	(0.655 - 0.888)	(0.657 - 0.892)	(0.753 - 1.066)
Age 65+	0.588***	0.587***	0.629***
	(0.494 - 0.698)	(0.493 - 0.698)	(0.516 - 0.767)
Secondary	1.003	1.009	0.949
	(0.827 - 1.217)	(0.832 - 1.222)	(0.781 - 1.155)
Some post secondary	0.861*	0.863*	0.837**
	(0.736 - 1.009)	(0.737 - 1.010)	(0.717 - 0.976)
Post secondary	0.837**	0.840**	0.730***
	(0.715 - 0.979)	(0.719 - 0.983)	(0.622 - 0.856)
Low middle income	0.938	0.936	0.926*
	(0.866 - 1.015)	(0.865 - 1.014)	(0.846 - 1.014)
High middle income	0.888***	0.888***	0.865***
	(0.812 - 0.971)	(0.812 - 0.971)	(0.783 - 0.955)
High income	0.868***	0.868***	0.834***
	(0.787 - 0.957)	(0.787 - 0.957)	(0.751 - 0.926)
Married	0.842***	0.842***	0.842***
	(0.759 - 0.933)	(0.759 - 0.934)	(0.749 - 0.947)
Separated	1.061	1.066	1.030
	(0.929 - 1.211)	(0.934 - 1.217)	(0.890 - 1.192)
Household size	0.984	0.984	0.981
	(0.962 - 1.007)	(0.962 - 1.008)	(0.955 - 1.007)
Employed	1.121***	1.173***	1.116**
	(1.055 - 1.191)	(1.084 - 1.269)	(1.023 - 1.218)
Immigrant	0.567***	0.579***	0.546***
	(0.451 - 0.714)	(0.458 - 0.732)	(0.421 - 0.707)
Cigarette price	0.787***	0.790***	0.714***
	(0.662 - 0.936)	(0.663 - 0.942)	(0.587 - 0.868)
Full ban		0.916***	0.933*
		(0.857 - 0.979)	(0.868 - 1.002)
Partial ban		0.988	1.030

		(0.918 - 1.062)	(0.952 - 1.114)
Newfoundland		0.963	0.892
		(0.720 - 1.288)	(0.656 - 1.211)
Prince Edward		1.201	1.237
		(0.891 - 1.619)	(0.903 - 1.694)
Nova Scotia		1.127	1.171
		(0.852 - 1.491)	(0.887 - 1.546)
New Brunswick		1.044	1.199
		(0.788 - 1.382)	(0.910 - 1.580)
Quebec		1.083	1.133
		(0.857 - 1.368)	(0.894 - 1.435)
Ontario		1.050	1.055
		(0.842 - 1.309)	(0.861 - 1.292)
Manitoba		0.985	1.048
		(0.755 - 1.285)	(0.803 - 1.367)
Saskatchewan		1.209	1.265*
		(0.939 - 1.556)	(0.986 - 1.623)
Alberta		1.249*	1.308**
		(0.974 - 1.601)	(1.053 - 1.625)
Observations	29118	29118	29118

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

Table 1.4
Odd ratios (95% confidence intervals) for the smoking prevalence regression (Warnings are defined to be in effect from July, using unstructured working correlation)

	Model 1	Model 2	Model 3
Graphic warnings	0.873***	0.874***	0.864***
	(0.820 - 0.929)	(0.820 - 0.931)	(0.805 - 0.927)
Male	1.167**	1.156**	1.153**
	(1.035 - 1.315)	(1.025 - 1.304)	(1.014 - 1.311)
Age 25-34	0.989	0.990	1.103
	(0.876 - 1.117)	(0.877 - 1.118)	(0.958 - 1.269)
Age 35-44	0.902	0.905	1.011
	(0.783 - 1.038)	(0.786 - 1.042)	(0.860 - 1.188)
Age 45-64	0.763***	0.766***	0.896
	(0.656 - 0.888)	(0.658 - 0.892)	(0.753 - 1.066)
Age 65+	0.588***	0.587***	0.629***
	(0.494 - 0.698)	(0.493 - 0.698)	(0.516 - 0.766)
Secondary	1.003	1.008	0.949
	(0.827 - 1.217)	(0.832 - 1.222)	(0.781 - 1.155)
Some post secondary	0.861*	0.863*	0.837**
	(0.736 - 1.008)	(0.737 - 1.009)	(0.717 - 0.976)
Post secondary	0.837**	0.840**	0.730***
	(0.715 - 0.979)	(0.719 - 0.983)	(0.622 - 0.856)
Low middle income	0.938	0.937	0.926*
	(0.866 - 1.016)	(0.865 - 1.014)	(0.846 - 1.014)
High middle income	0.888***	0.888***	0.865***
	(0.812 - 0.971)	(0.812 - 0.971)	(0.784 - 0.955)
High income	0.868***	0.868***	0.834***
	(0.788 - 0.958)	(0.787 - 0.957)	(0.751 - 0.925)
Married	0.842***	0.842***	0.843***
	(0.759 - 0.933)	(0.759 - 0.934)	(0.749 - 0.948)
Separated	1.061	1.067	1.031
	(0.929 - 1.211)	(0.934 - 1.218)	(0.890 - 1.193)
Household size	0.984	0.985	0.981
	(0.962 - 1.008)	(0.962 - 1.008)	(0.955 - 1.007)
Employed	1.121***	1.173***	1.116**
	(1.055 - 1.191)	(1.084 - 1.269)	(1.023 - 1.218)
Immigrant	0.567***	0.579***	0.546***
	(0.451 - 0.714)	(0.458 - 0.732)	(0.421 - 0.707)
Cigarette price	0.788***	0.792***	0.721***
	(0.663 - 0.937)	(0.665 - 0.943)	(0.592 - 0.878)
Full ban		0.916***	0.933*
		(0.857 - 0.979)	(0.868 - 1.002)

Partial ban		0.987	1.029
		(0.918 - 1.062)	(0.951 - 1.114)
Newfoundland		0.962	0.891
		(0.719 - 1.287)	(0.656 - 1.211)
Prince Edward		1.200	1.236
		(0.891 - 1.618)	(0.903 - 1.694)
Nova Scotia		1.126	1.170
		(0.851 - 1.490)	(0.886 - 1.545)
New Brunswick		1.043	1.200
		(0.788 - 1.382)	(0.910 - 1.581)
Quebec		1.082	1.134
		(0.857 - 1.367)	(0.895 - 1.436)
Ontario		1.050	1.056
		(0.842 - 1.309)	(0.862 - 1.294)
Manitoba		0.984	1.047
		(0.754 - 1.283)	(0.802 - 1.365)
Saskatchewan		1.208	1.263*
		(0.939 - 1.555)	(0.985 - 1.621)
Alberta		1.248*	1.308**
		(0.974 - 1.600)	(1.053 - 1.625)
Observations	29118	29118	29118

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

Table 1.5
Odd ratios (95% confidence intervals) for the smoking prevalence regression (warnings are defined to be in effect from December, using unstructured working correlation)

	Model 1	Model 2	Model 3
Graphic warnings	0.874***	0.875***	0.869***
	(0.821 - 0.930)	(0.822 - 0.933)	(0.810 - 0.931)
Male	1.167**	1.156**	1.153**
	(1.035 - 1.315)	(1.025 - 1.304)	(1.014 - 1.311)
Age 25-34	0.989	0.989	1.102
	(0.876 - 1.116)	(0.876 - 1.117)	(0.958 - 1.268)
Age 35-44	0.901	0.904	1.011
	(0.783 - 1.038)	(0.786 - 1.041)	(0.860 - 1.188)
Age 45-64	0.763***	0.766***	0.896
	(0.655 - 0.888)	(0.657 - 0.892)	(0.753 - 1.066)
Age 65+	0.588***	0.587***	0.629***
	(0.494 - 0.698)	(0.493 - 0.698)	(0.516 - 0.767)
Secondary	1.003	1.009	0.949
	(0.827 - 1.217)	(0.832 - 1.222)	(0.781 - 1.155)
Some post secondary	0.861*	0.863*	0.837**
	(0.736 - 1.009)	(0.738 - 1.010)	(0.717 - 0.976)
Post secondary	0.837**	0.840**	0.730***
	(0.715 - 0.979)	(0.719 - 0.983)	(0.622 - 0.856)
Low middle income	0.938	0.936	0.926*
	(0.866 - 1.015)	(0.865 - 1.014)	(0.846 - 1.014)
High middle income	0.888***	0.888***	0.865***
	(0.812 - 0.971)	(0.812 - 0.971)	(0.783 - 0.955)
High income	0.868***	0.868***	0.834***
	(0.787 - 0.957)	(0.787 - 0.957)	(0.751 - 0.926)
Married	0.842***	0.842***	0.842***
	(0.759 - 0.933)	(0.759 - 0.934)	(0.749 - 0.947)
Separated	1.061	1.066	1.030
	(0.929 - 1.211)	(0.934 - 1.217)	(0.890 - 1.192)
Household size	0.984	0.984	0.981
	(0.962 - 1.007)	(0.962 - 1.008)	(0.955 - 1.007)
Employed	1.121***	1.173***	1.116**
	(1.055 - 1.191)	(1.084 - 1.269)	(1.023 - 1.218)
Immigrant	0.567***	0.579***	0.546***
	(0.451 - 0.714)	(0.458 - 0.732)	(0.421 - 0.707)
Cigarette price	0.786***	0.789***	0.712***
	(0.661 - 0.936)	(0.662 - 0.941)	(0.586 - 0.866)
Full ban		0.916***	0.933*

		(0.857 - 0.979)	(0.868 - 1.002)
Partial ban		0.988	1.030
		(0.918 - 1.062)	(0.952 - 1.114)
Newfoundland		0.963	0.892
		(0.720 - 1.289)	(0.656 - 1.211)
Prince Edward		1.201	1.237
		(0.891 - 1.619)	(0.903 - 1.694)
Nova Scotia		1.127	1.171
		(0.852 - 1.492)	(0.887 - 1.546)
New Brunswick		1.044	1.199
		(0.788 - 1.382)	(0.910 - 1.580)
Quebec		1.083	1.132
		(0.857 - 1.368)	(0.894 - 1.434)
Ontario		1.050	1.055
		(0.842 - 1.309)	(0.861 - 1.292)
Manitoba		0.985	1.048
		(0.755 - 1.285)	(0.803 - 1.367)
Saskatchewan		1.209	1.265*
		(0.939 - 1.556)	(0.986 - 1.623)
Alberta		1.249*	1.308**
		(0.974 - 1.601)	(1.053 - 1.624)
Observations	29118	29118	29118

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

Table 1.6
Odd ratios (95% confidence intervals) for the quit attempts regression using warning scale (Unstructured Working Correlation)

	Model 1	Model 2	Model 3
Graphic warnings	1.326***	1.330***	1.331***
	(1.184 - 1.485)	(1.187 - 1.490)	(1.175 - 1.508)
Male	1.009	1.008	0.961
	(0.865 - 1.176)	(0.863 - 1.176)	(0.808 - 1.143)
Age 25-34	0.624***	0.626***	0.572***
	(0.482 - 0.809)	(0.482 - 0.813)	(0.431 - 0.760)
Age 35-44	0.554***	0.559***	0.541***
	(0.421 - 0.730)	(0.423 - 0.738)	(0.400 - 0.730)
Age 45-64	0.489***	0.491***	0.491***
	(0.366 - 0.654)	(0.366 - 0.660)	(0.357 - 0.676)
Age 65+	0.427***	0.418***	0.398***
	(0.287 - 0.634)	(0.282 - 0.621)	(0.257 - 0.617)
Secondary	1.136	1.138	1.120
	(0.877 - 1.472)	(0.876 - 1.478)	(0.846 - 1.483)
Some post secondary	1.161	1.157	1.164
	(0.925 - 1.459)	(0.920 - 1.455)	(0.912 - 1.485)
Post secondary	1.104	1.098	1.194
	(0.880 - 1.387)	(0.873 - 1.383)	(0.935 - 1.524)
Low middle income	1.042	1.048	1.047
	(0.848 - 1.279)	(0.853 - 1.288)	(0.843 - 1.300)
High middle income	1.003	1.021	0.985
	(0.812 - 1.239)	(0.825 - 1.263)	(0.787 - 1.234)
High income	0.876	0.890	0.824
	(0.692 - 1.108)	(0.701 - 1.132)	(0.635 - 1.068)
Married	0.987	0.963	0.883
	(0.810 - 1.203)	(0.789 - 1.174)	(0.710 - 1.096)
Separated	1.042	1.022	0.922
	(0.828 - 1.312)	(0.811 - 1.288)	(0.720 - 1.181)
Household size	1.010	1.012	1.031
	(0.955 - 1.068)	(0.957 - 1.070)	(0.969 - 1.098)
Employed	0.756***	0.801**	0.824*
	(0.653 - 0.876)	(0.653 - 0.984)	(0.660 - 1.029)
Immigrant	1.044	1.064	1.030
	(0.792 - 1.377)	(0.805 - 1.407)	(0.748 - 1.418)
cigarettes smoked per day 11-19	0.693***	0.690***	0.726***
	(0.600 - 0.801)	(0.597 - 0.798)	(0.617 - 0.855)
cigarettes smoked per day >20	0.561***	0.561***	0.615***

	(0.479 - 0.658)	(0.478 - 0.658)	(0.510 - 0.741)
Smoke within 31-60 mins after waking			1.166*
			(0.992 - 1.372)
Smoke after 60 mins from waking			1.050
			(0.876 - 1.259)
Full ban		0.931	0.943
		(0.767 - 1.129)	(0.762 - 1.167)
Partial ban		0.916	0.898
		(0.753 - 1.114)	(0.725 - 1.113)
Newfoundland		1.134	0.955
		(0.765 - 1.682)	(0.612 - 1.490)
Prince Edward		1.044	0.964
		(0.704 - 1.546)	(0.616 - 1.509)
Nova Scotia		1.187	1.067
		(0.817 - 1.722)	(0.705 - 1.613)
New Brunswick		0.894	0.916
		(0.590 - 1.355)	(0.584 - 1.437)
Quebec		1.003	1.024
		(0.730 - 1.377)	(0.716 - 1.464)
Ontario		1.024	1.015
		(0.755 - 1.390)	(0.714 - 1.444)
Manitoba		1.089	0.947
		(0.736 - 1.612)	(0.614 - 1.461)
Saskatchewan		1.602**	1.440
		(1.074 - 2.388)	(0.916 - 2.265)
Alberta		1.119	1.016
		(0.802 - 1.561)	(0.690 - 1.496)
Observations	6269	6269	5204

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

Table 1.7
Odd ratios (95% confidence intervals) for the quit attempts regression (Warnings are defined to be in effect from July, using unstructured working correlation)

	Model 1	Model 2	Model 3
Graphic warnings	1.326***	1.329***	1.325***
	(1.183 - 1.485)	(1.186 - 1.490)	(1.170 - 1.500)
Male	1.009	1.008	0.961
	(0.865 - 1.176)	(0.863 - 1.176)	(0.808 - 1.143)
Age 25-34	0.624***	0.626***	0.573***
	(0.482 - 0.808)	(0.482 - 0.812)	(0.431 - 0.761)
Age 35-44	0.554***	0.559***	0.541***
	(0.421 - 0.730)	(0.423 - 0.738)	(0.401 - 0.731)
Age 45-64	0.489***	0.491***	0.493***
	(0.366 - 0.654)	(0.366 - 0.659)	(0.358 - 0.677)
Age 65+	0.427***	0.419***	0.400***
	(0.287 - 0.634)	(0.282 - 0.621)	(0.258 - 0.619)
Secondary	1.136	1.138	1.120
	(0.877 - 1.472)	(0.875 - 1.478)	(0.846 - 1.483)
Some post secondary	1.161	1.156	1.164
	(0.925 - 1.458)	(0.919 - 1.455)	(0.912 - 1.485)
Post secondary	1.103	1.097	1.193
	(0.879 - 1.386)	(0.872 - 1.382)	(0.934 - 1.524)
Low middle income	1.042	1.048	1.048
	(0.848 - 1.280)	(0.853 - 1.288)	(0.844 - 1.301)
High middle income	1.004	1.021	0.987
	(0.813 - 1.240)	(0.826 - 1.263)	(0.788 - 1.236)
High income	0.877	0.892	0.826
	(0.693 - 1.109)	(0.702 - 1.133)	(0.637 - 1.070)
Married	0.987	0.962	0.882
	(0.810 - 1.202)	(0.789 - 1.174)	(0.710 - 1.096)
Separated	1.042	1.021	0.922
	(0.827 - 1.311)	(0.811 - 1.287)	(0.720 - 1.180)
Household size	1.010	1.012	1.031
	(0.955 - 1.068)	(0.957 - 1.070)	(0.969 - 1.098)
Employed	0.757***	0.801**	0.824*
	(0.653 - 0.876)	(0.652 - 0.984)	(0.660 - 1.029)
Immigrant	1.044	1.064	1.029
	(0.791 - 1.376)	(0.804 - 1.407)	(0.747 - 1.417)
cigarettes smoked per day 11-19	0.694***	0.690***	0.726***
	(0.600 - 0.801)	(0.597 - 0.798)	(0.617 - 0.854)
cigarettes smoked	0.561***	0.561***	0.614***

per day >20			
	(0.479 - 0.658)	(0.478 - 0.658)	(0.509 - 0.740)
Smoke within 31-60 mins after waking			1.166*
			(0.991 - 1.371)
Smoke after 60 mins from waking			1.050
			(0.876 - 1.259)
Full ban		0.932	0.944
		(0.768 - 1.131)	(0.763 - 1.169)
Partial ban		0.917	0.899
		(0.754 - 1.115)	(0.726 - 1.114)
Newfoundland		1.134	0.955
		(0.765 - 1.682)	(0.612 - 1.490)
Prince Edward		1.044	0.964
		(0.704 - 1.547)	(0.616 - 1.509)
Nova Scotia		1.186	1.066
		(0.817 - 1.721)	(0.705 - 1.612)
New Brunswick		0.895	0.917
		(0.591 - 1.356)	(0.585 - 1.438)
Quebec		1.003	1.024
		(0.730 - 1.377)	(0.716 - 1.464)
Ontario		1.024	1.015
		(0.754 - 1.390)	(0.713 - 1.443)
Manitoba		1.088	0.946
		(0.736 - 1.610)	(0.613 - 1.459)
Saskatchewan		1.602**	1.440
		(1.074 - 2.388)	(0.916 - 2.264)
Alberta		1.118	1.015
		(0.801 - 1.560)	(0.689 - 1.495)
Observations	6269	6269	5204

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

Table 1.8
Odd ratios (95% confidence intervals) for the quit attempts regression (Warnings are defined to be in effect from December, using unstructured working correlation)

	Model 1	Model 2	Model 3
Graphic warnings	1.325***	1.329***	1.332***
	(1.183 - 1.484)	(1.187 - 1.489)	(1.176 - 1.508)
Male	1.009	1.008	0.961
	(0.865 - 1.176)	(0.863 - 1.176)	(0.808 - 1.143)
Age 25-34	0.624***	0.626***	0.572***
	(0.482 - 0.809)	(0.482 - 0.813)	(0.431 - 0.760)
Age 35-44	0.554***	0.559***	0.540***
	(0.421 - 0.730)	(0.423 - 0.738)	(0.400 - 0.730)
Age 45-64	0.489***	0.491***	0.491***
	(0.366 - 0.654)	(0.366 - 0.660)	(0.357 - 0.676)
Age 65+	0.427***	0.418***	0.398***
	(0.287 - 0.634)	(0.282 - 0.621)	(0.257 - 0.617)
Secondary	1.136	1.138	1.120
	(0.877 - 1.472)	(0.876 - 1.478)	(0.846 - 1.483)
Some post secondary	1.162	1.157	1.164
	(0.925 - 1.459)	(0.920 - 1.455)	(0.912 - 1.485)
Post secondary	1.104	1.099	1.194
	(0.880 - 1.387)	(0.873 - 1.383)	(0.935 - 1.524)
Low middle income	1.042	1.048	1.047
	(0.848 - 1.279)	(0.853 - 1.287)	(0.843 - 1.300)
High middle income	1.003	1.021	0.985
	(0.812 - 1.239)	(0.825 - 1.263)	(0.787 - 1.234)
High income	0.876	0.890	0.823
	(0.692 - 1.108)	(0.701 - 1.132)	(0.635 - 1.067)
Married	0.987	0.963	0.883
	(0.810 - 1.203)	(0.789 - 1.174)	(0.710 - 1.096)
Separated	1.042	1.022	0.922
	(0.828 - 1.312)	(0.811 - 1.288)	(0.720 - 1.181)
Household size	1.010	1.012	1.031
	(0.955 - 1.068)	(0.957 - 1.070)	(0.969 - 1.098)
Employed	0.756***	0.801**	0.824*
	(0.653 - 0.876)	(0.653 - 0.984)	(0.660 - 1.029)
Immigrant	1.044	1.064	1.030
	(0.792 - 1.377)	(0.805 - 1.408)	(0.748 - 1.418)
cigarettes smoked per day 11-19	0.693***	0.690***	0.727***
	(0.600 - 0.801)	(0.597 - 0.798)	(0.617 - 0.855)
cigarettes smoked	0.561***	0.561***	0.615***

per day >20			
	(0.479 - 0.658)	(0.478 - 0.658)	(0.510 - 0.741)
Smoke within 31-60 mins after waking			1.167*
			(0.992 - 1.372)
Smoke after 60 mins from waking			1.050
			(0.876 - 1.259)
Full ban		0.931	0.943
		(0.767 - 1.129)	(0.762 - 1.167)
Partial ban		0.916	0.898
		(0.753 - 1.114)	(0.725 - 1.113)
Newfoundland		1.134	0.955
		(0.765 - 1.682)	(0.612 - 1.490)
Prince Edward		1.043	0.964
		(0.704 - 1.546)	(0.616 - 1.509)
Nova Scotia		1.187	1.067
		(0.818 - 1.722)	(0.705 - 1.613)
New Brunswick		0.894	0.916
		(0.590 - 1.355)	(0.584 - 1.437)
Quebec		1.003	1.024
		(0.730 - 1.377)	(0.716 - 1.464)
Ontario		1.024	1.015
		(0.755 - 1.391)	(0.714 - 1.445)
Manitoba		1.089	0.947
		(0.736 - 1.612)	(0.614 - 1.461)
Saskatchewan		1.602**	1.440
		(1.074 - 2.388)	(0.916 - 2.265)
Alberta		1.119	1.016
		(0.802 - 1.561)	(0.690 - 1.496)
Observations	6269	6269	5204

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

Table 1.9
Odd ratios (95% confidence intervals) for the smoking prevalence regression using warning scale (exchangeable working correlation)

	Model 1	Model 2	Model 3
Graphic warnings	0.869***	0.867***	0.852***
	(0.815 - 0.927)	(0.812 - 0.926)	(0.792 - 0.916)
Male	1.162**	1.146**	1.145**
	(1.029 - 1.311)	(1.015 - 1.294)	(1.006 - 1.304)
Age 25-34	1.040	1.038	1.162**
	(0.909 - 1.190)	(0.908 - 1.187)	(1.002 - 1.347)
Age 35-44	0.952	0.952	1.081
	(0.817 - 1.109)	(0.817 - 1.109)	(0.914 - 1.279)
Age 45-64	0.811**	0.811**	0.977
	(0.688 - 0.956)	(0.688 - 0.957)	(0.814 - 1.172)
Age 65+	0.657***	0.653***	0.729***
	(0.545 - 0.792)	(0.541 - 0.788)	(0.592 - 0.899)
Secondary	1.065	1.066	1.043
	(0.861 - 1.317)	(0.863 - 1.317)	(0.834 - 1.305)
Some post secondary	0.877	0.875	0.888
	(0.741 - 1.037)	(0.740 - 1.034)	(0.745 - 1.058)
Post secondary	0.856*	0.856*	0.783***
	(0.724 - 1.013)	(0.724 - 1.012)	(0.655 - 0.936)
Low middle income	0.939	0.936	0.922
	(0.861 - 1.023)	(0.859 - 1.020)	(0.835 - 1.018)
High middle income	0.885**	0.884**	0.854***
	(0.803 - 0.976)	(0.801 - 0.974)	(0.766 - 0.953)
High income	0.868***	0.864***	0.820***
	(0.781 - 0.963)	(0.778 - 0.960)	(0.732 - 0.918)
Married	0.827***	0.827***	0.826***
	(0.737 - 0.927)	(0.738 - 0.926)	(0.732 - 0.932)
Separated	1.028	1.031	0.993
	(0.892 - 1.185)	(0.896 - 1.188)	(0.853 - 1.156)
Household size	0.979	0.979	0.978
	(0.954 - 1.004)	(0.955 - 1.005)	(0.950 - 1.007)
Employed	1.136***	1.189***	1.160***
	(1.066 - 1.210)	(1.091 - 1.296)	(1.054 - 1.277)
Immigrant	0.558***	0.566***	0.528***
	(0.443 - 0.704)	(0.446 - 0.717)	(0.405 - 0.690)
Cigarette price	0.771***	0.784***	0.722***
	(0.646 - 0.921)	(0.656 - 0.938)	(0.592 - 0.882)
Full ban		0.913**	0.916**
		(0.848 - 0.983)	(0.845 - 0.992)
Partial ban		0.994	1.029

		(0.919 - 1.076)	(0.944 - 1.122)
Newfoundland		0.903	0.816
		(0.662 - 1.232)	(0.582 - 1.144)
Prince Edward		1.213	1.165
		(0.888 - 1.656)	(0.835 - 1.626)
Nova Scotia		1.170	1.179
		(0.880 - 1.555)	(0.902 - 1.541)
New Brunswick		1.027	1.112
		(0.766 - 1.376)	(0.836 - 1.480)
Quebec		1.108	1.109
		(0.872 - 1.407)	(0.874 - 1.407)
Ontario		1.069	1.002
		(0.852 - 1.341)	(0.813 - 1.235)
Manitoba		0.899	0.967
		(0.669 - 1.209)	(0.736 - 1.272)
Saskatchewan		1.205	1.201
		(0.930 - 1.563)	(0.936 - 1.541)
Alberta		1.266*	1.268**
		(0.979 - 1.638)	(1.008 - 1.594)
Observations	29118	29118	29118

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

Table 1.10
Odd ratios (95% confidence intervals) for the smoking prevalence regression (Warnings are defined to be in effect from July, using exchangeable working correlation)

	Model 1	Model 2	Model 3
Graphic warnings	0.868***	0.866***	0.850***
	(0.814 - 0.926)	(0.812 - 0.925)	(0.791 - 0.914)
Male	1.162**	1.146**	1.146**
	(1.029 - 1.312)	(1.015 - 1.294)	(1.006 - 1.304)
Age 25-34	1.040	1.039	1.162**
	(0.909 - 1.190)	(0.908 - 1.188)	(1.002 - 1.347)
Age 35-44	0.953	0.953	1.081
	(0.818 - 1.110)	(0.818 - 1.110)	(0.914 - 1.279)
Age 45-64	0.811**	0.811**	0.977
	(0.688 - 0.957)	(0.688 - 0.957)	(0.814 - 1.173)
Age 65+	0.657***	0.653***	0.730***
	(0.545 - 0.793)	(0.541 - 0.788)	(0.592 - 0.899)
Secondary	1.065	1.066	1.043
	(0.861 - 1.317)	(0.863 - 1.318)	(0.834 - 1.305)
Some post secondary	0.877	0.874	0.888
	(0.741 - 1.037)	(0.740 - 1.034)	(0.745 - 1.058)
Post secondary	0.856*	0.856*	0.783***
	(0.724 - 1.013)	(0.724 - 1.012)	(0.655 - 0.936)
Low middle income	0.939	0.936	0.922
	(0.861 - 1.023)	(0.858 - 1.020)	(0.835 - 1.018)
High middle income	0.885**	0.884**	0.855***
	(0.803 - 0.976)	(0.801 - 0.974)	(0.766 - 0.953)
High income	0.867***	0.864***	0.820***
	(0.781 - 0.963)	(0.778 - 0.960)	(0.732 - 0.918)
Married	0.827***	0.827***	0.826***
	(0.737 - 0.927)	(0.738 - 0.926)	(0.732 - 0.932)
Separated	1.028	1.032	0.994
	(0.892 - 1.185)	(0.896 - 1.188)	(0.854 - 1.157)
Household size	0.979	0.979	0.978
	(0.954 - 1.004)	(0.955 - 1.005)	(0.950 - 1.007)
Employed	1.136***	1.189***	1.160***
	(1.066 - 1.210)	(1.091 - 1.296)	(1.053 - 1.277)
Immigrant	0.558***	0.566***	0.528***
	(0.443 - 0.704)	(0.446 - 0.717)	(0.405 - 0.689)
Cigarette price	0.772***	0.785***	0.725***
	(0.647 - 0.921)	(0.656 - 0.939)	(0.593 - 0.885)
Full ban		0.913**	0.916**
		(0.848 - 0.983)	(0.845 - 0.992)

Partial ban		0.994	1.029
		(0.918 - 1.075)	(0.944 - 1.122)
Newfoundland		0.902	0.817
		(0.661 - 1.231)	(0.583 - 1.145)
Prince Edward		1.212	1.165
		(0.888 - 1.656)	(0.835 - 1.626)
Nova Scotia		1.170	1.179
		(0.880 - 1.555)	(0.902 - 1.541)
New Brunswick		1.027	1.113
		(0.766 - 1.376)	(0.836 - 1.480)
Quebec		1.107	1.109
		(0.872 - 1.406)	(0.874 - 1.407)
Ontario		1.069	1.002
		(0.852 - 1.342)	(0.813 - 1.235)
Manitoba		0.899	0.967
		(0.669 - 1.208)	(0.736 - 1.272)
Saskatchewan		1.205	1.201
		(0.929 - 1.563)	(0.936 - 1.540)
Alberta		1.266*	1.268**
		(0.979 - 1.637)	(1.008 - 1.594)
Observations	29118	29118	29118

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

Table 1.11
Odd ratios (95% confidence intervals) for the smoking prevalence regression (Warnings are defined to be in effect from December, using exchangeable working correlation)

	Model 1	Model 2	Model 3
Graphic warnings	0.869***	0.867***	0.852***
	(0.815 - 0.927)	(0.813 - 0.926)	(0.793 - 0.916)
Male	1.162**	1.146**	1.145**
	(1.029 - 1.311)	(1.015 - 1.294)	(1.006 - 1.304)
Age 25-34	1.040	1.038	1.161**
	(0.909 - 1.190)	(0.908 - 1.187)	(1.002 - 1.347)
Age 35-44	0.952	0.952	1.081
	(0.817 - 1.109)	(0.817 - 1.109)	(0.914 - 1.279)
Age 45-64	0.811**	0.811**	0.977
	(0.688 - 0.956)	(0.688 - 0.957)	(0.814 - 1.172)
Age 65+	0.657***	0.653***	0.729***
	(0.545 - 0.792)	(0.541 - 0.788)	(0.592 - 0.899)
Secondary	1.065	1.066	1.043
	(0.861 - 1.317)	(0.863 - 1.317)	(0.834 - 1.305)
Some post secondary	0.877	0.875	0.888
	(0.741 - 1.037)	(0.740 - 1.034)	(0.745 - 1.058)
Post secondary	0.856*	0.856*	0.783***
	(0.724 - 1.013)	(0.724 - 1.012)	(0.655 - 0.936)
Low middle income	0.939	0.936	0.922
	(0.861 - 1.023)	(0.859 - 1.020)	(0.835 - 1.018)
High middle income	0.886**	0.884**	0.854***
	(0.803 - 0.976)	(0.801 - 0.974)	(0.766 - 0.953)
High income	0.868***	0.864***	0.820***
	(0.781 - 0.963)	(0.778 - 0.960)	(0.732 - 0.918)
Married	0.827***	0.827***	0.826***
	(0.737 - 0.927)	(0.738 - 0.926)	(0.732 - 0.932)
Separated	1.028	1.031	0.993
	(0.892 - 1.185)	(0.896 - 1.188)	(0.853 - 1.156)
Household size	0.979	0.979	0.978
	(0.954 - 1.004)	(0.955 - 1.005)	(0.950 - 1.007)
Employed	1.136***	1.189***	1.160***
	(1.066 - 1.210)	(1.091 - 1.296)	(1.054 - 1.277)
Immigrant	0.558***	0.566***	0.529***
	(0.442 - 0.704)	(0.446 - 0.717)	(0.405 - 0.690)
Cigarette price	0.771***	0.784***	0.722***
	(0.646 - 0.920)	(0.655 - 0.938)	(0.591 - 0.881)
Full ban		0.913**	0.916**
		(0.848 - 0.983)	(0.845 - 0.992)

Partial ban		0.994	1.029
		(0.919 - 1.076)	(0.944 - 1.123)
Newfoundland		0.903	0.816
		(0.662 - 1.232)	(0.582 - 1.144)
Prince Edward		1.213	1.165
		(0.888 - 1.656)	(0.835 - 1.626)
Nova Scotia		1.170	1.179
		(0.880 - 1.555)	(0.902 - 1.541)
New Brunswick		1.027	1.112
		(0.766 - 1.376)	(0.836 - 1.480)
Quebec		1.108	1.108
		(0.872 - 1.407)	(0.873 - 1.407)
Ontario		1.069	1.002
		(0.852 - 1.341)	(0.813 - 1.234)
Manitoba		0.899	0.967
		(0.669 - 1.209)	(0.736 - 1.272)
Saskatchewan		1.205	1.201
		(0.930 - 1.563)	(0.936 - 1.541)
Alberta		1.266*	1.268**
		(0.979 - 1.638)	(1.008 - 1.594)
Observations	29118	29118	29118

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

Table 1.12
Odd ratios (95% confidence intervals) for the quit attempt regression using warning scale (exchangeable working correlation)

	Model 1	Model 2	Model 3
Graphic warnings	1.308***	1.313***	1.314***
	(1.167 - 1.465)	(1.172 - 1.472)	(1.161 - 1.488)
Male	1.002	1.004	0.958
	(0.859 - 1.169)	(0.860 - 1.172)	(0.805 - 1.139)
Age 25-34	0.619***	0.620***	0.562***
	(0.479 - 0.799)	(0.480 - 0.802)	(0.426 - 0.743)
Age 35-44	0.554***	0.557***	0.530***
	(0.421 - 0.728)	(0.423 - 0.734)	(0.394 - 0.714)
Age 45-64	0.494***	0.494***	0.487***
	(0.369 - 0.660)	(0.368 - 0.663)	(0.355 - 0.668)
Age 65+	0.437***	0.428***	0.402***
	(0.295 - 0.648)	(0.289 - 0.634)	(0.260 - 0.621)
Secondary	1.163	1.166	1.140
	(0.896 - 1.509)	(0.896 - 1.516)	(0.859 - 1.512)
Some post secondary	1.156	1.152	1.158
	(0.919 - 1.453)	(0.915 - 1.449)	(0.906 - 1.480)
Post secondary	1.118	1.113	1.210
	(0.890 - 1.405)	(0.884 - 1.401)	(0.947 - 1.547)
Low middle income	1.022	1.028	1.020
	(0.830 - 1.257)	(0.835 - 1.266)	(0.819 - 1.271)
High middle income	0.997	1.013	0.976
	(0.806 - 1.235)	(0.817 - 1.256)	(0.777 - 1.225)
High income	0.872	0.885	0.812
	(0.688 - 1.105)	(0.695 - 1.127)	(0.625 - 1.055)
Married	0.960	0.938	0.869
	(0.786 - 1.171)	(0.768 - 1.146)	(0.700 - 1.080)
Separated	1.003	0.985	0.901
	(0.796 - 1.264)	(0.781 - 1.243)	(0.703 - 1.156)
Household size	1.012	1.014	1.032
	(0.957 - 1.071)	(0.958 - 1.073)	(0.969 - 1.099)
Employed	0.753***	0.788**	0.819*
	(0.650 - 0.874)	(0.639 - 0.973)	(0.653 - 1.027)
Immigrant	1.025	1.041	1.009
	(0.778 - 1.351)	(0.787 - 1.376)	(0.732 - 1.390)
Full ban		0.952	0.953
		(0.780 - 1.160)	(0.766 - 1.185)
Partial ban		0.926	0.903
		(0.757 - 1.132)	(0.725 - 1.125)
cigarettes smoked per day	0.694***	0.691***	0.726***

11-19			
	(0.601 - 0.801)	(0.598 - 0.799)	(0.618 - 0.854)
cigarettes smoked per day >20	0.565***	0.565***	0.614***
	(0.482 - 0.662)	(0.481 - 0.663)	(0.509 - 0.741)
Smoke within 31-60 mins after waking			1.163*
			(0.986 - 1.372)
Smoke after 60 mins from waking			1.038
			(0.865 - 1.246)
Newfoundland		1.166	0.972
		(0.787 - 1.728)	(0.623 - 1.517)
Prince Edward		1.037	0.952
		(0.701 - 1.534)	(0.608 - 1.489)
Nova Scotia		1.186	1.069
		(0.819 - 1.718)	(0.708 - 1.612)
New Brunswick		0.881	0.899
		(0.580 - 1.339)	(0.572 - 1.414)
Quebec		1.009	1.027
		(0.735 - 1.385)	(0.719 - 1.468)
Ontario		1.030	1.025
		(0.759 - 1.398)	(0.721 - 1.457)
Manitoba		1.096	0.944
		(0.742 - 1.619)	(0.613 - 1.454)
Saskatchewan		1.601**	1.430
		(1.075 - 2.384)	(0.910 - 2.248)
Alberta		1.117	1.009
		(0.802 - 1.556)	(0.686 - 1.485)
Observations	6269	6269	5204

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

Table 1.13
Odd ratios (95% confidence intervals) for the quit attempts regression (Warnings are defined to be in effect from July, using exchangeable working correlation)

	Model 1	Model 2	Model 3
Graphic warnings	1.308***	1.313***	1.308***
	(1.167 - 1.466)	(1.172 - 1.472)	(1.155 - 1.481)
Male	1.002	1.004	0.958
	(0.859 - 1.169)	(0.859 - 1.172)	(0.805 - 1.139)
Age 25-34	0.618***	0.620***	0.563***
	(0.479 - 0.798)	(0.479 - 0.802)	(0.426 - 0.744)
Age 35-44	0.554***	0.557***	0.531***
	(0.421 - 0.728)	(0.423 - 0.734)	(0.395 - 0.716)
Age 45-64	0.493***	0.494***	0.488***
	(0.369 - 0.659)	(0.368 - 0.663)	(0.356 - 0.670)
Age 65+	0.437***	0.429***	0.404***
	(0.295 - 0.648)	(0.289 - 0.635)	(0.261 - 0.624)
Secondary	1.163	1.165	1.140
	(0.896 - 1.509)	(0.896 - 1.516)	(0.859 - 1.512)
Some post secondary	1.156	1.151	1.158
	(0.919 - 1.453)	(0.915 - 1.449)	(0.906 - 1.479)
Post secondary	1.117	1.112	1.210
	(0.889 - 1.404)	(0.883 - 1.400)	(0.947 - 1.546)
Low middle income	1.022	1.028	1.021
	(0.831 - 1.258)	(0.835 - 1.267)	(0.819 - 1.272)
High middle income	0.998	1.014	0.977
	(0.806 - 1.235)	(0.818 - 1.257)	(0.778 - 1.227)
High income	0.873	0.886	0.815
	(0.689 - 1.106)	(0.697 - 1.128)	(0.627 - 1.058)
Married	0.960	0.938	0.869
	(0.786 - 1.171)	(0.768 - 1.146)	(0.700 - 1.080)
Separated	1.002	0.984	0.901
	(0.795 - 1.263)	(0.780 - 1.242)	(0.703 - 1.155)
Household size	1.012	1.014	1.032
	(0.957 - 1.071)	(0.958 - 1.073)	(0.969 - 1.099)
Employed	0.754***	0.788**	0.819*
	(0.650 - 0.874)	(0.639 - 0.972)	(0.653 - 1.027)
Immigrant	1.025	1.040	1.008
	(0.777 - 1.351)	(0.786 - 1.376)	(0.731 - 1.390)
Full ban		0.953	0.954
		(0.781 - 1.161)	(0.767 - 1.186)
Partial ban		0.926	0.904
		(0.758 - 1.133)	(0.725 - 1.126)

cigarettes smoked per day 11-19	0.694***	0.691***	0.726***
	(0.601 - 0.802)	(0.598 - 0.799)	(0.617 - 0.854)
cigarettes smoked per day >20	0.565***	0.565***	0.614***
	(0.482 - 0.662)	(0.482 - 0.663)	(0.509 - 0.740)
Smoke within 31-60 mins after waking			1.162*
			(0.986 - 1.371)
Smoke after 60 mins from waking			1.038
			(0.865 - 1.246)
Newfoundland		1.166	0.972
		(0.787 - 1.728)	(0.623 - 1.517)
Prince Edward		1.037	0.952
		(0.701 - 1.534)	(0.608 - 1.489)
Nova Scotia		1.185	1.068
		(0.818 - 1.717)	(0.708 - 1.611)
New Brunswick		0.882	0.900
		(0.581 - 1.339)	(0.572 - 1.415)
Quebec		1.009	1.027
		(0.735 - 1.385)	(0.719 - 1.468)
Ontario		1.030	1.024
		(0.759 - 1.397)	(0.721 - 1.456)
Manitoba		1.095	0.943
		(0.741 - 1.618)	(0.613 - 1.452)
Saskatchewan		1.601**	1.430
		(1.075 - 2.384)	(0.910 - 2.247)
Alberta		1.116	1.009
		(0.802 - 1.555)	(0.685 - 1.484)
Observations	6269	6269	5204

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

Table 1.14
Odd ratios (95% confidence intervals) for the quit attempts regression (Warnings are defined to be in effect from December, using exchangeable working correlation)

	Model 1	Model 2	Model 3
Graphic warnings	1.308***	1.313***	1.315***
	(1.167 - 1.465)	(1.172 - 1.471)	(1.161 - 1.489)
Male	1.002	1.004	0.958
	(0.859 - 1.169)	(0.860 - 1.172)	(0.805 - 1.140)
Age 25-34	0.619***	0.620***	0.562***
	(0.479 - 0.799)	(0.480 - 0.803)	(0.426 - 0.743)
Age 35-44	0.554***	0.557***	0.530***
	(0.421 - 0.728)	(0.423 - 0.734)	(0.394 - 0.714)
Age 45-64	0.494***	0.494***	0.487***
	(0.369 - 0.660)	(0.368 - 0.663)	(0.354 - 0.668)
Age 65+	0.437***	0.428***	0.402***
	(0.295 - 0.648)	(0.289 - 0.634)	(0.260 - 0.621)
Secondary	1.163	1.166	1.140
	(0.896 - 1.509)	(0.896 - 1.516)	(0.859 - 1.512)
Some post secondary	1.156	1.152	1.158
	(0.920 - 1.453)	(0.915 - 1.450)	(0.906 - 1.480)
Post secondary	1.118	1.113	1.211
	(0.890 - 1.405)	(0.884 - 1.402)	(0.947 - 1.547)
Low middle income	1.022	1.028	1.020
	(0.830 - 1.257)	(0.835 - 1.266)	(0.819 - 1.271)
High middle income	0.997	1.013	0.976
	(0.806 - 1.235)	(0.817 - 1.256)	(0.777 - 1.225)
High income	0.872	0.885	0.812
	(0.688 - 1.105)	(0.695 - 1.127)	(0.625 - 1.055)
Married	0.960	0.938	0.869
	(0.786 - 1.171)	(0.768 - 1.146)	(0.700 - 1.080)
Separated	1.003	0.985	0.902
	(0.796 - 1.264)	(0.781 - 1.243)	(0.703 - 1.156)
Household size	1.012	1.014	1.032
	(0.957 - 1.071)	(0.958 - 1.073)	(0.969 - 1.099)
Employed	0.753***	0.788**	0.819*
	(0.650 - 0.874)	(0.639 - 0.973)	(0.653 - 1.027)
Immigrant	1.025	1.041	1.009
	(0.778 - 1.351)	(0.787 - 1.376)	(0.732 - 1.390)
Full ban		0.951	0.953
		(0.780 - 1.160)	(0.766 - 1.184)
Partial ban		0.925	0.903
		(0.757 - 1.132)	(0.725 - 1.125)

cigarettes smoked per day 11-19	0.694***	0.691***	0.726***
	(0.601 - 0.801)	(0.598 - 0.799)	(0.618 - 0.854)
cigarettes smoked per day >20	0.565***	0.565***	0.614***
	(0.482 - 0.662)	(0.481 - 0.663)	(0.509 - 0.741)
Smoke within 31-60 mins after waking			1.163*
			(0.987 - 1.372)
Smoke after 60 mins from waking			1.038
			(0.865 - 1.246)
Newfoundland		1.166	0.972
		(0.787 - 1.728)	(0.623 - 1.517)
Prince Edward		1.037	0.952
		(0.701 - 1.534)	(0.608 - 1.489)
Nova Scotia		1.187	1.069
		(0.819 - 1.718)	(0.709 - 1.612)
New Brunswick		0.881	0.899
		(0.580 - 1.339)	(0.572 - 1.414)
Quebec		1.009	1.027
		(0.735 - 1.385)	(0.719 - 1.468)
Ontario		1.030	1.025
		(0.759 - 1.398)	(0.721 - 1.457)
Manitoba		1.096	0.944
		(0.742 - 1.619)	(0.613 - 1.454)
Saskatchewan		1.601**	1.430
		(1.075 - 2.384)	(0.910 - 2.248)
Alberta		1.117	1.009
		(0.802 - 1.556)	(0.686 - 1.485)
Observations	6269	6269	5204

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

Table 1.15
Odd ratios (95% confidence intervals) for the smoking prevalence regression using warning scale (Autoregressive Correlation (AR1)

	Model 1	Model 2	Model 3
Graphic warnings	0.881***	0.885***	0.860***
	(0.825 - 0.942)	(0.827 - 0.948)	(0.797 - 0.927)
Male	1.181***	1.168**	1.162**
	(1.046 - 1.333)	(1.035 - 1.319)	(1.021 - 1.323)
Age 25-34	0.961	0.964	1.059
	(0.844 - 1.095)	(0.847 - 1.098)	(0.912 - 1.230)
Age 35-44	0.851**	0.858**	0.945
	(0.732 - 0.990)	(0.737 - 0.998)	(0.796 - 1.122)
Age 45-64	0.697***	0.703***	0.801**
	(0.593 - 0.819)	(0.598 - 0.828)	(0.666 - 0.962)
Age 65+	0.475***	0.477***	0.488***
	(0.394 - 0.573)	(0.394 - 0.576)	(0.393 - 0.605)
Secondary	0.952	0.959	0.858
	(0.787 - 1.151)	(0.793 - 1.159)	(0.704 - 1.045)
Some post secondary	0.814**	0.820**	0.759***
	(0.693 - 0.956)	(0.698 - 0.963)	(0.647 - 0.890)
Post secondary	0.769***	0.778***	0.646***
	(0.656 - 0.902)	(0.663 - 0.912)	(0.549 - 0.760)
Low middle income	0.934	0.934	0.917*
	(0.856 - 1.018)	(0.857 - 1.018)	(0.832 - 1.010)
High middle income	0.875***	0.877***	0.857***
	(0.797 - 0.961)	(0.798 - 0.964)	(0.772 - 0.952)
High income	0.847***	0.850***	0.827***
	(0.764 - 0.938)	(0.766 - 0.942)	(0.740 - 0.923)
Married	0.846***	0.847***	0.869**
	(0.760 - 0.943)	(0.760 - 0.944)	(0.766 - 0.986)
Separated	1.111	1.118	1.116
	(0.966 - 1.277)	(0.973 - 1.286)	(0.954 - 1.305)
Household size	0.988	0.988	0.981
	(0.964 - 1.013)	(0.964 - 1.013)	(0.953 - 1.009)
Employed	1.122***	1.177***	1.107**
	(1.051 - 1.198)	(1.082 - 1.280)	(1.010 - 1.213)
Immigrant	0.582***	0.600***	0.565***
	(0.461 - 0.734)	(0.473 - 0.761)	(0.435 - 0.735)
Cigarette price	0.833*	0.821**	0.772**
	(0.690 - 1.005)	(0.678 - 0.994)	(0.622 - 0.958)
Full ban		0.909***	0.935*
		(0.848 - 0.975)	(0.868 - 1.007)
Partial ban		0.992	1.029

		(0.918 - 1.073)	(0.948 - 1.118)
Newfoundland		1.034	0.954
		(0.782 - 1.368)	(0.710 - 1.282)
Prince Edward		1.157	1.295
		(0.857 - 1.562)	(0.941 - 1.781)
Nova Scotia		1.121	1.225
		(0.842 - 1.491)	(0.911 - 1.648)
New Brunswick		1.041	1.244
		(0.787 - 1.378)	(0.933 - 1.660)
Quebec		1.070	1.187
		(0.846 - 1.353)	(0.929 - 1.517)
Ontario		1.018	1.110
		(0.818 - 1.267)	(0.896 - 1.375)
Manitoba		1.032	1.113
		(0.784 - 1.358)	(0.836 - 1.481)
Saskatchewan		1.193	1.274*
		(0.920 - 1.547)	(0.969 - 1.674)
Alberta		1.201	1.335**
		(0.939 - 1.536)	(1.058 - 1.683)
Observations	29118	29118	29118

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

Table 1.16
Odd ratios (95% confidence intervals) for the smoking prevalence regression (Warnings are defined to be in effect from July, using Autoregressive Correlation (AR1))

	Model 1	Model 2	Model 3
Graphic warnings	0.881***	0.884***	0.857***
	(0.824 - 0.941)	(0.827 - 0.946)	(0.794 - 0.924)
Male	1.181***	1.168**	1.162**
	(1.046 - 1.333)	(1.035 - 1.319)	(1.021 - 1.323)
Age 25-34	0.962	0.965	1.060
	(0.845 - 1.095)	(0.847 - 1.099)	(0.912 - 1.231)
Age 35-44	0.852**	0.858**	0.946
	(0.732 - 0.991)	(0.738 - 0.998)	(0.796 - 1.123)
Age 45-64	0.697***	0.704***	0.801**
	(0.593 - 0.819)	(0.598 - 0.828)	(0.666 - 0.962)
Age 65+	0.475***	0.477***	0.488***
	(0.394 - 0.574)	(0.394 - 0.576)	(0.393 - 0.605)
Secondary	0.952	0.958	0.857
	(0.787 - 1.151)	(0.793 - 1.159)	(0.704 - 1.045)
Some post secondary	0.814**	0.820**	0.759***
	(0.692 - 0.956)	(0.698 - 0.963)	(0.647 - 0.890)
Post secondary	0.769***	0.778***	0.646***
	(0.656 - 0.902)	(0.663 - 0.912)	(0.549 - 0.760)
Low middle income	0.934	0.934	0.917*
	(0.857 - 1.018)	(0.857 - 1.018)	(0.833 - 1.010)
High middle income	0.875***	0.878***	0.858***
	(0.797 - 0.962)	(0.799 - 0.964)	(0.773 - 0.953)
High income	0.847***	0.850***	0.827***
	(0.764 - 0.939)	(0.766 - 0.943)	(0.740 - 0.924)
Married	0.846***	0.847***	0.869**
	(0.759 - 0.943)	(0.760 - 0.944)	(0.767 - 0.986)
Separated	1.111	1.119	1.117
	(0.966 - 1.277)	(0.973 - 1.286)	(0.955 - 1.306)
Household size	0.989	0.988	0.981
	(0.964 - 1.013)	(0.964 - 1.013)	(0.953 - 1.009)
Employed	1.122***	1.177***	1.107**
	(1.051 - 1.198)	(1.082 - 1.280)	(1.010 - 1.213)
Immigrant	0.582***	0.599***	0.565***
	(0.461 - 0.734)	(0.473 - 0.760)	(0.435 - 0.734)
Cigarette price	0.834*	0.823**	0.779**
	(0.691 - 1.005)	(0.680 - 0.995)	(0.627 - 0.967)
Full ban		0.909***	0.935*
		(0.848 - 0.975)	(0.868 - 1.007)

Partial ban		0.992	1.029
		(0.918 - 1.073)	(0.948 - 1.117)
Newfoundland		1.033	0.953
		(0.781 - 1.366)	(0.709 - 1.282)
Prince Edward		1.157	1.294
		(0.857 - 1.561)	(0.941 - 1.780)
Nova Scotia		1.119	1.223
		(0.841 - 1.489)	(0.910 - 1.645)
New Brunswick		1.040	1.244
		(0.786 - 1.377)	(0.933 - 1.660)
Quebec		1.069	1.188
		(0.845 - 1.352)	(0.930 - 1.518)
Ontario		1.018	1.110
		(0.818 - 1.268)	(0.896 - 1.376)
Manitoba		1.031	1.111
		(0.783 - 1.357)	(0.835 - 1.479)
Saskatchewan		1.193	1.272*
		(0.920 - 1.546)	(0.968 - 1.672)
Alberta		1.201	1.335**
		(0.939 - 1.536)	(1.058 - 1.683)
Observations	29118	29118	29118

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

Table 1.17
Odd ratios (95% confidence intervals) for the smoking prevalence regression (Warnings are defined to be in effect from December, using Autoregressive Correlation (AR1))

	Model 1	Model 2	Model 3
Graphic warnings	0.882***	0.886***	0.860***
	(0.825 - 0.943)	(0.827 - 0.948)	(0.798 - 0.928)
Male	1.181***	1.168**	1.162**
	(1.046 - 1.333)	(1.035 - 1.319)	(1.021 - 1.323)
Age 25-34	0.961	0.964	1.059
	(0.844 - 1.094)	(0.847 - 1.098)	(0.912 - 1.230)
Age 35-44	0.851**	0.858**	0.945
	(0.732 - 0.990)	(0.737 - 0.998)	(0.796 - 1.122)
Age 45-64	0.697***	0.703***	0.801**
	(0.593 - 0.819)	(0.598 - 0.828)	(0.666 - 0.962)
Age 65+	0.475***	0.477***	0.488***
	(0.394 - 0.573)	(0.394 - 0.576)	(0.393 - 0.605)
Secondary	0.952	0.959	0.858
	(0.787 - 1.151)	(0.793 - 1.159)	(0.704 - 1.045)
Some post secondary	0.814**	0.820**	0.759***
	(0.693 - 0.956)	(0.698 - 0.963)	(0.647 - 0.890)
Post secondary	0.769***	0.778***	0.646***
	(0.656 - 0.902)	(0.663 - 0.912)	(0.549 - 0.760)
Low middle income	0.934	0.934	0.917*
	(0.856 - 1.018)	(0.856 - 1.018)	(0.832 - 1.010)
High middle income	0.875***	0.877***	0.857***
	(0.797 - 0.961)	(0.798 - 0.964)	(0.772 - 0.952)
High income	0.847***	0.850***	0.827***
	(0.764 - 0.938)	(0.766 - 0.942)	(0.740 - 0.923)
Married	0.846***	0.847***	0.869**
	(0.760 - 0.943)	(0.760 - 0.944)	(0.766 - 0.986)
Separated	1.111	1.118	1.116
	(0.966 - 1.277)	(0.973 - 1.286)	(0.954 - 1.305)
Household size	0.988	0.988	0.981
	(0.964 - 1.013)	(0.964 - 1.013)	(0.953 - 1.009)
Employed	1.122***	1.177***	1.107**
	(1.051 - 1.198)	(1.082 - 1.280)	(1.010 - 1.213)
Immigrant	0.582***	0.600***	0.565***
	(0.461 - 0.734)	(0.473 - 0.761)	(0.435 - 0.735)
Cigarette price	0.832*	0.820**	0.771**
	(0.689 - 1.005)	(0.677 - 0.994)	(0.621 - 0.957)
Full ban		0.909***	0.935*
		(0.848 - 0.975)	(0.868 - 1.007)

Partial ban		0.992	1.029
		(0.918 - 1.073)	(0.948 - 1.118)
Newfoundland		1.034	0.954
		(0.782 - 1.368)	(0.710 - 1.282)
Prince Edward		1.157	1.295
		(0.857 - 1.562)	(0.941 - 1.781)
Nova Scotia		1.121	1.225
		(0.842 - 1.492)	(0.911 - 1.648)
New Brunswick		1.041	1.244
		(0.787 - 1.378)	(0.932 - 1.660)
Quebec		1.070	1.187
		(0.846 - 1.353)	(0.929 - 1.517)
Ontario		1.018	1.110
		(0.818 - 1.267)	(0.896 - 1.375)
Manitoba		1.032	1.113
		(0.784 - 1.358)	(0.836 - 1.481)
Saskatchewan		1.193	1.274*
		(0.920 - 1.547)	(0.969 - 1.674)
Alberta		1.201	1.335**
		(0.939 - 1.536)	(1.058 - 1.683)
Observations	29118	29118	29118

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

Table 1.18
Odd ratios (95% confidence intervals) for the quit attempt regression using warning scale, and Autoregressive Correlation (AR1)

	Model 1	Model 2	Model 3
Graphic warnings	1.323***	1.333***	1.398***
	(1.155 - 1.515)	(1.163 - 1.528)	(1.200 - 1.629)
Male	1.044	1.034	1.057
	(0.865 - 1.260)	(0.855 - 1.249)	(0.852 - 1.311)
Age 25-34	0.497***	0.499***	0.505***
	(0.363 - 0.680)	(0.364 - 0.684)	(0.355 - 0.720)
Age 35-44	0.475***	0.482***	0.500***
	(0.338 - 0.669)	(0.341 - 0.681)	(0.344 - 0.729)
Age 45-64	0.433***	0.437***	0.444***
	(0.302 - 0.620)	(0.304 - 0.627)	(0.300 - 0.656)
Age 65+	0.333***	0.329***	0.356***
	(0.200 - 0.554)	(0.198 - 0.547)	(0.204 - 0.621)
Secondary	1.287	1.306	1.351*
	(0.935 - 1.772)	(0.944 - 1.807)	(0.944 - 1.932)
Some post secondary	1.242	1.241	1.319*
	(0.943 - 1.636)	(0.941 - 1.636)	(0.979 - 1.777)
Post secondary	1.223	1.222	1.327*
	(0.928 - 1.611)	(0.924 - 1.617)	(0.976 - 1.806)
Low middle income	0.990	1.009	1.079
	(0.784 - 1.250)	(0.799 - 1.275)	(0.836 - 1.393)
High middle income	0.912	0.938	0.926
	(0.714 - 1.165)	(0.732 - 1.201)	(0.707 - 1.214)
High income	0.767*	0.788	0.720**
	(0.580 - 1.014)	(0.594 - 1.047)	(0.525 - 0.987)
Married	1.074	1.035	1.003
	(0.839 - 1.373)	(0.809 - 1.324)	(0.762 - 1.319)
Separated	1.184	1.158	0.979
	(0.893 - 1.571)	(0.874 - 1.535)	(0.721 - 1.328)
Household size	1.014	1.020	1.016
	(0.949 - 1.083)	(0.954 - 1.090)	(0.941 - 1.097)
Employed	0.795***	0.912	0.859
	(0.669 – 0.946)	(0.721 - 1.155)	(0.661 - 1.117)
Immigrant	1.101	1.110	1.121
	(0.795 - 1.525)	(0.799 - 1.541)	(0.778 - 1.615)
Full ban		0.850	0.964
		(0.680 - 1.062)	(0.752 - 1.235)
Partial ban		0.826*	0.912
		(0.659 - 1.034)	(0.710 - 1.170)
cigarettes smoked	0.676***	0.679***	0.720***

per day 11-19			
	(0.569 - 0.803)	(0.571 - 0.806)	(0.587 - 0.882)
cigarettes smoked per day >20	0.514***	0.512***	0.590***
	(0.425 - 0.622)	(0.423 - 0.621)	(0.469 - 0.742)
Smoke within 31-60 mins after waking			1.179*
			(0.969 - 1.433)
Smoke after 60 mins from waking			1.144
			(0.901 - 1.453)
Newfoundland		1.060	0.859
		(0.639 - 1.757)	(0.482 - 1.530)
Prince Edward		0.817	0.782
		(0.492 - 1.356)	(0.443 - 1.383)
Nova Scotia		1.200	1.084
		(0.747 - 1.929)	(0.636 - 1.848)
New Brunswick		0.784	0.794
		(0.460 - 1.334)	(0.443 - 1.423)
Quebec		0.919	0.999
		(0.607 - 1.392)	(0.632 - 1.578)
Ontario		0.945	0.976
		(0.631 - 1.414)	(0.626 - 1.521)
Manitoba		0.961	0.877
		(0.581 - 1.590)	(0.525 - 1.466)
Saskatchewan		1.328	1.258
		(0.779 - 2.266)	(0.699 - 2.266)
Alberta		0.957	1.045
		(0.621 - 1.475)	(0.640 - 1.708)
Observations	4720	4720	3799

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

Table 1.19
Odd ratios (95% confidence intervals) for the quit attempts regression (Warnings are defined to be in effect from July, using Autoregressive Correlation (AR1))

	Model 1	Model 2	Model 3
Graphic warnings	1.323***	1.332***	1.392***
	(1.154 - 1.515)	(1.162 - 1.527)	(1.194 - 1.621)
Male	1.044	1.033	1.056
	(0.864 - 1.260)	(0.855 - 1.249)	(0.851 - 1.311)
Age 25-34	0.496***	0.499***	0.505***
	(0.363 - 0.680)	(0.364 - 0.684)	(0.355 - 0.720)
Age 35-44	0.475***	0.482***	0.501***
	(0.338 - 0.669)	(0.341 - 0.681)	(0.344 - 0.729)
Age 45-64	0.433***	0.437***	0.444***
	(0.303 - 0.620)	(0.304 - 0.627)	(0.300 - 0.657)
Age 65+	0.333***	0.330***	0.357***
	(0.200 - 0.555)	(0.199 - 0.548)	(0.205 - 0.623)
Secondary	1.287	1.306	1.351*
	(0.935 - 1.773)	(0.944 - 1.807)	(0.944 - 1.932)
Some post secondary	1.242	1.241	1.318*
	(0.943 - 1.636)	(0.941 - 1.636)	(0.978 - 1.776)
Post secondary	1.222	1.222	1.327*
	(0.928 - 1.610)	(0.923 - 1.616)	(0.975 - 1.806)
Low middle income	0.989	1.008	1.077
	(0.783 - 1.250)	(0.798 - 1.274)	(0.834 - 1.392)
High middle income	0.911	0.937	0.926
	(0.713 - 1.164)	(0.732 - 1.200)	(0.706 - 1.213)
High income	0.767*	0.789	0.720**
	(0.580 - 1.014)	(0.594 - 1.048)	(0.525 - 0.988)
Married	1.072	1.034	1.002
	(0.838 - 1.372)	(0.808 - 1.323)	(0.762 - 1.318)
Separated	1.183	1.157	0.977
	(0.892 - 1.569)	(0.873 - 1.534)	(0.720 - 1.326)
Household size	1.014	1.020	1.016
	(0.949 - 1.083)	(0.954 - 1.090)	(0.942 - 1.097)
Employed	0.796**	0.913	0.860
	(0.669 - 0.947)	(0.721 - 1.155)	(0.662 - 1.118)
Immigrant	1.101	1.110	1.121
	(0.795 - 1.525)	(0.800 - 1.541)	(0.778 - 1.615)
Full ban		0.850	0.964
		(0.680 - 1.063)	(0.753 - 1.235)
Partial ban		0.826*	0.912
		(0.660 - 1.034)	(0.711 - 1.170)

cigarettes smoked per day 11-19	0.676***	0.679***	0.720***
	(0.569 - 0.803)	(0.571 - 0.807)	(0.587 - 0.882)
cigarettes smoked per day >20	0.515***	0.513***	0.589***
	(0.425 - 0.623)	(0.423 - 0.621)	(0.468 - 0.741)
Smoke within 31-60 mins after waking			1.177
			(0.968 - 1.432)
Smoke after 60 mins from waking			1.144
			(0.901 - 1.453)
Newfoundland		1.059	0.860
		(0.639 - 1.756)	(0.483 - 1.532)
Prince Edward		0.817	0.783
		(0.492 - 1.356)	(0.443 - 1.384)
Nova Scotia		1.200	1.084
		(0.746 - 1.928)	(0.636 - 1.847)
New Brunswick		0.784	0.795
		(0.461 - 1.335)	(0.444 - 1.424)
Quebec		0.920	0.999
		(0.607 - 1.392)	(0.632 - 1.579)
Ontario		0.944	0.975
		(0.631 - 1.413)	(0.626 - 1.520)
Manitoba		0.960	0.876
		(0.580 - 1.588)	(0.524 - 1.463)
Saskatchewan		1.328	1.258
		(0.779 - 2.266)	(0.699 - 2.265)
Alberta		0.956	1.044
		(0.620 - 1.474)	(0.639 - 1.705)
Observations	4720	4720	3799

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

Table 1.20
Odd ratios (95% confidence intervals) for the quit attempts regression (Warnings are defined to be in effect from December, using Autoregressive Correlation (AR1))

	Model 1	Model 2	Model 3
Graphic warnings	1.323***	1.333***	1.398***
	(1.155 - 1.515)	(1.163 - 1.528)	(1.201 - 1.629)
Male	1.044	1.034	1.057
	(0.865 - 1.260)	(0.855 - 1.249)	(0.852 - 1.311)
Age 25-34	0.497***	0.499***	0.505***
	(0.363 - 0.680)	(0.364 - 0.684)	(0.355 - 0.720)
Age 35-44	0.475***	0.482***	0.500***
	(0.338 - 0.669)	(0.341 - 0.681)	(0.344 - 0.729)
Age 45-64	0.433***	0.437***	0.444***
	(0.302 - 0.620)	(0.304 - 0.627)	(0.300 - 0.656)
Age 65+	0.333***	0.329***	0.356***
	(0.200 - 0.554)	(0.198 - 0.547)	(0.204 - 0.621)
Secondary	1.287	1.306	1.351*
	(0.935 - 1.772)	(0.944 - 1.807)	(0.944 - 1.932)
Some post secondary	1.242	1.241	1.319*
	(0.943 - 1.636)	(0.941 - 1.636)	(0.979 - 1.777)
Post secondary	1.223	1.222	1.327*
	(0.928 - 1.611)	(0.924 - 1.617)	(0.976 - 1.806)
Low middle income	0.990	1.009	1.079
	(0.784 - 1.250)	(0.799 - 1.275)	(0.836 - 1.393)
High middle income	0.912	0.938	0.926
	(0.714 - 1.165)	(0.732 - 1.201)	(0.707 - 1.214)
High income	0.767*	0.788	0.720**
	(0.580 - 1.014)	(0.594 - 1.047)	(0.525 - 0.987)
Married	1.074	1.035	1.003
	(0.839 - 1.373)	(0.809 - 1.324)	(0.762 - 1.319)
Separated	1.184	1.158	0.979
	(0.893 - 1.571)	(0.874 - 1.536)	(0.721 - 1.328)
Household size	1.014	1.020	1.016
	(0.949 - 1.083)	(0.954 - 1.090)	(0.941 - 1.097)
Employed	0.795**	0.912	0.859
	(0.669 - 0.946)	(0.721 - 1.155)	(0.661 - 1.117)
Immigrant	1.101	1.110	1.121
	(0.795 - 1.525)	(0.799 - 1.541)	(0.778 - 1.615)
Full ban		0.850	0.964
		(0.680 - 1.062)	(0.752 - 1.235)
Partial ban		0.826*	0.911
		(0.659 - 1.034)	(0.710 - 1.170)

cigarettes smoked per day 11-19	0.676***	0.679***	0.720***
	(0.569 - 0.803)	(0.571 - 0.806)	(0.587 - 0.882)
cigarettes smoked per day >20	0.514***	0.512***	0.590***
	(0.425 - 0.622)	(0.423 - 0.621)	(0.469 - 0.742)
Smoke within 31-60 mins after waking			1.179
			(0.970 - 1.433)
Smoke after 60 mins from waking			1.144
			(0.901 - 1.453)
Newfoundland		1.060	0.859
		(0.639 - 1.757)	(0.482 - 1.530)
Prince Edward		0.817	0.782
		(0.492 - 1.356)	(0.442 - 1.383)
Nova Scotia		1.200	1.084
		(0.747 - 1.929)	(0.636 - 1.848)
New Brunswick		0.783	0.794
		(0.460 - 1.333)	(0.443 - 1.422)
Quebec		0.919	0.999
		(0.607 - 1.392)	(0.632 - 1.578)
Ontario		0.945	0.976
		(0.631 - 1.414)	(0.626 - 1.521)
Manitoba		0.961	0.877
		(0.581 - 1.591)	(0.525 - 1.467)
Saskatchewan		1.328	1.258
		(0.779 - 2.266)	(0.699 - 2.266)
Alberta		0.957	1.046
		(0.621 - 1.475)	(0.640 - 1.708)
Observations	4720	4720	3799

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

Table 1.21.

A summary for the odd ratios (95% confidence intervals) for the prevalence regression

	Model 1	**Model 2**	**Model 3**
Unstructured working correlation			
Warning scale	0.874***	0.875***	0.868***
	(0.821 - 0.930)	(0.821 - 0.932)	(0.809 - 0.931)
July	0.873***	0.874***	0.864***
	(0.820 - 0.929)	(0.820 - 0.931)	(0.805 - 0.927)
December	0.874***	0.875***	0.869***
	(0.821 - 0.930)	(0.822 - 0.933)	(0.810 - 0.931)
Exchangeable working correlation			
Warning scale	0.869***	0.867***	0.852***
	(0.815 - 0.927)	(0.812 - 0.926)	(0.792 - 0.916)
July	0.868***	0.866***	0.850***
	(0.814 - 0.926)	(0.812 - 0.925)	(0.791 - 0.914)
December	0.869***	0.867***	0.852***
	(0.815 - 0.927)	(0.813 - 0.926)	(0.793 - 0.916)
Autoregressive Correlation (AR1)			
Warning scale	0.881***	0.885***	0.860***
	(0.825 - 0.942)	(0.827 - 0.948)	(0.797 - 0.927)
July	0.881***	0.884***	0.857***
	(0.824 - 0.941)	(0.827 - 0.946)	(0.794 - 0.924)
December	0.882***	0.886***	0.860***
	(0.825 - 0.943)	(0.827 - 0.948)	(0.798 - 0.928)

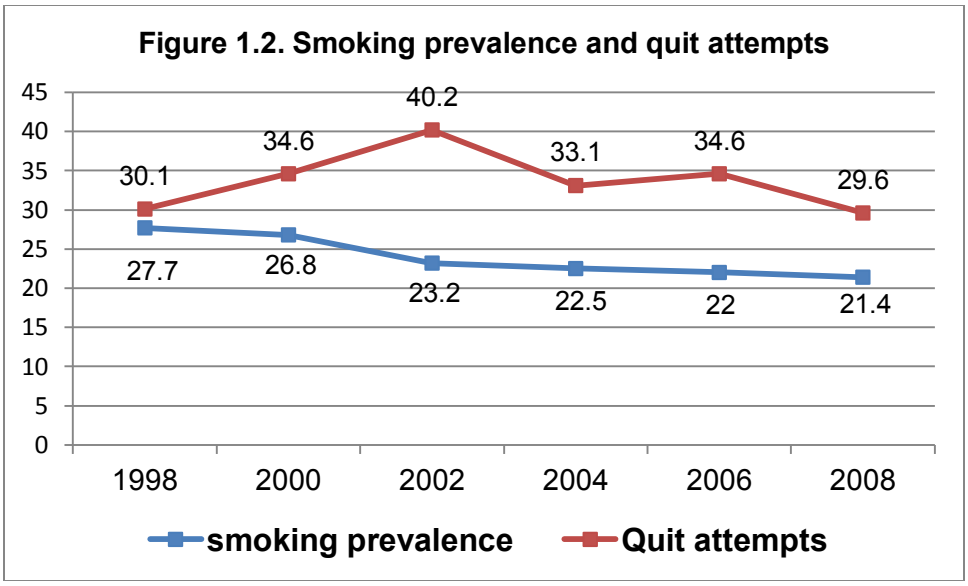
Table 1.22.
A summary for the odd ratios (95% confidence intervals) for the quit attempts regression

	Model 1	Model 2	Model 3
Unstructured working correlation			
Warning scale	1.326***	1.330***	1.331***
	(1.184 - 1.485)	(1.187 - 1.490)	(1.175 - 1.508)
July	1.326***	1.329***	1.325***
	(1.183 - 1.485)	(1.186 - 1.490)	(1.170 - 1.500)
December	1.325***	1.329***	1.332***
	(1.183 - 1.484)	(1.187 - 1.489)	(1.176 - 1.508)
Exchangeable working correlation			
Warning scale	1.308***	1.313***	1.314***
	(1.167 - 1.465)	(1.172 - 1.472)	(1.161 - 1.488)
July	1.308***	1.313***	1.308***
	(1.167 - 1.466)	(1.172 - 1.472)	(1.155 - 1.481)
December	1.308***	1.313***	1.315***
	(1.167 - 1.465)	(1.172 - 1.471)	(1.161 - 1.489)
Autoregressive Correlation (AR1)			
Warning scale	1.323***	1.333***	1.398***
	(1.155 - 1.515)	(1.163 - 1.528)	(1.200 - 1.629)
July	1.323***	1.332***	1.392***
	(1.154 - 1.515)	(1.162 - 1.527)	(1.194 - 1.621)
December	1.323***	1.333***	1.398***
	(1.155 - 1.515)	(1.163 - 1.528)	(1.201 - 1.629)

Figures

Figure 1.1
Canadian graphic cigarette warning labels under the Tobacco Products Information Regulations

Source: Health Canada. Available at : http://www.hc-sc.gc.ca/hc-ps/tobac-tabac/legislation/label-etiquette/other-autre-eng.php



Source: Authors' compilation using data from NPHS

Essay 2

The effect of job stress on health risk behaviors

Abstract

This essay examined the effect of job stress on three key health risk-behaviors: smoking; alcohol consumption and the body mass index (BMI), using data from the Canadian National Population Health Survey. Findings in the extant literature are inconclusive and were mainly based on standard models which can model differential responses to job stress only by observed characteristics. However, the effect of job stress on smoking and drinking may largely depend on unobserved characteristics such as: self control, stress-coping ability, personality traits and health preferences. Accordingly, for smoking and alcohol consumption, we used a latent class model to capture heterogeneous responses to job stress. For job stress and BMI, panel estimation methods were used to account for individual-level unobserved heterogeneity. The results suggested that the effects of job stress on smoking and alcohol consumption differ substantially for at least two "types" of individuals, light and heavy users. In particular, it was found find that job stress had a positive and statistically significant impact on smoking intensity, but only for light smokers, while it had a positive and significant impact on alcohol consumption mainly for heavy drinkers. In contrast to the OLS results, the random and fixed effects results showed no statistically significant relationship between job stress and BMI. These results provided suggestive evidence that the mixed findings in the literature may partly be due to unobserved individual heterogeneity that previous studies have ignored.

2.1. Introduction

The work environment has witnessed dramatic changes in recent years as a result of globalization, competition, technological advances and economic uncertainty. Working conditions are more frequently characterized by a high work load, an effort-reward imbalance, less job security, and the continual need to update skills (Cooper et al,. 2010). Consequently, there is a growing concern that the workplace has adverse effects on the physical and psychological well-being of workers (Cooper et al,. 2010; Karasek and Theorell, 1990). Substantial economic losses have been attributed to work-related stress. For example, work stress costs employers over $300 billion in the U.S (Karasek and Theorell, 1990) and £25.9 billion in the U.K annually (Sainsbury Centre for Mental Health, 2007), whereas in Canada, work time lost due to stress costs $12 billion per year (Canadian Mental Health Association). It has been reported that work stress is responsible for 19% of absenteeism cost, 40% of turnover cost and 60% of workplace accidents (Tangri, 2003). In addition, a growing body of research has linked chronic stress to a wide range of adverse health outcomes such as mental disorder, cardiovascular disease, anxiety, depression, hostility, heart attack, headaches, back pain and colorectal cancer (Chandola et al., 2008; Heart and Stroke Foundation of Canada, 2000; Stansfeld and Candy, 2006). In particular, studies have shown that stress can exacerbate several unhealthy behaviors such as smoking, alcohol use and excessive body weight (Karasek and Theorell, 1990; Ng and Jeffery, 2003; Kouvonen et al., 2005a & 2005b).

The adverse health effects due to tobacco and excessive alcohol use are well documented in the literature. Smoking is the leading preventable cause of disease and premature death in the world (World Health Organization, 2011). It is a major risk factor for many diseases such as heart attacks, strokes, chronic obstructive pulmonary disease,

cardiovascular disease and cancer (Centers for Disease Control and Prevention, 2008; U.S. Department of Health and Human Services, 2010). Each year, about 6 million deaths are due to tobacco use and, by 2030, tobacco-related deaths are expected to reach 8 million yearly (World Health Organization, 2011). Chronic alcohol abuse also has serious effects on physical and mental health and can as well lead to an increased risk of accidents and crimes. Long-term excessive use of alcohol can exacerbate some medical conditions and is associated with a high risk of morbidity and mortality (Testino, 2008; McGinnis and Foege, 1999). Obesity is a precursor for cardiovascular diseases, type 2 diabetes, hypertension, stroke, liver disease and certain types of cancer (Visscher and Seidell, 2001; Hu, 2008)

The association between job stress and smoking or alcohol use can be explained mainly on two grounds. First, individuals can self-medicate stress-induced physiological effects (such as elevated cortisol, suppressed serotonic, and catecholamine secretion) by smoking or drinking to achieve internal stability (homeostasis) (Koob and Le moal, 1997; Ayyagari and Sindelar, 2010). Alcohol and cigarettes could also be used as anti-anxiety or anti-depressant agents to relieve the impact of job stress (Mensch and Kandel, 1988). Second, job stress can reduce an individual's self-control, which makes it difficult for current smokers or drinkers to quit or reduce smoking or drinking intensity and may induce former smokers or drinkers to relapse and start to smoke or drink again (Ayyagari and Sindelar, 2010; Muraven and Baumeister, 2000). Given that smoking and drinking are usually initiated before joining the labor market, several studies have reported that the impact of job stress on smoking and drinking intensity is more important than its impact on smoking and drinking status (Green and Johnson, 1990; Niedhammer et al., 1998;

Greenlund et al., 1995; Landsbergis et al., 1998). Some potential pathways by which stress can also affect body weight have been documented. For example, severe stress causes the body to secret cortisol (a hormone released in response to stress) which acts to deposit abdominal body fat and increase appetite (Raine, 2004). Stress may also lead to poor eating habits and hence increase body weight (Dallman et al., 2003; Oliver et al., 2000; Pak et al., 2000; Bowman and Vinyard, 2004; Stunkard and Allison, 2003; Oliver and Wardle, 1999). Furthermore, stress-induced fatigue may encourage a sedentary lifestyle (Schneider and Becker, 2005; Karasek and Theorell, 1990; Amick et al., 2002).

Several theoretical frameworks have been developed to model the effect of job stress on workers' physical and mental health. The widely used job stress measures are Siegrist (1996) effort-reward imbalance and Karasek (1979) demand-control models. According to the effort-reward imbalance model, stress results from a lack of fairness in contractual obligations where job rewards are less than proportionate to job tasks or efforts. The Karasek job strain model, which is the dominant job-stress theory, characterizes stress as a combination of high psychological demands and low decision latitude. Decision latitude reflects an individual's control over his duties and authority to make decisions. Psychological demands reflect workload issues such as time pressures, conflicting demands, pace of work and degree of concentration required.

Empirical evidence on the relationship between job strain and smoking intensity is inconclusive (Siegrist and Rodel, 2006). In some studies, smoking intensity is positively associated with job demands (Tsutsumi et al., 2003; Hellerstedt and Jeffery, 1997; Kuper and Marmot, 2003; Kouvonen et al., 2005a) and with job strain (Green and Johnson, 1990; Kuper and Marmot, 2003; Kouvonen et al., 2005a; John et al., 2006), while

negatively associated with job control (Kuper and Marmot, 2003; Kouvonen et al., 2005a; Kawakami et al., 1998). For example, in a Finnish study of 46,190 public sector employees, Kouvonen et al. (2005) found that workers with high job strain were more likely to be smokers than workers in jobs with low strain. They also found a positive and significant association between high job strain and smoking intensity among smokers. However, other studies found no significant association between smoking intensity and job demand (Greenlund et al., 1995; Otten et al., 1999; Brisson et al., 2000), job control (Greenlund et al., 1995; Brisson et al., 2000) or job strain (Greenlund et al., 1995; Otten et al., 1999; Brisson et al., 2000; Reed et al., 1989). For example, in a cross-sectional study of 6,995 white collar workers in 21 organizations, Brisson et al. (2000) found no consistent association between smoking prevalence or intensity and high job strain. In a study of 3,701 Dutch workers, Otten et al. (1999) found no significant association between job strain or high job demands and smoking behavior among men or women. However, they found a significant association for job control and smoking behavior, but only for men.

Findings from previous studies investigating the impact of job strain on alcohol consumption are similarly mixed (Siegrist and Rodel, 2006). While some studies found a positive association between job strain, or any of its components, and alcohol consumption (Tsutsumi et al., 2003; Kuper and Marmot, 2003; Romelsjo et al., 1992; San Jose et al., 2000), other studies found no relationship (Greenlund et al., 1995; Reed et al., 1989; Mezuk et al., 2011; Kouvonen et al., 2005b; Amick et al., 2008). In a prospective cohort study, Van Loon et al. (2000) examined the cross-sectional associations between job strain and several lifestyle risk factors for cancer, including smoking and alcohol

consumption, low intake of fruit and vegetables, and physical inactivity. They found no statistically significant associations between any of cancer-related lifestyles and job strain. However, in another study, San Jose et al. (2000) found that stressful working conditions were positively associated with heavy and binge drinking in both men and women. Using a random sample of households in five metropolitan areas in the United States, Muntaner et al. (1995) found a higher risk of drug abuse or dependence in individuals with high strain jobs and in individuals with high levels of physical demands and decision authority.

The association between job strain and body mass index (BMI) is also decidedly inconclusive (for a comprehensive review, see Overgaard et al., 2004; Siegrist and Rodel, 2006). In some studies, body weight was associated with job demands (Ostry et al. 2006; Jonsson et al., 1999; Niedhammer et al., 1998), with job control (Kivimäki et al., 2002; Steptoe et al., 1999; Martikainen and Marmot, 1999) and with job strain (Kouvonen et al., 2005a; Martikainen and Marmot, 1999; Hellerstedt and Jeffrey, 1997). However, other studies reported no significant association between body weight and job strain or any of its components (Netterstrom et al., 1991; Theorell et al., 1993; Amick et al., 1998; Brisson et al., 2000; Ishizaki et al., 2004). Ostry et al. (2006) found gender differences in the association between psychosocial working conditions and BMI. Their results showed a positive association between psychological demand, working long hours and BMI among males, while no significant association was found among females. Among Finnish public sector employees, Kouvonen et al. (2005c) reported that lower job control and higher job strain were associated with a higher BMI. They found that the strength of this association is affected by the way work stress scores are constructed. Using data on 3,843

employees from 32 worksites in Minnesota, Hellerstedt and Jeffery (1997) studied the association between job strain and several health behaviors, including BMI. The authors showed that job demands and job strain were positively associated with BMI only for women. Findings from other job stress models such as the effort-reward imbalance model were equally inconclusive about the relationship between job stress and BMI (e.g., Kouvonen et al., 2005b; Kivimäki et al., 2002). In a prospective cohort study of 812 employees, Kivimaki et al. (2002) found that an effort-reward imbalance predicted increased BMI for over a 10 year window. In a cross-sectional Finnish study, Kouvonen et al. (2005) reported that higher effort-reward imbalance was associated with a higher BMI when using aggregated scores for job stress; however the association became weak when individual scores were used.

This study proposes that the mixed findings in the extant literature that have examined the relationship between job stress and health-risk behaviors may in part be due to unobserved characteristics that are not fully captured by standard models. Moreover, most previous studies used a one-period (cross sectional) measure of job strain which may only reflect temporary effects, or small samples that are not necessarily representative of the population, while other studies focused only on some stressful occupations.

This paper examines the effect of job-related stress on the intensity of smoking, alcohol consumption and body weight. Job stress was measured by the Karasek's job strain model (high job demands and low job control). For smoking and alcohol consumption, we used a latent class model (LCM) to capture population unobserved heterogeneity, and examine whether there were differences in behavioral responses to job

strain. The latent class framework, unlike the standard models, is able to unmask hidden or complex relationships. For body weight, we examined whether findings from standard cross-sectional analyses are confirmed when panel estimation methods are used to control for unobserved individual characteristics.

To preview the results: we found that the effects of job strain on smoking and alcohol consumption substantially differed for at least two "types" of individuals, light cigarette or alcohol users and heavy cigarette or alcohol users, in contrast to the OLS results, the panel estimation results showed no statistically significant association between job strain and BMI.

The rest of this paper is structured as follows: Section 2.2 describes the data; Section 2.3 presents the empirical method; results are discussed in Section 2.4 while the conclusions are summarized in Section 2.5.

2.2. Data

This study used data from the Statistics Canada National Population Health Survey (NPHS) household component. The NPHS is a nationally representative sample of the Canadian population which collects respondent's self-reported health-related behavior, as well as corresponding economic and socio-demographic variables. The NPHS commenced in 1994/95 with a subsequent follow up every two years. The survey includes household residents in all Canadian provinces excluding those living on Indian Reserves and Crown Lands, full-time members of the Canadian Forces Bases and some remote areas of Ontario and Quebec. Since the first cycle, there have been seven follow-up surveys, and so cycle eight (2008/09) is currently available. The first three cycles (1994/95, 1996/97 and 1998/99) had both cross-sectional and longitudinal components. The NPHS became strictly longitudinal from cycle four (2000/01). This study used data

from cycle four (2000/01) to cycle eight (2008/09) since job strain information was not available in cycles two and three (1996/97 and 1998/99). The attrition rates between two consecutive waves were: 7.6% (between wave 2000 to wave 2002), 7.5% (2002-2004), 5.4% (2004-2006) and 9.2% (2006-2008). In each wave, the NPHS sampling weights were adjusted in order for the data to be representative of the Canadian population. Accordingly, in this study, all analyses were population weighted using the NPHS sampling weights.

The outcome variables are daily smoking intensity (number of cigarettes), alcohol consumption (number of drinks) and BMI. The BMI was derived from self-reported anthropometric measurements (height and weight) available and is calculated as body weight in kilograms divided by height in meters squared. We restricted the sample to those 18-65 years old since the smoking rate of those greater than 65 years is relatively small and also their health related issues may further complicate the analysis. Also, those over 65 are unlikely to be working. Job strain, the main independent variable of interest, is an index that is derived from job related questions on decision latitude (skill discretion and decision authority) together with psychological demands. It was measured as a ratio of psychological demands and decision latitude, where higher values indicate greater job strain (Karasek and Theorell, 1990). We stratified individuals based on the distribution of scores into tertiles to represent low, medium, and high levels of strain.[11] Internal consistency of two sub-components of the NPHS job content questionnaire (JCQ), psychological demand ($\alpha = 0.34$) and job control ($\alpha = 0.61$) for the initial cross-sectional sample (1994/1995) has been reported (Wilkins and Beaudet, 1998). Low or

[11] Lallukka et al., 2008 used the median in the distribution of the sum score as a cut-off point for high job demands and high job control.

moderate internal consistency does not necessarily imply lack of validity of the JCQ, as it may well represent lack of redundancy in each item's contribution to the measurement of workplace-related stress (McDowell, 2006). For example, low internal consistency is plausible "where a measure records the inputs or the cause of the variable to be measured such as using life events to measure stress" (McDowell, 2006, pg. 44).

The study followed standard practice in the literature by using a number of control variables. Real cigarette taxes (only for smoking intensity equation), which include both the provincial and federal components, were included in the estimation. Age was represented in three categories: 18-29 (reference category), 30-44, and 45-65. Household income was represented by four dummy variables: low income, low-middle income, high-middle income (reference category), and high income (see Table 2.1).

'Insert Table 2.1 about here'

This classification was based on total household income and the number of people living in the household (for a detailed description, see Statistics Canada, 2009). Gender was captured by a dummy variable (male =1, female = 0). Individual's educational attainment was represented in four categories: less than secondary, secondary, some post secondary (reference category), and post secondary.

Marital status was represented by three categories: married, separated and single (reference category). Household size is the family size. Ethnicity was captured by a dummy variable (immigrant = 1, Canadian born = 0). Workplace smoking restriction was represented by three categories: no ban (reference category), partial ban (smoking allowed in designated areas), and full ban. We included a measure of social support in the

workplace since it has been suggested as an important stress modifier (Azagba and Sharaf, 2011). A higher social support score indicates lower workplace support.

Health status was represented by individual health utility index (HUI). The HUI is a set of generic, preference-based systems for measuring health status developed by the health utilities group at McMaster University. The index was constructed based on several dimensions of health status such as vision, hearing, speech, mobility, pain, dexterity, self-care, emotion and cognition. Each dimension had a score based on preference measurements from random samples of the general population (Statistics Canada, 2009; Horsman et al., 2003). Studies have validated the HUI as a more objective measure of individual health status than the commonly used self-rated health (Sadana et al., 2002).

Provincial dummy variables were included with British Columbia as the reference category. To control for job-specific factors other than job strain which can affect smoking and alcohol consumption, seven occupational categories were extracted from the 2007 North American Industry Classification System available in the NPHS. We classified an individual's occupation into one of seven groups: mechanical, trade, professional, managerial, health, service, and farm (reference category). A linear time trend was included for the smoking and alcohol regression estimations. Additional variables were included in the BMI equation. We controlled for lifestyle behaviors (such as smoking, alcohol consumption and physical activity). Smoking status was classified as: never smoker (reference category), current smoker, and former smoker. Similarly, never drinker (reference category), current drinker, and former drinker represented drinking status. Individual physical activity level was represented by three categories:

active, moderate, and inactive (reference category). Table 2.2 provides a complete definition of the variables used in the analysis.

'Insert Table 2.2 about here'

2.3. Methods

To examine the relationship between job strain, smoking and alcohol consumption, the following reduced-form model was estimated:

$$y_{ijt} = \gamma jobstrain_{it} + \beta' X_{it} + \delta \mathcal{T}_t + \theta Q_{jt} + \varphi OC_{it} + \varepsilon_{ijt} \qquad (1)$$

where i indicates the individual, j represents province of residence, and t represents the year, y represents the daily number of cigarettes or alcohol drinks consumed. $jobstrain$ represents the three categories of strain levels, $\boldsymbol{X}$ is a vector of other control variables including: cigarette taxes, age, income, gender, household size, education, marital status, workplace social support, workplace smoking restrictions, and ethnicity. $\mathcal{T}$ represents a linear time trend. The province fixed-effect variable, Q, was included to capture smoking ban regulations and other cultural factors that may be province-specific (in Canada, municipalities can enact by-laws like smoking bans or restrictions on public places). OC represents occupational classifications and ε_{ijt} is the standard time variant residual term which is adjusted for clustering at the individual level.

We began our analysis by using conventional econometric models (OLS, Poisson, and the negative binomial) to estimate Equation (1). These standard specifications produce a one population estimate of the job strain coefficient, γ, by assuming that the impact of job strain on smoking or alcohol consumption is equal for all individuals. While in some instances this generalization may be correct, it will be misleading if the population is characterized by distinct subpopulations. In particular, responses to job

strain could likely depend on unobserved characteristics such as: self control, stress coping ability, health preference, personality (e.g. neuroticism) and other "decision-making characteristics" (Fletcher et al., 2009). It has been argued that personality traits can play a significant role in the way people perceive and react to stress (Cooper et al., 2010). Accordingly, we estimated Equation (1) using a latent class framework to account for individual unobserved heterogeneity in response to job strain.

The latent class model splits the population into subpopulations of different types, in this case, light or heavy smokers and drinkers according to an individual's latent status. In this model, the dependent variable, y, comes from a population which comprises C distinct subpopulations, with unknown mixing weights $\pi_1, \dots, \pi_{C,}$ where $0 \leq \pi_j \leq 1$ and $\sum_{j=1}^{C} \pi_j = 1$. The finite mixture density of y with C support points is given by

$$f(y_i|\mathbf{\Theta}) = \sum_{j=1}^{C-1} \pi_j f_j(y_i|\theta_j) + \pi_C f_C(y_C|\theta_C) \quad (2)$$

where the mixing weights (probabilities), π_j, are estimated along with the other parameters, denoted $\mathbf{\Theta}$, $j = 1, \dots, C$ are the latent classes. The C point latent negative binomial distributions are specified as

$$f_j(y_i) = \frac{\Gamma(y_i+\psi_{j,i})}{\Gamma(\psi_{j,i})\Gamma(y_i+1)} \left(\frac{\psi_{j,i}}{\lambda_{j,i}+\psi_{j,i}}\right)^{\psi_{j,i}} \left(\frac{\lambda_{j,i}}{\lambda_{j,i}+\psi_{j,i}}\right)^{y_i} \quad (3)$$

where:

$\lambda_{\mathrm{j,i}} = \exp(\chi_{\mathrm{i}}'\beta_{\mathrm{j}})$;

$\Gamma(.)$ is the gamma function;

$\psi_{\mathrm{j,i}} = (1/\alpha_{\mathrm{j}})\lambda_{\mathrm{j,i}}^{\mathrm{k}}$

Substituting for $\psi_{\mathrm{j,i}}$ in $f_j(y_i)$ yields

$$f_j(y_i|x_i) = \frac{\Gamma(y_i+(\lambda_{\mathrm{j,i}}^{\mathrm{k}}/\alpha_{\mathrm{j}}))}{\Gamma(\lambda_{\mathrm{j,i}}^{\mathrm{k}}/\alpha_{\mathrm{j}})\Gamma(y_i+1)} (\alpha_{\mathrm{j}}\lambda_{\mathrm{j,i}}^{1-\mathrm{k}} + 1)^{-\lambda_{\mathrm{j,i}}^{\mathrm{k}}/\alpha_{\mathrm{j}}} \left(1 + \frac{\lambda_{\mathrm{j,i}}^{\mathrm{k}-1}}{\alpha_{\mathrm{j}}}\right)^{-y_i} \quad (4)$$

In this study, we used the Poisson ($i.e.$ the dispersion paremeter, $\alpha = 0$) and negative binomial 2 ($i.e. \alpha > 0 \; and \; k = 0$) variant for the mixture component densities. Other advantages of using the latent class framework have been documented in the literature: (a) it enables unobserved heterogeneity to be captured in a simple, intuitive way; (b) it is semi-parametric, since the mixing variable is not distribution specific; (c) it is valid even if the underlying mixing distribution is continuous; (d) usually two or three points are sufficient to approximate the mixing distribution; and (e) some continuous mixing models may not have a closed-form solution (Deb and Trivedi, 1997 & 2002).

In health-related outcomes, the use of a latent class framework is even more appealing, given that an individual's observed characteristics may not reflect that individual's long-term health preferences (Deb and Trivedi, 2002; Sarma et al., 2007). Following previous studies, we hypothesized that individuals' unobserved health attitudes are captured by a finite mixture distribution which splits the population into two distinct classes of smokers and drinkers (Deb and Trivedi, 1997 & 2002; Sarma et al., 2007). We estimated a two latent components negative binomial model for smoking and a two latent components Poisson model for alcohol consumption. We classified the two components into a light-use group, on the basis of low predicted mean, and a heavy-use group, with a high predicted mean.

The following simple reduced form empirical model of adult BMI was estimated:

$$BMI_{ijt} = \alpha_0 + \alpha_1 (jobstrain)_{it} + \alpha_2 X_{it} + \alpha_3 \mathcal{T}_t + \alpha_4 \mathcal{Q}_{jt} + \alpha_5 OC_{it} + \varepsilon_{ijt} \quad (5)$$

where

$i, j \; and \; t$ index for individual, province of residence and time period

BMI is a measure of adult body weight

$jobstrain$ represents the categories of strain levels

$\boldsymbol{X}$ is a vector of other control variables including: age, age squared, income, sex, education, marital status, workplace social support, ethnicity, physical activity status, smoking and drinking status. $\mathcal{T}$ represents the year effects. The province fixed-effect variable, Q, was included to capture regional and other cultural factors that may influence an individual's BMI. OC represents occupational classifications and ε_{it} is the standard time variant residual term which is adjusted for clustering at the individual level.

We first estimated Equation (5) by pooled ordinary least square (OLS), since the existing literature is mostly cast in a pooled cross-sectional framework. To correct for observation clustering, the standard errors in the OLS regression were adjusted for clustering at the individual level. OLS estimates from Equation (5) may result in a confounding bias when unobserved individual-specific characteristics are crucial in the determination of the outcome variable, BMI (Wooldridge 2002). The observed individual covariates may not reflect genetics, environmental influences, food self-control, stress coping ability and other lifestyle characteristics. To capture the influence of potential unobserved individual factors, we used panel data estimation methods. Accordingly, Equation (5) can be rewritten as:

$$BMI_{ijt} = \beta_1(jobstrain)_{it} + \beta_2 X_{it} + \beta_3 \mathcal{T}_t + \beta_4 Q_{jt} + \beta_5 OC_{it} + \mu_i + v_{ijt} \qquad (6)$$

The error term, ε_{ijt}, from Equation (1) becomes $\mu_i + v_{ijt}$ where μ_i represents time invariant individual-specific effects and v_{ijt} is the standard residual term. We estimated Equation (4) separately, by RE and FE models. In the RE model, μ_i is assumed to be uncorrelated with other covariates in the model and in the FE model μ_i is permitted to be

correlated with the regressors. While estimates from the FE model are consistent and less efficient than the RE estimates, the RE estimates are inconsistent if the FE specification is the appropriate model (Wooldridge, 2002). However, a Hausman test (at the 1% significance level) suggested that the FE was the preferred model. We reported estimates from both the FE and RE models. Longitudinal attrition (non-response) bias would result if the response pattern of individuals has an effect on BMI. To test for non-response bias, we used the simple-addition variable test by Verbeek and Nijman (1992). Three variables reflecting survey response patterns were created: the number of cycles in which the individual appears in, a dummy indicating if an individual responds in the next cycle, and also a dummy showing whether the individual responds in all cycles. We ran separate regressions (OLS and RE) for the unbalanced sample with each of the attrition variables included. These test results did not reject the null hypothesis ($p < 0.1$) of no attrition bias in all six estimations.

'Insert Table 2.3 about here'

2.4. Results

The summary statistics for the variables used in the analysis are reported in Table 2.3. On average, smokers consumed 12.8 cigarettes per day and drinkers consumed 0.6 drinks per day. About one third of the sample worked in jobs with high strain while a quarter worked in jobs with medium strain. On average, the health utility index of Canadian adult workers of more than 0.9 indicated a good functional health. A score of 1 indicates perfect functional health. Household size was 3 on average. 49% of the Canadian workers had full bans on smoking in the workplace whereas 37% had partial bans. 55% of the smoking sample was male, 54% were married, 68% had post secondary education or above and 10% were immigrants. For the alcohol consumption sample, 53%

was male, 63% was married, 77% had at least a post secondary education and 14% were immigrants. The sample characteristics of the BMI estimation are also shown in Table 2.2. The average BMI of the sample was 26.1. A sizeable portion of the adult work force belongs to jobs with high strain (33%) and medium strain (24%). About 54% of the sample was male. The physical activity index showed that over 48% of the adult working population was inactive.

First, we presented results from the traditional model with an average population estimates for the effect of strain on cigarettes consumption in Table 2.4. Only the OLS results were reported here since we found that there were no significant differences with the Poisson and negative binomial models. Next, the LCM results enabled us to examine whether there exists a differential health behavior response to job strain. The results supported the presence of at least two distinct latent classes of smokers or drinkers. These results emphasize the importance of controlling for unobserved heterogeneity in estimating the effect of job strain on smoking and alcohol consumption.

'Insert Table 2.4 about here'

2.4.1 Smoking results

The single equation OLS (no latent subgroups) model for cigarette consumption with different specifications is reported in Table 2.4. Model 1 presents the baseline specification. An additional covariate, workplace social support, was added in model 2. In model 3, we added individual's health status (HUI), province of residence and occupational fixed effects. We also excluded occupational categories in a different specification (unreported, but available on request), but there was no effect on the results. We found that high job strain had a positive and significant effect on smoking intensity

compared to low job strain and this result was robust to models 2 and 3 specifications. The inclusion of workplace social support, which acts as a stress modifier, was significant in model 2 and thus reduced the impact of job strain. Note that the positive sign of the social support coefficient indicates that a low social support was associated with high smoking intensity. This is due to the way social support index was defined, where a high value indicates low workplace social support. The impact of medium job strain was similar except for model 3, where it had no significant effect on smoking intensity. Other variables included in the model had the expected signs. The socioeconomic variables (SES) confirmed the standard SES smoking gradient: those with more education and income tend to smoke less. The real cigarette tax had a moderate negative impact, and males smoked more than females. Immigrants smoked less than natives and workplace smoking restrictions had a negative and significant effect on the quantity smoked.

'Insert Table 2.5 about here'

The results from the LCM which examines differential responses to job strain based on unobserved individual characteristics are presented in Table 2.5. The results indicated a substantial difference between the two latent classes. In particular, we found that a large group (over 70%) was light smokers and the effect of high job strain was positive and significant for this group. The estimates for the effect of high job strain for the group of heavy smokers were considerably smaller and not statistically significant. These results were also robust to the inclusion of other variables in models 2 and 3. Similar findings of positive and significant effects were obtained for medium job strain except for model 3. The impact of the other control variables was generally similar to the OLS results.

2.4.2 Alcohol consumption results

As with cigarette consumption, single equation (no latent subgroups) OLS estimates of the job strain effects on the intensity of drinking are reported in Table 2.6. In all model specifications, the coefficient of high job strain was not statistically significant. Also, medium job strain had no significant effect on alcohol consumption except for model 1. The effects of other variables in the model were somewhat similar to the smoking results presented above. Being immigrant, married, more educated and older significantly reduced the number of drinks consumed. The impact of household size was also negative and significant. Those in the high income category drank more. Some of the provincial and occupation variables were also significant.

'Insert Table 2.6 about here'

The LCM results reported in Table 2.7 indicated a significant heterogeneity between the two latent classes. The average daily drinking of one group was about five times as large as the other group. In particular, a small group (less than 11%) was heavy drinkers with an average of about 2.1 drinks per day while the large group (over 89%) was light drinkers with about 0.4 drinks. In contrast to the single equation results, we found a modest and statistically significant effect of job strain on drinking. The effect of high or medium strain was positive and significant for the heavy use group. It was only significant at a 10% significance level when workplace social support, health status, province and occupation variables were included in the model (see model 3). The coefficient of high job strain was negative for light drinkers and was also significant in

models 2 and 3. This result may not be surprising since the average alcohol consumption for this group was relatively low; it is possible that light drinkers may self-medicate job stress by ways other than drinking (e.g., tobacco and food consumption). The effects of the other control variables were qualitatively similar to the OLS estimates.

Insert Table 2.7 about here

2.4.3 BMI results

The cross-sectional OLS results are reported in Table 2.8. Model 1 presents the baseline specification. An additional covariate, workplace social support, was added in model 2. In model 3, we added individual health status and province of residence while occupational fixed effects were included in model 4. We found a significant positive association between job strain and BMI, after controlling for demographics, socioeconomic status, lifestyle behaviors, health status, social support, ethnicity, a time trend, and occupational and provincial fixed effects. In particular, compared to jobs with low strain, individuals in jobs with high strain had higher BMI, and this result was robust to the inclusion of additional control variables (see models 2, 3 and 4). Similarly, individuals in jobs with medium strain had a higher BMI compared to those in jobs with low strain though with a smaller marginal difference. For the other control variables, results showed that males, married individuals and former smokers had a higher BMI compared to their reference categories. Being a current smoker compared to the reference group (never smoker) reduced the BMI, though we are not suggesting that this result resolves the debate between smoking and obesity. The physical activity (active and moderate) and immigrant variables had the expected negative signs. The year dummies showed a significant positive trend in the BMI over time.

(Insert Table 2.8 about here)

Results from the panel data estimation methods are presented in Tables 2.9 and 2.10. Table 2.9 presents the results from the FE model while the RE model estimates are reported in Table 2.10. In contrast to the cross-sectional analysis, results from the panel data methods, FE and RE, showed no statistically significant association between job strain and BMI. This finding was robust to the inclusion of workplace social support, individual health status, occupational and provincial fixed effects. Other covariates in the panel data models were generally similar to the OLS results. Results from the panel estimation methods (FE and RE) suggested that not controlling for unobserved individual heterogeneity can lead to misleading conclusions about the effect of job strain on the BMI.

(Insert Table 2.9 & 2.10 about here)

2.5. Conclusion

In this study, we used nationally representative data from the Canadian National Population Health Survey to assess the effect of job strain on three key health-risk behaviors: smoking, alcohol consumption and body weight. This study was motivated by the inconclusive findings in the related literature which were mainly based on the standard average population estimate models. The contribution of the current study to the literature is threefold. First, we used a measure of job strain that better represents individuals' long-term work conditions rather than the one-period (cross sectional) measure. Second, the use of latent class model and panel estimation methods enabled us to account for individual-level unobserved heterogeneity. Third, we compared the results from standard models to the latent class, random and fixed effects estimation methods. The results provided suggestive evidence that the standard models did not fully capture

the relationship between job strain and health-risk behaviors and hence may partly account for the mixed findings in previous studies.

The results of this study indicated that among smokers, light users were the most vulnerable group. While for alcohol consumption, the effect of job strain was positive and significant mainly for heavy drinkers. In contrast to the OLS results, both the fixed and random effects model showed no statistically significant relationship between job strain and BMI. The findings were robust to the inclusion of workplace social support, health status, province and occupation fixed effects. Results also revealed the importance of the workplace social support which acts as a stress modifier. The inclusion of the social support index reduced the impact of job strain. Workplace intervention measures may be beneficial, particularly for the high risk groups. Some intervention strategies have been shown to be effective (American Institute of Stress; Cahill et al., 2008; Cook et al., 1996). For example, nicotine replacement therapy which promotes gradual withdrawal from the harmful effects of nicotine, health promotion or wellness programs, stress management programs (e.g. individual and group counseling), social support and employee assistance programs have all proven to be beneficial. Early intervention may prevent light smokers from getting addicted to smoking. In general, stress management and moves to relieve stressful working conditions could be an integral part of any smoking or drinking reduction program.

The individuals' differential responses to job stress can be explained on several grounds. A possible reason for the differential effects of job strain between light and heavy smokers may be due to the varying degree of sensitization to tobacco use among these groups. Since heavy smokers are already at higher levels of consumption, they may

self-medicate stress through other ways (e.g. alcohol and food consumption). Individuals have different preferences and hence may differ in the type of self medicating strategies they use to cope with stress. For example, some individuals may respond to stress by smoking more, while others may consume more food or alcohol (Conway et al., 1981). This implies that the way individuals perceive and react to stress may vary with unobserved characteristics. These health risk behaviors could be substitutes for some individuals while for others they may be complementary stress relievers.

Some individuals, especially those whose consumption quantities are apparently not affected by stress, may engage in compensatory behaviors which are not reflected by the observed consumption quantities. For instance, smokers may consume cigarettes more intensively through increasing the number of puffs, length of inhalation, or by blocking the ventilation holes on the filter while consuming the same number of cigarettes (Adda and Cornaglia, 2006). We believe that this compensatory behavior is of particular importance when assessing the impact of stress on health risk behaviors. However, this behavior was not captured by the current study since there was no relevant information about it in the data set. Another limitation of the study was the use of self-reported BMI. It has been documented that individuals tend to over-report their height and under-report their weight (McAdams et al., 2007). This may bias the estimated association between job stress and BMI and affect the consistency of the estimated parameters. However, the panel structure of the data helps to mitigate this bias. Also, as long as the errors are not systematic and BMI is the dependent variable, consistent estimates can still be obtained.

In summary, this chapter demonstrated the importance of controlling for individual-level unobserved heterogeneity in estimating the effect of job strain on health-risk

behaviors. Available health surveys data on health risk behaviors commonly mask much of the variability in behavioral response. The results of this essay provide suggestive evidence that the inconclusive findings in the literature may in part be due to unobserved individual characteristics that have been largely ignored in previous studies.

Appendix

Table 2.1. Income categories based on NPHS classification.

	Income	**Household Size**
Low income	Less than $15,000	1 or 2 persons
	Less than $20,000	3 or 4 persons
	Less than $30,000	5 or more persons
Low middle income	$15,000 to $29,999	1 or 2 persons
	$20,000 to $39,999	3 or 4 persons
	$30,000 to $59,999	5 or more persons
High middle income	$30,000 to $59,999	1 or 2 persons
	$40,000 to $79,999	3 or 4 persons
	$60,000 to $79,999	5 or more persons
High income	$60,000 or more	1 or 2 persons
	$80,000 or more	3 persons or more

Source: NPHS Household Component, Cycle 8 (2008/2009)

Table 2.2. Variables definition.

Variable	Definition
Quantity(cigarette)	Daily number of cigarette smoked
Quantity(alcohol)	Daily number of drinks
BMI	Body mass index
Low strain	=1 if job strain score belongs to the first quantile, 0 otherwise
Medium strain	=1 if job strain score belongs to the second quantile, 0 otherwise
High strain	=1 if job strain score belongs to the third quantile, 0 otherwise
Real cigarette tax	=Real excise cigarette tax per carton
Trend	=Linear year trend
Male	=1 if gender is male, 0 otherwise
Female	=1 if gender is female, 0 otherwise
Married	=1 if married/ living with a partner/common-law, 0 otherwise
Separated	=1 if widowed/separated/divorced, 0 otherwise
Single	=1 if never married, 0 otherwise (base category)
Less than secondary	=1 if education is less than secondary, 0 otherwise
Secondary	=1 if education is secondary, 0 otherwise
Some post secondary	=1 if education is some post secondary, 0 otherwise
Post secondary	=1 if education is post secondary, 0 otherwise
Age 18-29	=1 if aged 18-29 years, 0 otherwise
Age 30-44	=1 if aged 30-44 years, 0 otherwise
Age 45-65	=1 if aged 45-65 years, 0 otherwise
Low income	=1 if household income is in low income group, 0 otherwise
Low middle income	=1 if household income is in middle low income group, 0 otherwise
High middle income	=1 if household income is in middle high income group, 0 otherwise
High income	=1 if household income in high income group, 0 otherwise
Household size	=Number of people living in a household
Non immigrant	=1 if country of birth is Canada, 0 otherwise
Immigrant	=1 if country of birth is not Canada, 0 otherwise
No ban	=1 if there is no workplace restrictions on smoking,0 otherwise
Partial ban	=1 if smoking is allowed in designated areas,0 otherwise
Full ban	=1 if there is full workplace restrictions on smoking,0 otherwise
Social support	Social support score, indicating the social support available to the respondent at his/her main job in the past 12 months.
HUI	Health utility index
Never smoker	=1 if never a smoker,0 otherwise
Current smoker	=1 if currently a daily or occasional smoker,0 otherwise
Former smoker	=1 if former a smoker,0 otherwise

Never drinker	=1 if never a drinker,0 otherwise
Current drinker	=1 if currently drinks,0 otherwise
Former drinker	=1 if former a drinker,0 otherwise
Active	=1 if physically active,0 otherwise
Moderate	=1 if physical activity is moderate,0 otherwise
Inactive	=1 if physically inactive,0 otherwise
Newfoundland	=1 if province of residence is Newfoundland, 0 otherwise
Prince Edward	=1 if province of residence is Prince Edward, 0 otherwise
Nova Scotia	=1 if province of residence is Nova Scotia, 0 otherwise
New Brunswick	=1 if province of residence is New Brunswick, 0 otherwise
Quebec	=1 if province of residence is Quebec, 0 otherwise
Ontario	=1 if province of residence is Ontario, 0 otherwise
Manitoba	=1 if province of residence is Manitoba, 0 otherwise
Saskatchewan	=1 if province of residence is Saskatchewan, 0 otherwise
Alberta	=1 if province of residence is Alberta, 0 otherwise
British Columbia	=1 if province of residence is British Columbia, 0 otherwise
Mechanical	=1 if individual's job belong to mechanical occupations,0 otherwise
Trade	=1 if individual's job belong to trade occupations,0 otherwise
Professional	=1 if individual's job belong to professional occupations,0 otherwise
Managerial	=1 if individual's job belong to managerial occupations,0 otherwise
Health	=1 if individual's job belong to health occupations,0 otherwise
Service	=1 if individual's job belong to services occupations,0 otherwise
Farm	=1 if individual's job belong to farm occupations,0 otherwise

Table 2.3: Descriptive statistics.

	Smoking		**Alcohol**		**BMI**	
Variables	Mean	S.D	Mean	S.D	Mean	SD
Outcome	12.845	0.099	0.617	0.007	26.098	4.840
High strain	0.372	0.005	0.314	0.003	0.325	0.468
Medium strain	0.231	0.005	0.235	0.003	0.244	0.429
Low strain	0.397	0.006	0.412	0.003	0.427	0.494
Male	0.554	0.006	0.533	0.003	0.537	0.498
Female	0.446	0.006	0.467	0.003	0.462	0.498
Married	0.540	0.006	0.628	0.003	0.267	0.442
Separated	0.144	0.004	0.102	0.002	0.630	0.482
Single	0.316	0.005	0.269	0.003	0.101	0.302
Less secondary	0.152	0.004	0.096	0.002	0.099	0.299
Secondary	0.171	0.004	0.135	0.002	0.139	0.346
Some post secondary	0.313	0.005	0.283	0.003	0.285	0.451
Post secondary	0.364	0.005	0.485	0.003	0.474	0.499
Age 18-29	0.294	0.005	0.249	0.003	-	-
Age 30-44	0.363	0.005	0.359	0.003	-	-
Age 45-65	0.343	0.005	0.392	0.003	-	-
Age (continuous form)	-	-	-	-	40.158	12.143
Low income	0.047	0.002	0.030	0.001	0.031	0.174
Low middle income	0.150	0.004	0.108	0.002	0.114	0.318
High middle income	0.354	0.005	0.320	0.003	0.321	0.467
High income	0.375	0.005	0.475	0.003	0.465	0.498
Household size	2.900	0.015	3.067	0.008	-	-
Non immigrant	0.897	0.003	0.857	0.002	0.848	0.358
Immigrant	0.103	0.003	0.142	0.002	0.151	0.358
No ban	0.138	0.004	-	-	-	-
Partial ban	0.367	0.005	-	-	-	-
Full ban	0.492	0.006	-	-	-	-
Social support	4.192	0.022	4.014	0.012	4.005	1.916
HUI	0.907	0.002	0.923	0.001	0.922	0.127
Never smoker	-	-	-	-	0.330	0.470
Current smoker	-	-	-	-	0.261	0.439
Former smoker	-	-	-	-	0.407	0.491
Never drinker	-	-	-	-	0.035	0.184
Current drinker	-	-	-	-	0.886	0.317
Former drinker	-	-	-	-	0.076	0.266
Active	-	-	-	-	0.249	0.432
Moderate	-	-	-	-	0.273	0.445
Inactive	-	-	-	-	0.475	0.499
Newfoundland	0.016	0.125	0.016	0.001	0.016	0.125
Prince Edward	0.006	0.001	0.005	0.000	0.004	0.069
Nova Scotia	0.033	0.002	0.030	0.001	0.029	0.170

New Brunswick	0.023	0.002	0.022	0.001	0.023	0.150
Quebec	0.265	0.005	0.257	0.003	0.247	0.431
Ontario	0.369	0.005	0.372	0.003	0.372	0.483
Manitoba	0.035	0.002	0.035	0.001	0.036	0.186
Saskatchewan	0.034	0.002	0.032	0.001	0.031	0.175
Alberta	0.119	0.004	0.109	0.002	0.111	0.314
British Columbia	0.103	0.003	0.116	0.002	0.119	0.324
Mechanical	0.221	0.005	0.191	0.002	0.193	0.395
Trade	0.216	0.005	0.193	0.002	0.200	0.400
Professional	0.123	0.004	0.143	0.002	0.136	0.343
Managerial	0.143	0.004	0.172	0.002	0.172	0.378
Health	0.085	0.003	0.113	0.002	0.112	0.315
Service	0.167	0.004	0.144	0.002	0.143	0.350
Farm	0.040	0.002	0.040	0.001	0.037	0.190
N	7880		27063		28371	

The statistics are weighted using the NPHS sampling weights.

Table 2.4: OLS model for smoking: daily number of cigarette consumption.

	Model 1	Model 2	Model 3
High strain	1.328***	1.154***	1.026***
	(0.278)	(0.276)	(0.274)
Medium strain	0.567**	0.457*	0.379
	(0.254)	(0.254)	(0.254)
Real cigarette tax	-0.047***	-0.046***	-0.028*
	(0.017)	(0.017)	(0.017)
Trend	-0.121**	-0.128***	-0.191***
	(0.048)	(0.049)	(0.047)
Male	2.821***	2.781***	2.717***
	(0.300)	(0.296)	(0.306)
Married	0.339	0.288	0.309
	(0.337)	(0.337)	(0.335)
Separated	2.010***	1.919***	1.973***
	(0.493)	(0.484)	(0.487)
Less secondary	2.019***	1.951***	1.773***
	(0.440)	(0.435)	(0.445)
Secondary	0.352	0.310	0.231
	(0.433)	(0.432)	(0.430)
Post secondary	-0.608*	-0.642*	-0.621*
	(0.356)	(0.350)	(0.349)
Age 30-44	3.190***	3.202***	3.183***
	(0.338)	(0.338)	(0.340)
Age 45-65	5.064***	5.069***	4.957***
	(0.404)	(0.401)	(0.404)
Low income	0.531	0.460	0.205
	(0.475)	(0.470)	(0.476)
Low middle income	0.758**	0.837***	0.624**
	(0.307)	(0.305)	(0.312)
High income	-0.900***	-0.828***	-0.616**
	(0.290)	(0.284)	(0.285)
Household size	-0.126	-0.123	-0.105
	(0.112)	(0.111)	(0.111)
Immigrant	-2.878***	-2.887***	-2.638***
	(0.594)	(0.593)	(0.597)
Partial ban	-1.864***	-1.901***	-1.817***
	(0.392)	(0.392)	(0.397)
Full ban	-3.349***	-3.441***	-3.347***
	(0.399)	(0.403)	(0.415)
Social support		0.157***	0.094
		(0.058)	(0.058)
HUI			-4.649***

			(0.922)
Newfoundland			0.353
			(0.914)
Prince Edward			1.642**
			(0.731)
Nova Scotia			0.671
			(0.765)
New Brunswick			1.788**
			(0.813)
Quebec			1.552**
			(0.625)
Ontario			0.474
			(0.612)
Manitoba			0.680
			(0.780)
Saskatchewan			1.152
			(0.725)
Alberta			0.696
			(0.619)
Mechanical			-0.047
			(0.647)
Trade			0.103
			(0.664)
Professional			-0.877
			(0.714)
Managerial			-0.456
			(0.694)
Health			-0.452
			(0.750)
Service			-0.018
			(0.666)
Observations	7880	7763	7696

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Model 1 presents the baseline specification. An additional covariate, workplace social support, is added in model 2. In model 3, we add individual's health status (HUI), province of residence and occupational fixed effects.

Table 2.5. Latent class model for smoking: daily number of cigarette consumption.

	Model 1		Model 2		Model 3	
	Comp1	**comp2**	**comp1**	**Comp2**	**Comp1**	**Comp2**
High strain	0.116***	0.016	0.111***	0.002	0.102***	-0.009
	(0.027)	(0.033)	(0.027)	(0.033)	(0.028)	(0.031)
Medium strain	0.061**	-0.007	0.056**	-0.013	0.045	-0.013
	(0.027)	(0.026)	(0.027)	(0.026)	(0.027)	(0.026)
Real cigarette tax	-0.002	-0.004*	-0.003	-0.004*	-0.002	-0.0003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Trend	-0.013**	-0.0001	-0.013**	-0.001	-0.017***	-0.009
	(0.005)	(0.006)	(0.005)	(0.006)	(0.005)	(0.006)
Male	0.144***	0.221***	0.141***	0.221***	0.132***	0.214***
	(0.036)	(0.073)	(0.034)	(0.060)	(0.033)	(0.063)
Married	0.029	0.008	0.025	0.002	0.001	0.042
	(0.038)	(0.043)	(0.038)	(0.041)	(0.037)	(0.051)
Separated	0.169***	0.066	0.164***	0.064	0.150***	0.099**
	(0.049)	(0.048)	(0.049)	(0.050)	(0.047)	(0.049)
Less secondary	0.177***	0.059	0.177***	0.048	0.160***	0.030
	(0.043)	(0.044)	(0.043)	(0.044)	(0.044)	(0.050)
Secondary	0.028	0.056	0.024	0.052	0.009	0.052
	(0.042)	(0.052)	(0.042)	(0.051)	(0.042)	(0.057)
Post secondary	-0.102***	0.043	-0.104***	0.036	-0.096***	0.037
	(0.037)	(0.042)	(0.037)	(0.041)	(0.036)	(0.045)
Age 30-44	0.261***	0.234***	0.265***	0.230***	0.271***	0.212***
	(0.039)	(0.058)	(0.039)	(0.048)	(0.039)	(0.055)
Age 45-65	0.385***	0.322***	0.389***	0.321***	0.392***	0.281***
	(0.045)	(0.051)	(0.045)	(0.049)	(0.045)	(0.057)
Low income	0.048	0.063	0.051	0.043	0.015	0.048
	(0.048)	(0.075)	(0.048)	(0.076)	(0.049)	(0.079)
Low middle income	0.072**	0.020	0.081***	0.020	0.057*	0.017
	(0.031)	(0.028)	(0.031)	(0.028)	(0.030)	(0.029)
High income	-0.085***	-0.023	-0.078**	-0.031	-0.057*	-0.018
	(0.031)	(0.030)	(0.031)	(0.029)	(0.030)	(0.036)
Household size	-0.011	-0.003	-0.011	-0.003	-0.008	-0.006
	(0.012)	(0.011)	(0.012)	(0.011)	(0.012)	(0.011)
Immigrant	-0.296***	-0.008	-0.300***	-0.024	-0.273***	-0.057
	(0.057)	(0.109)	(0.058)	(0.102)	(0.061)	(0.089)
Partial ban	-0.103***	-0.100***	-0.106***	-0.100***	-0.102***	-0.081**
	(0.035)	(0.031)	(0.036)	(0.031)	(0.036)	(0.036)
Full ban	-0.250***	-0.137***	-0.255***	-0.148***	-0.244***	-0.141***
	(0.037)	(0.045)	(0.038)	(0.039)	(0.038)	(0.048)
Social support			0.007	0.015**	0.004	0.011
			(0.006)	(0.006)	(0.006)	(0.006)
HUI					-0.274***	-0.224*
					(0.091)	(0.124)
Newfoundland					0.044	0.006

					(0.089)	(0.162)
Prince Edward					0.119	0.128
					(0.075)	(0.118)
Nova Scotia					0.011	0.147
					(0.077)	(0.102)
New Brunswick					0.209***	-0.002
					(0.079)	(0.130)
Quebec					0.076	0.215**
					(0.067)	(0.105)
Ontario					0.010	0.127
					(0.065)	(0.110)
Manitoba					-0.018	0.174
					(0.080)	(0.130)
Saskatchewan					0.075	0.070
					(0.076)	(0.113)
Alberta					0.063	0.059
					(0.066)	(0.112)
Mechanical					0.019	-0.059
					(0.069)	(0.050)
Trade					0.014	-0.018
					(0.060)	(0.051)
Professional					-0.090	-0.034
					(0.071)	(0.071)
Managerial					-0.081	0.050
					(0.066)	(0.057)
Health					-0.076	0.026
					(0.072)	(0.097)
Service					-0.001	-0.016
					(0.064)	(0.056)
π_1	0.729 (0.056)	0.271	0.722 (0.044)	0.278	0.746 (0.056)	0.254
Observations	7880	7880	7763	7763	7696	7696

Robust standard errors in parentheses; π_1 stands for the probability that an observation is in comp1; *** p<0.01, ** p<0.05, * p<0.1. Model 1 presents the baseline specification. An additional covariate, workplace social support, is added in model 2. In model 3, we add individual's health status (HUI), province of residence and occupational fixed effects.

Table 2.6. OLS model for daily alcohol consumption.

	Model 1	**Model 2**	**Model 3**
High strain	0.007	-0.007	-0.010
	(0.014)	(0.014)	(0.014)
Medium strain	0.031**	0.020	0.019
	(0.015)	(0.016)	(0.016)
Trend	0.010***	0.009***	0.009***
	(0.002)	(0.002)	(0.002)
Male	0.485***	0.480***	0.462***
	(0.012)	(0.012)	(0.013)
Married	-0.142***	-0.137***	-0.122***
	(0.018)	(0.018)	(0.018)
Separated	0.012	0.017	0.018
	(0.024)	(0.025)	(0.025)
Less secondary	-0.034	-0.027	-0.038
	(0.024)	(0.024)	(0.025)
Secondary	0.041*	0.051**	0.041*
	(0.022)	(0.022)	(0.022)
Post secondary	-0.040***	-0.044***	-0.034**
	(0.014)	(0.014)	(0.014)
Age 30-44	-0.113***	-0.120***	-0.116***
	(0.018)	(0.019)	(0.019)
Age 45-65	-0.099***	-0.112***	-0.106***
	(0.020)	(0.020)	(0.020)
Low income	0.013	0.008	0.001
	(0.033)	(0.034)	(0.034)
Low middle income	-0.007	-0.018	-0.023
	(0.020)	(0.020)	(0.020)
High income	0.178***	0.178***	0.172***
	(0.013)	(0.014)	(0.014)
Household size	-0.021***	-0.020***	-0.022***
	(0.005)	(0.005)	(0.005)
Immigrant	-0.147***	-0.140***	-0.173***
	(0.017)	(0.017)	(0.018)
Social support		0.009**	0.008**
		(0.004)	(0.004)
HUI			-0.075
			(0.052)
Newfoundland			-0.024
			(0.032)
Prince Edward			-0.099***
			(0.033)
Nova Scotia			-0.116***

			(0.029)
New Brunswick			-0.082***
			(0.030)
Quebec			-0.053**
			(0.023)
Ontario			0.012
			(0.023)
Manitoba			-0.053*
			(0.030)
Saskatchewan			-0.060**
			(0.031)
Alberta			-0.093***
			(0.025)
Mechanical			0.088***
			(0.033)
Trade			0.013
			(0.032)
Professional			0.022
			(0.032)
Managerial			0.020
			(0.031)
Health			-0.068**
			(0.031)
Service			0.143***
			(0.034)
Observations	27063	25637	25472

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Model 1 presents the baseline specification. An additional covariate, workplace social support, is added in model 2. In model 3, we add individual's health status (HUI), province of residence and occupational fixed effects.

Table 2.7. Latent class model for daily alcohol consumption.

	Model 1		Model 2		Model 3	
	Comp1	**comp2**	**comp1**	**Comp2**	**comp1**	**comp2**
High strain	-0.041	0.131***	-0.067**	0.112**	-0.063**	0.092*
	(0.028)	(0.050)	(0.029)	(0.056)	(0.030)	(0.049)
Medium strain	0.028	0.108**	0.005	0.010*	0.002	0.099*
	(0.028)	(0.051)	(0.029)	(0.054)	(0.030)	(0.055)
Trend	0.014***	0.020**	0.012***	0.018**	0.013***	0.018**
	(0.004)	(0.008)	(0.004)	(0.008)	(0.004)	(0.008)
Male	0.852***	0.966***	0.835***	0.949***	0.785***	0.899***
	(0.027)	(0.054)	(0.028)	(0.056)	(0.031)	(0.061)
Married	-0.198***	-0.205***	-0.188***	-0.197***	-0.157***	-0.186***
	(0.032)	(0.063)	(0.032)	(0.065)	(0.034)	(0.061)
Separated	0.003	0.097	0.004	0.102	0.022	0.057
	(0.045)	(0.072)	(0.046)	(0.076)	(0.047)	(0.076)
Less secondary	-0.161***	0.008	-0.136***	0.004	-0.150***	-0.035
	(0.047)	(0.064)	(0.048)	(0.066)	(0.050)	(0.066)
Secondary	-0.0001	0.123*	0.014	0.147**	0.012	0.097
	(0.040)	(0.065)	(0.040)	(0.066)	(0.042)	(0.061)
Post secondary	0.026	-0.270***	0.016	-0.273***	0.036	-0.241***
	(0.028)	(0.055)	(0.029)	(0.056)	(0.030)	(0.055)
Age 30-44	-0.178***	-0.217***	-0.192***	-0.213***	-0.183***	-0.196***
	(0.034)	(0.055)	(0.034)	(0.056)	(0.035)	(0.056)
Age 45-65	-0.010***	-0.236***	-0.121***	-0.251***	-0.105***	-0.209***
	(0.036)	(0.067)	(0.037)	(0.070)	(0.038)	(0.069)
Low income	0.023	0.056	0.022	0.058	0.017	0.101
	(0.075)	(0.105)	(0.076)	(0.112)	(0.078)	(0.117)
Low middle income	-0.122***	0.153***	-0.130***	0.116**	-0.141***	0.110**
	(0.046)	(0.057)	(0.048)	(0.058)	(0.049)	(0.056)
High income	0.408***	0.150***	0.410***	0.144***	0.406***	0.131**
	(0.028)	(0.053)	(0.029)	(0.055)	(0.031)	(0.053)
Household size	-0.036***	-0.053***	-0.034***	-0.053**	-0.036***	-0.067***
	(0.011)	(0.020)	(0.011)	(0.021)	(0.011)	(0.017)
Immigrant	-0.240***	-0.336***	-0.226***	-0.307***	-0.258***	-0.365***
	(0.044)	(0.092)	(0.045)	(0.097)	(0.051)	(0.111)
Social support			-6.09e-05	0.030**	-0.002	0.027**
			(0.007)	(0.012)	(0.007)	(0.013)
HUI					0.177*	-0.340**
					(0.107)	(0.146)
Newfoundland					-0.043	-0.037
					(0.064)	(0.135)
Prince Edward					-0.307***	0.028
					(0.075)	(0.158)
Nova Scotia					-0.309***	-0.062
					(0.069)	(0.116)
New Brunswick					-0.203***	-0.126

					(0.067)	(0.118)
Quebec					-0.074	-0.061
					(0.046)	(0.109)
Ontario					-0.101**	0.192*
					(0.044)	(0.102)
Manitoba					-0.186***	0.090
					(0.064)	(0.120)
Saskatchewan					-0.192***	0.103
					(0.061)	(0.141)
Alberta					-0.302***	0.071
					(0.052)	(0.109)
Mechanical					0.094	0.132
					(0.059)	(0.084)
Trade					0.012	-0.004
					(0.060)	(0.086)
Professional					0.106*	-0.165
					(0.064)	(0.100)
Managerial					0.062	-0.074
					(0.061)	(0.093)
Health					-0.234***	-0.321**
					(0.074)	(0.132)
Service					0.237***	0.197**
					(0.063)	(0.095)
π_1	0.905 (0.010)	0.095	0.903 (0.011)	0.097	0.890 (0.013)	0.11
Observations	27063	27063	25637	25637	25472	25472

Robust standard errors in parentheses; π_1 stands for the probability that an observation is in comp1; *** p<0.01, ** p<0.05, * p<0.1. Model 1 presents the baseline specification. An additional covariate, workplace social support, is added in model 2. In model 3, we add individual's health status (HUI), province of residence and occupational fixed effects.

Table 2.8. The effect of job strain on BMI- cross sectional OLS results.

	Model 1	**Model 1**	**Model 3**	**Model 4**
High strain	0.708***	0.719***	0.577***	0.570***
	(0.121)	(0.119)	(0.116)	(0.115)
Medium strain	0.255***	0.258***	0.218**	0.220**
	(0.096)	(0.097)	(0.095)	(0.095)
Male	1.643***	1.644***	1.662***	1.618***
	(0.134)	(0.134)	(0.133)	(0.134)
Married	0.338*	0.337*	0.328*	0.307*
	(0.173)	(0.173)	(0.173)	(0.172)
Separated	0.108	0.107	0.046	0.043
	(0.254)	(0.254)	(0.253)	(0.253)
Age	0.297***	0.298***	0.296***	0.298***
	(0.033)	(0.033)	(0.033)	(0.033)
Age square	-0.003***	-0.003***	-0.003***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
Less secondary	0.222	0.223	0.235	0.204
	(0.229)	(0.229)	(0.229)	(0.230)
Secondary	-0.005	-0.006	-0.056	-0.084
	(0.205)	(0.205)	(0.203)	(0.203)
Post secondary	-0.409***	-0.409***	-0.369**	-0.359**
	(0.146)	(0.146)	(0.146)	(0.150)
Low income	-0.061	-0.060	-0.186	-0.175
	(0.261)	(0.261)	(0.256)	(0.259)
Low middle income	0.036	0.036	-0.003	-0.015
	(0.145)	(0.145)	(0.142)	(0.142)
High income	-0.130	-0.130	-0.132	-0.120
	(0.107)	(0.107)	(0.107)	(0.106)
Immigrant	-0.792***	-0.792***	-0.850***	-0.832***
	(0.191)	(0.191)	(0.200)	(0.202)
Current smoker	-0.556***	-0.554***	-0.580***	-0.582***
	(0.164)	(0.164)	(0.163)	(0.164)
Former smoker	0.373***	0.373***	0.372***	0.367***
	(0.135)	(0.135)	(0.134)	(0.135)
Current drinker	0.483*	0.485*	0.527**	0.558**
	(0.257)	(0.257)	(0.255)	(0.254)
Former drinker	1.043***	1.044***	0.976***	0.995***
	(0.294)	(0.294)	(0.291)	(0.290)
Active	-0.686***	-0.687***	-0.675***	-0.678***
	(0.119)	(0.119)	(0.119)	(0.119)
Moderate	-0.228**	-0.229**	-0.200**	-0.203**
	(0.101)	(0.101)	(0.099)	(0.098)
Year_2002	0.239***	0.240***	0.215***	0.217***
	(0.062)	(0.062)	(0.063)	(0.063)

Year_2004	0.366***	0.365***	0.322***	0.319***
	(0.071)	(0.071)	(0.070)	(0.071)
Year_2006	0.631***	0.631***	0.603***	0.607***
	(0.083)	(0.083)	(0.083)	(0.084)
Year_2008	0.811***	0.809***	0.781***	0.786***
	(0.096)	(0.096)	(0.096)	(0.096)
Social support		-0.012	0.008	0.005
		(0.025)	(0.025)	(0.025)
Health utility index			-2.085***	-2.069***
			(0.440)	(0.440)
Newfoundland			0.646**	0.627**
			(0.255)	(0.254)
Prince Edward			0.470*	0.448
			(0.276)	(0.275)
Nova Scotia			0.833***	0.820***
			(0.289)	(0.290)
New Brunswick			0.928***	0.921***
			(0.283)	(0.282)
Quebec			-0.622***	-0.624***
			(0.169)	(0.169)
Ontario			0.217	0.221
			(0.176)	(0.175)
Manitoba			0.770***	0.747***
			(0.284)	(0.285)
Saskatchewan			1.161***	1.156***
			(0.331)	(0.330)
Mechanical				-0.152
				(0.269)
Trade				0.037
				(0.263)
Professional				-0.520*
				(0.278)
Managerial				-0.051
				(0.269)
Health				-0.272
				(0.298)
Service				-0.500*
				(0.279)
Observations	28371			

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. All the estimations (except the random effect which is not supported by weight in Stata) are weighted using the NPHS sampling weights. Model 1 presents the baseline specification. An additional covariate, workplace social support, is added in model 2. In model 3, we add individual's health status (HUI) and province of residence. In model 4 we add occupational fixed effects.

Table 2.9.The effect of job strain on BMI- fixed effects results

	Model 1	**Model 1**	**Model 3**	**Model 4**
High strain	0.001	-0.0004	0.004	0.006
	(0.046)	(0.046)	(0.046)	(0.046)
Medium strain	0.020	0.020	0.024	0.025
	(0.043)	(0.043)	(0.042)	(0.042)
Age	0.089	0.089	0.096	0.092
	(0.075)	(0.075)	(0.075)	(0.075)
Age square	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Married	0.469***	0.470***	0.477***	0.482***
	(0.096)	(0.096)	(0.096)	(0.096)
Separated	-0.005	-0.004	-0.004	-0.0004
	(0.137)	(0.137)	(0.136)	(0.136)
Less secondary	-0.329	-0.331	-0.329	-0.329
	(0.313)	(0.312)	(0.313)	(0.314)
Secondary	-0.345	-0.346	-0.366*	-0.370*
	(0.222)	(0.221)	(0.221)	(0.221)
Post secondary	0.035	0.035	0.035	0.031
	(0.092)	(0.092)	(0.092)	(0.093)
Low income	-0.200	-0.201	-0.191	-0.183
	(0.147)	(0.147)	(0.146)	(0.145)
Low middle income	-0.028	-0.028	-0.036	-0.032
	(0.073)	(0.073)	(0.073)	(0.073)
High income	0.032	0.032	0.035	0.035
	(0.051)	(0.051)	(0.051)	(0.051)
Current smoker	-0.573***	-0.573***	-0.580***	-0.578***
	(0.129)	(0.129)	(0.129)	(0.129)
Former smoker	-0.073	-0.073	-0.078	-0.078
	(0.098)	(0.098)	(0.098)	(0.098)
Current drinker	-0.028	-0.028	-0.027	-0.027
	(0.185)	(0.185)	(0.185)	(0.186)
Former drinker	0.095	0.095	0.095	0.092
	(0.160)	(0.161)	(0.161)	(0.162)
Active	-0.263***	-0.263***	-0.261***	-0.257***
	(0.058)	(0.058)	(0.058)	(0.058)
Moderate	-0.089*	-0.089*	-0.089*	-0.089*
	(0.046)	(0.046)	(0.046)	(0.046)
Year_2002	0.398***	0.398***	0.375***	0.376***
	(0.140)	(0.140)	(0.142)	(0.143)
Year_2004	0.669**	0.668**	0.630**	0.633**
	(0.275)	(0.275)	(0.279)	(0.280)
Year_2006	1.081***	1.081***	1.025**	1.029**

	(0.410)	(0.410)	(0.415)	(0.417)
Year_2008	1.416***	1.416***	1.344**	1.347**
	(0.547)	(0.547)	(0.554)	(0.556)
Social support		0.003	0.002	0.002
		(0.011)	(0.011)	(0.011)
Health utility index			-0.284	-0.285
			(0.185)	(0.184)
Newfoundland			-0.800*	-0.793*
			(0.410)	(0.415)
Prince Edward			-0.273	-0.285
			(0.316)	(0.318)
Nova Scotia			0.402	0.415
			(0.320)	(0.323)
New Brunswick			0.243	0.251
			(0.386)	(0.387)
Quebec			1.178**	1.160**
			(0.520)	(0.520)
Ontario			-0.137	-0.165
			(0.304)	(0.306)
Manitoba			0.183	0.182
			(0.453)	(0.455)
Saskatchewan			-0.308	-0.314
			(0.374)	(0.375)
Mechanical				-0.141
				(0.144)
Trade				-0.205
				(0.147)
Professional				0.062
				(0.155)
Managerial				-0.187
				(0.152)
Health				-0.254
				(0.189)
Service				-0.160
				(0.155)
Observations	28371			

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. all the estimations (except the random effect which is not supported by weight in Stata) are weighted using the NPHS sampling weights. Model 1 presents the baseline specification. An additional covariate, workplace social support, is added in model 2. In model 3, we add individual's health status (HUI) and province of residence. In model 4 we add occupational fixed effects.

Table 2.10.The effect of job strain on BMI- random effects results

	Model 1	**Model 1**	**Model 3**	**Model 4**
High strain	0.045	0.039	0.029	0.0316
	(0.036)	(0.036)	(0.036)	(0.036)
Medium strain	0.018	0.015	0.011	0.013
	(0.033)	(0.033)	(0.033)	(0.033)
Age	0.240***	0.240***	0.241***	0.238***
	(0.018)	(0.018)	(0.018)	(0.018)
Age square	-0.002***	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Male	1.318***	1.317***	1.332***	1.318***
	(0.097)	(0.097)	(0.096)	(0.098)
Married	0.328***	0.328***	0.325***	0.325***
	(0.075)	(0.075)	(0.075)	(0.075)
Separated	-0.110	-0.110	-0.112	-0.110
	(0.107)	(0.107)	(0.107)	(0.107)
Less secondary	0.089	0.088	0.090	0.087
	(0.136)	(0.136)	(0.136)	(0.136)
Secondary	-0.016	-0.017	-0.043	-0.043
	(0.123)	(0.123)	(0.122)	(0.122)
Post secondary	-0.047	-0.046	-0.036	-0.040
	(0.063)	(0.063)	(0.063)	(0.064)
Low income	-0.103	-0.103	-0.113	-0.111
	(0.096)	(0.096)	(0.096)	(0.096)
Low middle income	0.015	0.016	0.008	0.009
	(0.057)	(0.057)	(0.057)	(0.057)
High income	-0.042	-0.042	-0.041	-0.044
	(0.040)	(0.040)	(0.040)	(0.040)
Immigrant	-1.158***	-1.158***	-1.137***	-1.124***
	(0.150)	(0.150)	(0.155)	(0.155)
Current smoker	-0.548***	-0.549***	-0.543***	-0.544***
	(0.082)	(0.083)	(0.083)	(0.083)
Former smoker	0.044	0.045	0.050	0.050
	(0.066)	(0.066)	(0.066)	(0.066)
Current drinker	0.208*	0.208*	0.213*	0.212*
	(0.111)	(0.111)	(0.111)	(0.111)
Former drinker	0.240**	0.241**	0.234**	0.235**
	(0.108)	(0.108)	(0.108)	(0.108)
Active	-0.420***	-0.420***	-0.418***	-0.419***
	(0.041)	(0.041)	(0.042)	(0.042)
Moderate	-0.148***	-0.148***	-0.146***	-0.147***
	(0.034)	(0.035)	(0.035)	(0.035)
Year_2002	0.236***	0.236***	0.235***	0.235***
	(0.035)	(0.035)	(0.035)	(0.035)

Yearr_2004	0.309***	0.310***	0.307***	0.308***
	(0.039)	(0.039)	(0.039)	(0.039)
Yearr_2006	0.532***	0.532***	0.531***	0.533***
	(0.046)	(0.046)	(0.046)	(0.046)
Year_2008	0.675***	0.677***	0.676***	0.677***
	(0.054)	(0.054)	(0.054)	(0.054)
Social support		0.010	0.012	0.012
		(0.009)	(0.008)	(0.009)
Health utility index			-0.382**	-0.380**
			(0.148)	(0.149)
Newfoundland			0.108	0.109
			(0.194)	(0.194)
Prince Edward			0.130	0.131
			(0.193)	(0.193)
Nova Scotia			0.374*	0.374*
			(0.202)	(0.202)
New Brunswick			0.463**	0.469**
			(0.198)	(0.198)
Quebec			-0.850***	-0.841***
			(0.148)	(0.148)
Ontario			-0.118	-0.108
			(0.133)	(0.132)
Manitoba			0.374**	0.373**
			(0.184)	(0.183)
Saskatchewan			0.232	0.228
			(0.185)	(0.185)
Mechanical				-0.266**
				(0.118)
Trade				-0.221*
				(0.118)
Professional				-0.234*
				(0.125)
Managerial				-0.167
				(0.123)
Health				-0.262*
				(0.141)
Service				-0.356***
				(0.120)
Observations	28371			

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. all the estimations (except the random effect which is not supported by weight in Stata) are weighted using the NPHS sampling weights. Model 1 presents the baseline specification. An additional covariate, workplace social support, is added in model 2. In model 3, we add individual's health status (HUI) and province of residence. In model 4 we add occupational fixed effects.

Essay 3

Fruits and vegetables consumption and body mass index: A quantile regression approach

Abstract

Empirical evidence on the relationship between fruits and vegetables (FV) consumption and body weight is inconclusive. Previous studies mostly used linear regression methods to study the correlates of the conditional mean of the body mass index (BMI). This approach may be less informative if the association between FV consumption and the BMI significantly varies across the BMI distribution. The association between FV consumption and the BMI was examined using quantile regression. A nationally representative sample of 11,818 individuals from the Canadian Community Health Survey (2004) was used. A quantile regression model was estimated in order to account for the potential heterogeneous association between FV intake and the BMI at different points of the conditional BMI distribution. The analyses were stratified by gender. The multivariate analyses revealed that the association between FV consumption and the BMI was negative and statistically significant for both males and females; however, this association varied across the conditional quantiles of the BMI distribution. In particular, the estimates were larger for individuals at the higher quantiles of the distribution. The OLS model overstated (understated) the association between FV intake and the BMI at the lower (higher) half of the conditional BMI distribution. Findings of the standard models that assume uniform response across different quantiles of the BMI distribution may be misleading. The findings of this study suggest that increasing the consumption of FV may be an effective dietary strategy to control weight and mitigate the risk of obesity.

3.1. Introduction

The dramatic rise in obesity prevalence and its well documented adverse effects have become a challenging issue for policy makers and academics over the last two decades. An individual is classified as obese when the body mass index (BMI) equals 30 or more (BMI is calculated as weight in kilograms divided by height in meters squared). Over one billion individuals worldwide are overweight, with about 300 million obese (World Health Organization, 2011). Obesity is a precursor of many chronic diseases (e.g. cardiovascular disease, type 2 diabetes, hypertension, liver disease, as well as certain types of cancer) (Hu, 2008). Obese individuals were more likely to report poor self-rated health (MacMinn et al., 2007). In addition, obesity may cause psychological disorders through societal prejudice and discrimination against obese individuals (Wadden et al., 2002; Cawley, 2004). Research on the relationship between body weight and labor outcomes have shown that obese individuals were more likely to have lower earnings and have lower odds of finding a job particularly for females (Cawley, 2004).

Moreover, the economic cost attributable to overweight and obesity is substantial (Katzmarzyk and Janssen, 2004; Finkelstein et al., 2005; Society of Actuaries, 2011). For example, a recent study estimated that the total economic cost of overweight and obesity in the US is $270 billion yearly and the cost in Canada is $30 billion yearly (Society of Actuaries, 2011). There has been remarkable increase in the prevalence of obesity in Canada, the adult obesity prevalence rate almost doubled from 13.8% in 1978 to 23.1% in 2004 (Tjepkema, 2006). This has been confirmed by an increase in the average BMI of Canadian adults from 25.2 in 1994 to 26.5 in 2008.

Several studies have argued that technological innovations may have contributed to increase body weight through a reduction in food prices, as well as the promotion of sedentary behaviors (Bleich et al., 2008; Asfaw, 2011; Lakdawalla and Philipson, 2009; Auld and Powell, 2009; Cutler et al., 2003). For example, using a series of cross-sectional data in a multi-country analysis, Bleich et al., 2008 examined the relative impact of calorie intake and energy expenditure on the rising obesity epidemic among developed countries. The authors found that the rise in obesity rates was mainly due to the increased in calorie intake. They also suggested that "the shift toward increased calorie intake is associated with technological innovations such as reduced food prices as well as changing socio-demographic factors such as increased urbanization and increased female labor force participation" (Bleich et al., 2008, pg. 291). Using generalized method of moments, Asfaw (2011) examined the relation between processed food and obesity among Guatemalans and found that the risk of obesity and overweight was directly related to household expenditure on highly and partially processed foods. Cutler et al. (2003) provided suggestive evidence that technological innovations in food processing by manufacturers have exacerbated obesity growth. According to the authors, individuals have increased food consumption as a result of lower time costs of preparing food at home. Anderson et al. (2003) found that the increased in the percentage of females' participation in the labor force have contributed to increase in child obesity.

The World Health Organization (WHO) (2003) together with empirical studies has linked individual's diet and nutrition behavior including the consumption of fruits and vegetables (FV) to the global rise in obesity[12]. The health benefits of adequate consumption of FV daily (5 servings or a minimum of 400 grams) are enormous (WHO,

[12] For a systematic review of the literature see Rolls et al., 2004; Tohill et al., 2004.

2003; Bazzano, 2006). Inadequate consumption of FV has been linked to about 2.7 million deaths per year worldwide, 19% of gastrointestinal cancers, 31% of ischemic heart diseases and 11% of strokes (WHO, 2002 & 2003).

The rising obesity rate in Canada has been accompanied by increasingly poor eating behavior among Canadians. According to Health Canada, Canadian eating habits do not fully meet Canada's food guide to healthy eating. A significant proportion of the Canadian population aged 12 and older reported consuming FV less than 5 times per day (Statistics Canada, 2010). For example, during the period 2003-2010, about half of Canadian females and more than 60% of males consumed FV less than five times per day (see Figure 3.1). It is assumed that the frequency of FV consumption is equal to serving hence consuming FV less than 5 times per day is below the recommended level (Riediger and Moghadasian, 2008). Whereas in the US, more than two third of adults consumed fruits less than two times per day and three quarters consumed vegetables less than three times per day in 2009 (Center for Disease Control and Prevention, 2010).

'Insert Figure 3.1 about here'

High intake of FV may help in reducing the risk of obesity because most FV are high in water and fiber content and low in fat content (Rolls et al., 2004). Thus, adding FV to the diet enhances satiety, reduces feelings of deprivation and hunger, and reduces energy intake (Rolls et al., 2004). There is mixed empirical evidence about the association between FV intake and body weight in both clinical (Rolls et al., 2004) and epidemiologic studies (Tohill et al., 2004). In some studies, body weight was negatively associated with the intake of FV (He et al., 2004; Newby et al., 2003), while other studies found no significant association (Field et al., 2003; Smit-Warner et al., 2000; Patterson et

al., 1990). For example, using a sample of children and adolescents in the United States, Field et al. (2003) found that the intake of FV or juice is not related to changes in BMI during three years of follow-up. In a prospective cohort study among middle-aged women, He et al. (2004) found that the higher the consumption of FV over time, the lower the risk of obesity and weight gain. Using a sample of participants in the Baltimore Longitudinal Study of Aging, Newby et al. (2003) found that consuming a diet rich in FV and low in fat, dairy, whole grains, meat, fast food, and soda is associated with smaller gains in BMI and waist circumference.

Recently, several studies have examined the indirect effect of FV on the BMI through its prices. For example, using repeated cross-sectional US data; Auld and Powell (2009) found that the prices of FV were positively associated with adolescents' BMI. They also found that a decrease in the relative price of FV (a proxy for low energy-dense foods) tends to reduce the BMI, if the price per calorie of less energy-dense foods is lower than those of high energy dense food. Sturm and Datar (2005) found that lower real prices for FV predict a significantly lower gain in BMI between kindergarten and third grade. Some studies reported that there are gender differences in eating patterns and report how these affect body weight (Wirfalt et al., 1997; Wirfalt and Jeffery, 2001). Baker and Wardle (2003) found that men consume fewer servings of FV daily than women. They attributed this to poorer nutrition knowledge of men relative to women. They also found that men were less likely to know the healthy recommendations for FV intake, and the benefits of FV consumption for disease prevention.

The objective of this study was to examine the association between FV intake and body weight along different points of the BMI distribution using data from the Canadian

Community Health Survey (CCHS). The key contribution of this study is twofold. First, most of the previous studies reported only the bivariate association between the intake of FV and BMI, without controlling for confounding factors like socio-demographic and lifestyle (such as physical activity and smoking status) which have been shown to be important determinants of individual BMI (Tohill et al., 2004). Second, previous multivariate studies mostly used linear regression methods to examine the correlates of the conditional mean of BMI. This approach may be less informative if the association between the intake of FV and the BMI significantly varies across the BMI distribution. Moreover, logistic regression treats observations that exceed a particular cut off level equally. For example two individuals with a BMI of 40 and 30 are equally classified as being obese, notwithstanding the intensity of obesity for the first person is higher. This leads to a statistical loss of information that may be relevant for intervention measures. Individuals may respond differently to the factors causing obesity, depending on their location in the BMI distribution.

Accordingly, this study used a quantile regression framework to characterize the heterogeneous association across the different quantiles of the BMI distribution. This is relevant to the nutrition and obesity literature where attention is given to certain segments of the BMI distributions. For example, individuals in the upper quantiles of the BMI distribution, both obese and overweight, are of more interest to policies aimed at reducing obesity. Standard linear regressions, like OLS, estimate the effect of different covariates on the conditional mean of the BMI. This average effect may over or under estimate the influence of the covariates at different points across the BMI distribution and hence may lead to misleading policy inferences.

3.2. Data

This study used data from the Statistics Canada 2004 Canadian Community Health Survey (CCHS) cycle 2.2. The CCHS is a nationally representative cross-sectional survey of the Canadian population and it collects important information related to health status, health care utilization and other determinants of health. The survey excludes those living on Indian Reserves and Crown Lands, institutional residents, full-time members of the Canadian forces, and residents of certain remote regions. 45,889 households were selected to participate in Cycle 2.2 of the CCHS. However, a national response rate of 76.5% was achieved. Data were collected in person (93%) and about 7% of respondents had their first 24-hour dietary recall interview completed over the telephone. The nutrition questionnaire of the CCHS consists of two components: general health and 24-hour dietary recall. The general health component had information about socio-demographic characteristics of respondents, their height and weight, physical activity, and chronic health conditions. The 24-hour dietary recall component had information about all the food and beverages a respondent consumed during the 24 hours preceding the interview. A second dietary recall interview was conducted 3 to 10 days after the initial interview. We restricted the sample to those aged 14-65 years, and after excluding missing observations, the sample includes 11,818 individuals. Seniors (aged 65+) tend to have a low BMI due to ageing rather than dietary choice.[13] The eating behavior of children is largely affected by their parental background. Accordingly, we restricted our sample to those aged 14-65 so as to minimize factors that may bias our results.

[13] In a different specification, we restricted the age to those aged 20-65 and similar results were obtained.

The BMI, which is the dependent variable, was derived from the measured anthropometric information (height and weight) available in the CCHS. The BMI was calculated as body weight in kilograms divided by height in meters squared. The merit of using the 2004 CCHS cycle 2.2 is that the BMI was based on a respondent's actual (measured) weight and height. This was done personally by the interviewer.[14] This study followed the standard in the literature by using a set of covariates that has been shown to be potential determinants of the BMI. The independent variable of interest is an individual's FV consumption. This variable indicates the total number of times per day the respondent consumes FV. Other individual socio-demographic and lifestyle variables were also included in the analysis. Age was represented in three categories: 14-30 (reference group), 31 to 50, and 51 to 65. Gender is captured by a dummy variable (male =0, female = 1). Marital status was represented in three categories: married, separated and single (reference group). Individual's educational attainment was represented in four categories: less than secondary, secondary, some post secondary (reference group), and post secondary. Household income was represented in four categories: less than $30,000 (reference group), $30,000 to $49,999, $50,000 to $79,999 and $80,000 or more. A dummy variable indicating individual social interaction (sense of belonging to a local community) was included (strong =1, weak = 0). Individual physical activity level was represented by three categories: active, moderate, and inactive (reference group). This classification was based on the total daily energy expenditure values (kcal/kg/day) on leisure-time physical activities. The daily energy expenditure for each activity was measured using the frequency, duration per session and the metabolic energy cost of the activity. An individual was classified as physically active if the total daily energy

[14] For detailed information about the CCHS, see Statistics Canada, 2005.

expenditure was greater than 3, as moderately active if the total daily energy expenditure was greater than 1.5 and less than 3 and inactive otherwise. For more information see (Statistics Canada, 2005). Smoking status was classified as: never smoker (reference group), current smoker, and former smoker. Immigration status was captured by a dummy variable (immigrant = 1, non-immigrant = 0). Provincial or regional effects were captured in five categories: Ontario, British Columbia, Atlantic (comprising New Brunswick, Prince Edward Island, Nova Scotia and Newfoundland and Labrador), Western (Alberta, Saskatchewan and Manitoba) with Quebec as the reference group.

3.3. Method

Economists have developed economic models to explain how individuals engage in different consumption behaviors. Individuals maximize their utility subject to income, time and other resource constraints (e.g., Lakdawalla and Philipson, 2009; Auld and Powell, 2009). Some of these models are based on the Becker and Murphy (1988) rational addiction (RA) framework which has become the canonical model of analysis. Consumers in this model make optimal choices on what to consume. Borrowing from the behavioral economics literature, Ruhm (2010) added to the traditional economic model by allowing for the possibility that individual weight outcomes could also be determined by biological and environmental cues. These cues can subvert the decision part of the brain which may lead to sub-optimal choices. In his model, advances in food engineering by producers may have contributed to the difficulty of resisting food cravings.

To examine how BMI is associated with the frequency of FV consumption across the BMI distribution, we estimated the following quantile regression (Koenker and Bassett, 1978; Koenker and Hallock, 2001):

$$Q_{BMI}(\tau|fv_{ij}, \boldsymbol{X}_{ij}) = \alpha(\tau) + \beta(\tau)fv_{ij} + \boldsymbol{X}_{ij}\boldsymbol{\theta}(\tau) \quad (1)$$

where:

i and j denote individual and province of residence;

Q_{BMI} denotes individual's Body Mass Index which is derived from measured height and weight;

fv denotes the frequency of FV consumption

X is a vector of control variables.

τ represents quantile, $Q_{BMI}(\tau|fv_{ij}, \boldsymbol{X}_{ij})$ is the τth conditional BMI quantile function.

Re-estimating equation (1) by varying the quantile, τ captures the heterogeneous association between BMI and fv along the different points in the conditional BMI distribution.

Analogously, a baseline linear regression model below is estimated.

$$\text{BMI} = \beta_0 + \beta_1 fv_{ij} + \boldsymbol{\theta}\boldsymbol{X}_{ij} \quad (2)$$

'Insert Table 3.1 about here'

3.4. Results

Summary statistics of the variables used in the analyses are reported in Table 3.1. The mean BMI was 26.5, which indicates that, on average, the study population was slightly overweight. The average number of FV consumption per day was about 4 and this is below the recommended number of 5 times per day. Those aged 14 to 30 accounted for 33% of the sample, 31 to 50 (42%) and 51 to 65 (25%). In terms of educational level completed, about 60% have completed one or more post secondary education, 18%

completed secondary education and 21% had less than secondary education. A large percentage (54%) of the sample was physically inactive, 26% were moderately active and 20% physically active. About 53% were female, male (47%) and 21% were immigrants. About 26% of the sample was current smokers, 23% were former smokers and 51% had never smoked.

3.4.1. Full Sample Regression Results

The BMI quantile regression and the OLS estimates for the full sample are reported in Table 3.2 for some selected quantiles between the 10th and 90th BMI distribution. In addition, the OLS and quantile regression estimates plots for the BMI determinants over the entire BMI distribution are presented in Figures 3.2 to 3.5. The conditional mean estimate of BMI showed a negative relationship between FV and BMI. The quantile regression enabled us to examine the heterogeneous responses of individual's BMI to the model covariates at different tails of the BMI distribution.

While the results revealed that the frequency of FV intake had a negative and statistically significant association with BMI, the coefficient of FV varied across quantiles of the conditional BMI distribution. In particular, the FV coefficient increased in size for individuals at higher points of the conditional BMI distribution. For example, the coefficient of FV at the 90th quantile was almost three times the estimate at the 30th quantile, suggesting that an increase in the intake of FV may be an effective dietary strategy to control weight and reduce the risk of obesity especially for the overweight. The FV estimate at the 50th quantile (median) was equal to the OLS estimate.

'Insert Table 3.2 about here'

'Insert Figures 3.2 to 3.5 about here'

In terms of other control variables, the results showed differences across the quantiles of the BMI distribution. For demographic variables (see the OLS and quantile regression estimates plots in Figure 3.2). Age had a positive relationship with BMI; those that are older (51 to 65 years old, 31 to 50) had higher BMI than the reference group (14 to 30 years old). The female coefficient was negative and statistically significant, indicating that females had less BMI compared to males. At the 90th quantile, the female estimate changed sign to positive. This means that at the 90th percentile, females' BMI were higher than males. Those married and separated had higher BMI than single; the effect was greater at higher percentiles of the conditional BMI distribution mainly for separated. The socioeconomic status variables (education and income) showed less consistent relationship with BMI, for example, individuals with less than secondary education had less BMI up to the 50th quantiles of the conditional BMI distribution compared to the reference category, those with some post secondary education. The OLS results (see Table 3.2) showed that physical activity (active and moderate) statistically and significantly reduced BMI. The quantile regression results indicated that the effect of physical activity was more at the higher half of the conditional BMI distribution. Being a former smoker had a positive and statistically significant association with BMI compared to the reference category (never smoker), where the contrary was found for current smokers. Though, the OLS results indicated no statistically significant difference between current smoker and the reference category, never smoker. Negative and statistically

significant relationship was found between immigrant status and BMI. The Atlantic and Western provinces had higher BMI compared to the referenced category, Quebec.

3.4.2. Male Regression Results

The OLS and some selected quantile regression results for males are reported in Table 3.3 while the OLS and quantile regression estimates plots for the conditional BMI distribution are shown in Figures 3.6 to 3.9. The regression estimates based on gender stratification revealed a similar pattern to the full population estimates shown in Table 3.2. The association between the frequency of FV intake and the BMI was negative and statistically significant. Age and marital status (mainly for those married) had positive relationship with the BMI. The association between individual education attainment and the BMI was less clear both in terms of sign and size of estimates. For the income variables, individuals in a high income household had higher BMI than those in a low income household. Smoking status, physical activity, immigration status and province of residence variables estimates were similar to the full sample results.

'Insert Tables 3.3 & 3.4 about here'

'Insert Figures 3.6 to 3.9 about here'

3.4.3. Female Regression Results

The regression results (OLS and quantile) for females are reported in Table 3.4 while the regression estimates plots for the conditional BMI distribution are shown in Figures 3.10 to 3.13. The regression estimates for females were identical to the male results. The frequency of FV consumption was found to be negatively related to BMI. Age and

marital status variables had a positive relationship with the BMI across the conditional distribution. The association between socioeconomic status variables and BMI were mostly negative compared to the respective reference categories. These results differ from males, where most of the estimates were negative. Physical activity, immigration status and province of residence variables estimates were similar to the male sample results. The results indicated no statistically significant relationship between smoking status and BMI for females (except for higher quantiles of the regression results).

'Insert Figures 3.10 to 3.13 about here'

3.5. Discussion

It has been reported that worldwide, 1 in 3 and 1 in 9 adults are overweight and obese respectively (Anand and Yussuf, 2011). Several studies had associated increased prevalence of obesity and excess weight to the eating behavior of individuals which includes FV consumption (Rolls et al., 2004; Tohill et al., 2004). The health benefits of consuming FV are numerous (WHO, 2003; Bazzano, 2006).

Evidence from the clinical and epidemiological literature on the relationship between the intake of FV and body weight is inconclusive. In this study, we examined the association between the consumption of FV and the BMI using data from the Canadian Community Health Survey. Based on the unconditional estimates, we found that the daily average number of FV servings among individuals in our sample was about 4, which is below the recommended number of 5 servings per day. Results, from the OLS baseline model, showed that the conditional mean of the BMI was negatively and significantly associated with FV consumption. We used a quantile regression to characterize the effect of FV consumption on the entire BMI distribution. We found that the association between

FV intake and BMI was negative and statistically significant. Quantile regression showed that this association varies significantly across the conditional BMI distribution. In particular, the effect of FV increases in size for individuals at higher points of the conditional BMI distribution. The estimates for both males and females revealed similar patterns to the full population estimates that FV intake is negatively and significantly associated with BMI. The OLS model overstated (understated) the effect of FV intake on the BMI at the lower (higher) half of the conditional BMI distribution. Accordingly, conclusions from standard models (e.g., OLS) that assume uniform responses across different quantiles of the BMI distribution may be misleading.

Results for the other BMI determinants were comparable to previous studies. Socioeconomic status (SES), as usually measured by income and education level, largely affects the dietary choices of individuals (Smith and Baghurst, 1992). The level of income affects the amount of financial resources available for healthy and nutritious food, and also the time devoted to physical activity (Yoon et al., 2006). Educational attainment affects nutritional knowledge and awareness about the benefits of physical activity. Several studies have shown that people with higher SES had healthier, nutritionally more balanced diets and are more physically active than those with lower SES (Lim and Taylor, 2005). Existing literature mostly found a negative association between SES and the BMI among females in developed countries, however, this association was less consistent among males (Sobal and Stunkard, 1989). In line with previous studies (e.g., McLaren, 2007, Sanchez-Vaznaugh et al., 2009), we found a negative SES gradient in BMI among females, and a relatively strong positive income gradient among males.

Results for both males and females showed that smoking status significantly affects the BMI. In particular, we found that smokers had a lower BMI, while former smokers had a higher BMI, compared to those who never smoked. This is consistent with the general belief that smoking cessation is usually associated with an increase in the BMI (Munafo et al., 2009). For example, using a prospective study, Munafo et al. (2009) found that the BMI of never and former smokers was on average 1.6 kg/m^2 higher than the BMI of current smokers. The authors also found an average increase in BMI of 1.6 kg/m^2 due to smoking cessation. It has been reported that smoking suppresses the appetite (Jo et al., 2002), where smokers may have higher metabolic rates than non-smokers and hence smoking may be used to control weight (Li et al., 2003).

We found that immigrants had lower BMI than non immigrants. This is in line with the findings of an early study on differences in obesity prevalence among US immigrants and natives (Goel et al., 2004). The authors found that immigrants in the United States in general had lower BMI than non immigrants, but these differences decrease overtime due to acculturation and the influence of the US lifestyle. Results also showed that the BMI increases with age and this is consistent with a previous study by Baum and Ruhm (2009), who predicted an annual increase in the BMI of 0.12 kg/m^2. Since physical activity affects the expenditure side of the energy balance equation, it is well established that regular physical activity is an important determinant of body weight, people who are physically active are less likely to be obese (Jakicic, 2009). Our results are consistent with this evidence. Provincial differences in BMI are in line with the trend in Canada. For example, individuals in the Atlantic Provinces tend to have higher BMI than those in other provinces (Heart and Stroke Foundation Canada, 1999).

This study has some strength. First, the BMI used was based on measured height and weight rather than the frequently used self-reported measures. It has been documented that individuals tend to over-report their height and under-report their weight, which may have implications in terms of the consistency of estimated parameters. Second, many of the previous studies reported only the bivariate association between the intake of FV and BMI which could lead to misleading conclusions about the true association (Rolls et al., 2004). Moreover, previous multivariate studies mostly estimated the effect of FV on the conditional mean of BMI or the likelihood of being obese using standard linear or binary response regressions. Results from these estimation methods assumed that the effect of the explanatory variables is the same at different parts of the BMI distribution. However, nutrition promotion and weight management policies give more attention to individuals at certain segments of the BMI distribution.

The current study has some limitations. First, we can infer causality from the cross-sectional data used in this study. Second, due to data limitations, the intake of FV was based on the number of times per day an individual consumes FV rather than the quantity consumed. Third, we did not control for the form in which FV were consumed. FV in their natural physical shape are low in energy density and have higher satiety effects, while they become more energy dense when cooked, canned, served with high-calorie sauces or dried (Rolls et al., 2004). Fourth, there may be omitted variable bias due to unobserved individual characteristics like preferences.

3.6. Conclusion

From the public policy perspective, the findings of this paper suggest that policies aimed at increasing the intake of FV may help to control weight and mitigate the risk of

obesity. The multivariate analyses showed that conclusions from the standard models that assume uniform response across different quantiles of BMI distribution may be misleading. Accordingly, understanding how the association between FV and BMI depends on individuals' location on the BMI distribution may help in implementing intervention measures that target the most vulnerable groups (overweight and obese).

Table 3.1. Summary statistics.

Variables	**Mean**	**S.D**
BMI	26.50	5.73
Fruits &Vegetables	4.20	2.14
Age		
Age 14-30	0.33	0.47
Age 31-50	0.42	0.49
Age 51-65	0.25	0.43
Gender		
Male	0.47	0.50
Female	0.52	0.50
Marital status		
Single	0.32	0.46
Married	0.58	0.49
Separated	0.10	0.28
Educational attainment		
Less secondary education	0.21	0.41
Secondary education	0.18	0.38
Some post secondary	0.10	0.30
Post secondary	0.50	0.50
Income Level		
Income level(less than30)	0.17	0.38
Income level(30-49)	0.21	0.40
Income level(50-79)	0.27	0.44
Income level(>=80)	0.27	0.44
Social interaction		
Strong	0.61	0.48
Weak	0.38	0.48
Physical activity		
Active	0.20	0.40
Moderate	0.26	0.44
Inactive	0.54	0.50
Smoking status		
Current smoker	0.26	0.44
Former smoker	0.23	0.42
Never smoker	0.51	0.50
Immigration status		
Immigrants	0.21	0.41
Non immigrants	0.78	0.41
Province of residence		
Quebec	0.27	0.44
Ontario	0.34	0.47
British Columbia	0.13	0.34
Atlantic provinces	0.08	0.27
Western provinces	0.17	0.38
N	11818	

The statistics are weighted using the CCHS sampling weights.

Table 3.2. OLS and quantile regression results for BMI determinants at selected quantiles for the whole sample.

	OLS		Quantile regression estimates				
			(10)	(30)	(50)	(70)	(90)
Fruit & vegetables	-0.183***		-0.110***	-0.113***	-0.182***	-0.235***	-0.292***
	(0.050)		(0.026)	(0.029)	(0.039)	(0.052)	(0.078)
Age							
Age 31-50	2.024***		1.430***	1.579***	1.758***	1.643***	1.984***
	(0.330)		(0.140)	(0.166)	(0.225)	(0.326)	(0.539)
Age 51-65	2.889***		2.200***	2.513***	2.657***	2.692***	3.411***
	(0.352)		(0.153)	(0.183)	(0.240)	(0.336)	(0.563)
Gender							
Female	-0.489**		-1.275***	-1.557***	-1.180***	-0.403*	0.982***
	(0.213)		(0.105)	(0.127)	(0.161)	(0.206)	(0.307)
Marital status							
Married	0.831***		0.703***	1.208***	1.378***	0.940***	0.630
	(0.317)		(0.127)	(0.159)	(0.221)	(0.326)	(0.493)
Separated	1.013**		1.083***	1.362***	1.296***	1.512***	1.404**
	(0.444)		(0.168)	(0.242)	(0.317)	(0.443)	(0.681)
Educational attainment							
Less secondary	-0.187		-0.792***	-0.567***	-0.441*	0.046	0.645
	(0.356)		(0.164)	(0.199)	(0.255)	(0.329)	(0.492)
Secondary	0.171		0.287	-0.133	-0.580**	0.153	1.599***
	(0.427)		(0.196)	(0.228)	(0.291)	(0.380)	(0.542)
Post secondary	-0.407		0.066	-0.342*	-0.475*	-0.094	-0.135
	(0.342)		(0.170)	(0.199)	(0.254)	(0.325)	(0.459)
Income Level							
Income 30-49	0.319		0.492***	0.081	0.441*	0.828***	0.558
	(0.265)		(0.124)	(0.178)	(0.226)	(0.291)	(0.396)
Income 50-79	0.385		0.144	0.116	0.420*	0.646**	0.792*
	(0.275)		(0.136)	(0.174)	(0.217)	(0.277)	(0.411)
Income 80 and above	0.203		0.174	0.108	0.208	0.409	0.347
	(0.343)		(0.149)	(0.182)	(0.225)	(0.286)	(0.474)
Social interaction							
Strong	0.169		0.215**	0.096	0.137	0.393*	-0.380
	(0.229)		(0.109)	(0.128)	(0.162)	(0.211)	(0.323)
Physical activity							
Active	-1.216***		0.175	-0.303*	-0.798***	-1.688***	-2.678***
	(0.248)		(0.120)	(0.155)	(0.195)	(0.266)	(0.415)
Moderate	-0.707***		0.182	-0.186	-0.454**	-0.894***	-1.681***
	(0.264)		(0.136)	(0.155)	(0.194)	(0.248)	(0.369)
Smoking status							
Current smoker	-0.086		-0.273**	-0.164	-0.432**	-0.168	0.452
	(0.257)		(0.110)	(0.143)	(0.186)	(0.246)	(0.397)

Former smoker	0.880**		0.502***	0.649***	0.812***	0.757***	1.185**
	(0.350)		(0.151)	(0.173)	(0.214)	(0.276)	(0.461)
Immigration status							
Immigrant	-1.122***		-0.209	-0.903***	-1.082***	-1.313***	-2.253***
	(0.396)		(0.154)	(0.184)	(0.235)	(0.310)	(0.546)
Province of residence							
Ontario	0.341		-0.075	0.210	0.526**	0.419	0.921*
	(0.362)		(0.151)	(0.184)	(0.235)	(0.314)	(0.501)
British Columbia	0.108		0.071	0.064	0.030	0.051	0.838
	(0.383)		(0.172)	(0.217)	(0.281)	(0.368)	(0.565)
Atlantic	0.956***		0.514***	0.833***	0.743***	0.834***	2.150***
	(0.332)		(0.152)	(0.182)	(0.236)	(0.308)	(0.487)
Western	0.835**		0.496***	0.523***	0.752***	0.727**	1.944***
	(0.337)		(0.131)	(0.178)	(0.229)	(0.306)	(0.489)
Constant	25.39***		19.86***	22.59***	24.72***	27.09***	31.46***
	(0.451)		(0.239)	(0.291)	(0.368)	(0.457)	(0.653)
Observations	11,784						

Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The estimates are population weighted using the CCHS sampling weights.

Table 3.3. OLS and quantile regression results for the BMI determinants at selected quantiles for males.

	OLS		**Quantile regression estimates**				
			(10)	**(30)**	**(50)**	**(70)**	**(90)**
Fruit & vegetables	-0.165***		-0.109**	-0.089*	-0.177***	-0.162***	-0.238***
	(0.061)		(0.051)	(0.051)	(0.051)	(0.034)	(0.051)
Age							
Age 31-50	1.932***		1.286***	1.947***	1.552***	1.812***	1.942***
	(0.425)		(0.222)	(0.272)	(0.290)	(0.237)	(0.447)
Age 51-65	2.844***		1.883***	2.399***	2.361***	2.804***	3.844***
	(0.467)		(0.261)	(0.313)	(0.321)	(0.251)	(0.551)
Marital status							
Married	0.687		1.247***	1.099***	1.337***	0.478*	0.0611
	(0.425)		(0.203)	(0.273)	(0.293)	(0.251)	(0.462)
Separated	0.294		0.826**	0.362	0.502	0.240	0.613
	(0.655)		(0.365)	(0.387)	(0.440)	(0.346)	(0.669)
Educational attainment							
Less secondary	0.051		-0.877**	-0.792**	-0.148	0.224	1.674***
	(0.429)		(0.344)	(0.350)	(0.331)	(0.229)	(0.406)
Secondary	0.881*		0.931**	0.352	0.513	0.835***	1.342***
	(0.455)		(0.374)	(0.399)	(0.382)	(0.272)	(0.403)
Post secondary	0.315		0.299	0.326	0.419	0.557**	-0.329
	(0.379)		(0.360)	(0.349)	(0.338)	(0.225)	(0.358)
Income level							
Income 30-49	0.996***		1.007***	0.933***	0.859***	1.089***	0.726**
	(0.337)		(0.258)	(0.321)	(0.303)	(0.212)	(0.355)
Income 50-79	1.282***		0.585**	1.068***	1.250***	1.328***	1.919***
	(0.386)		(0.281)	(0.319)	(0.281)	(0.202)	(0.355)
Income 80 and above	1.191***		1.093***	1.269***	0.863***	1.117***	1.146***
	(0.370)		(0.307)	(0.335)	(0.289)	(0.203)	(0.364)
Social interaction							
Strong	0.008		0.183	0.107	0.274	0.278*	-1.056***
	(0.257)		(0.191)	(0.214)	(0.205)	(0.148)	(0.255)
Physical activity							
Active	-0.648**		0.033	0.148	-0.402	-1.078***	-1.918***
	(0.329)		(0.224)	(0.245)	(0.250)	(0.183)	(0.346)
Moderate	-0.801***		-0.081	-0.325	-0.343	-0.946***	-2.157***
	(0.295)		(0.251)	(0.272)	(0.246)	(0.171)	(0.272)
Smoking status							
Current smoker	-0.224		-0.468**	-0.377	-0.594**	-0.540***	0.843***
	(0.326)		(0.232)	(0.256)	(0.241)	(0.170)	(0.313)
Former smoker	1.102***		0.861***	1.427***	1.245***	1.212***	-0.264
	(0.317)		(0.274)	(0.293)	(0.272)	(0.192)	(0.295)
Immigration status							

Immigrant	-1.385***		-0.678**	-1.252***	-1.369***	-1.440***	-1.946***
	(0.385)		(0.333)	(0.334)	(0.296)	(0.193)	(0.356)
Province of residence							
Ontario	0.644*		-0.194	0.437	0.798***	0.309	1.320***
	(0.367)		(0.291)	(0.327)	(0.303)	(0.211)	(0.365)
British Columbia	0.347		-0.117	0.086	0.533	-0.295	0.638
	(0.414)		(0.340)	(0.374)	(0.357)	(0.247)	(0.395)
Atlantic	0.784*		0.149	0.582*	0.817***	0.246	1.464***
	(0.402)		(0.321)	(0.326)	(0.305)	(0.217)	(0.382)
Western	1.246***		0.340	0.673**	1.255***	1.134***	2.433***
	(0.378)		(0.253)	(0.316)	(0.293)	(0.209)	(0.372)
Constant	24.12***		19.45***	21.19***	23.22***	26.13***	31.26***
	(0.527)		(0.449)	(0.476)	(0.465)	(0.306)	(0.548)
Observations	5,358						

Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The estimates are population weighted using the CCHS sampling weights.

Table 3.4. OLS and quantile regression results for the BMI determinants at selected quantiles for females.

	OLS		**Quantile regression estimates**				
			(10)	**(30)**	**(50)**	**(70)**	**(90)**
Fruit & vegetables	-0.177**		-0.109***	-0.180***	-0.151**	-0.211***	-0.279**
	(0.074)		(0.032)	(0.034)	(0.059)	(0.067)	(0.111)
Age							
Age 31-50	2.146***		1.123***	1.487***	1.898***	1.585***	4.050***
	(0.479)		(0.210)	(0.213)	(0.343)	(0.424)	(0.711)
Age 51-65	2.810***		1.961***	2.405***	2.692***	2.859***	4.674***
	(0.491)		(0.212)	(0.228)	(0.356)	(0.426)	(0.733)
Marital status							
Married	1.011**		0.309*	1.255***	1.480***	1.766***	0.023
	(0.455)		(0.188)	(0.201)	(0.320)	(0.382)	(0.709)
Separated	1.357**		0.932***	1.543***	1.625***	2.868***	0.175
	(0.613)		(0.225)	(0.280)	(0.451)	(0.510)	(0.914)
Educational attainment							
Less secondary	-0.330		-0.226	-0.207	-0.358	0.277	-0.910
	(0.556)		(0.232)	(0.239)	(0.376)	(0.458)	(0.691)
Secondary	-0.349		0.571**	-0.363	-1.281***	-0.393	0.572
	(0.642)		(0.237)	(0.273)	(0.423)	(0.502)	(0.822)
Post secondary	-0.930*		0.039	-0.529**	-1.160***	-0.781*	-1.142
	(0.564)		(0.229)	(0.237)	(0.366)	(0.441)	(0.711)
Income level							
Income 30-49	-0.134		0.011	-0.530**	0.002	0.267	-0.687
	(0.393)		(0.161)	(0.209)	(0.334)	(0.377)	(0.545)
Income 50-79	-0.286		-0.140	-0.352*	-0.391	-0.061	-0.981*
	(0.388)		(0.174)	(0.199)	(0.330)	(0.353)	(0.571)
Income 80 and above	-0.552		-0.399**	-0.801***	-0.577*	-0.522	-0.970
	(0.559)		(0.173)	(0.209)	(0.346)	(0.392)	(0.766)
Social interaction							
Strong	0.347		0.366***	0.064	0.026	0.489*	0.583
	(0.372)		(0.135)	(0.160)	(0.252)	(0.287)	(0.480)
Physical activity							
Active	-1.754***		0.192	-0.282	-1.195***	-2.246***	-3.975***
	(0.359)		(0.173)	(0.206)	(0.321)	(0.322)	(0.566)
Moderate	-0.622		0.248*	0.090	-0.515*	-0.941***	-0.787
	(0.416)		(0.148)	(0.185)	(0.296)	(0.342)	(0.566)
Smoking status							
Current smoker	0.112		0.085	-0.134	0.114	0.970***	0.048
	(0.392)		(0.142)	(0.173)	(0.285)	(0.327)	(0.554)
Former smoker	0.727		0.375**	0.009	0.180	0.928**	1.693**
	(0.625)		(0.172)	(0.208)	(0.335)	(0.390)	(0.835)
Immigration status							
Immigrant	-0.910		-0.149	-0.792***	-0.652*	-0.956**	-2.199**

	(0.665)		(0.186)	(0.219)	(0.375)	(0.451)	(0.873)
Province of residence							
Ontario	0.186		0.067	-0.118	0.588	0.304	0.024
	(0.592)		(0.180)	(0.216)	(0.366)	(0.434)	(0.786)
British Columbia	-0.096		0.362	-0.297	0.265	0.231	0.379
	(0.610)		(0.251)	(0.265)	(0.438)	(0.507)	(0.896)
Atlantic	1.137**		0.860***	0.746***	1.210***	1.619***	2.638***
	(0.515)		(0.187)	(0.210)	(0.365)	(0.425)	(0.759)
Western	0.504		0.681***	0.077	0.568	0.276	1.366*
	(0.545)		(0.175)	(0.210)	(0.359)	(0.426)	(0.778)
Constant	25.58***		18.76***	22.33***	24.16***	26.54***	33.62***
	(0.708)		(0.316)	(0.327)	(0.542)	(0.612)	(0.981)
Observations	6,426						

Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The estimates are population weighted using the CCHS sampling weights.

Figure 3.1.

Percentage of males and females aged 12 or older reporting that they consumed fruits and vegetables at least five times daily in Canada from 2003 to 2010.

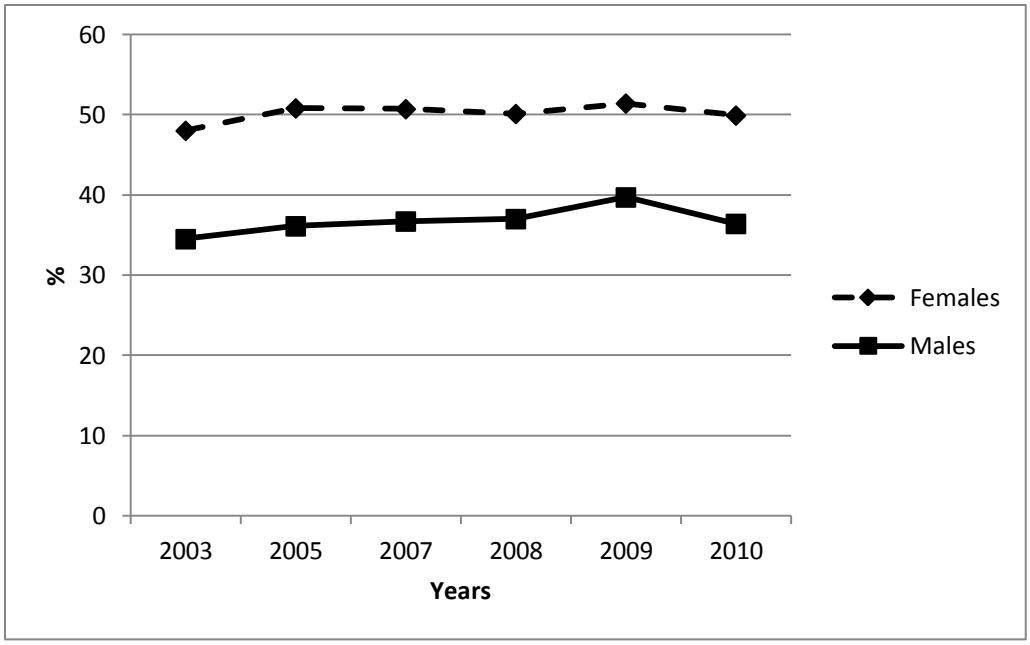


Figure 3.2.
OLS and quantile regression estimates for BMI determinants for whole sample: demographic factors

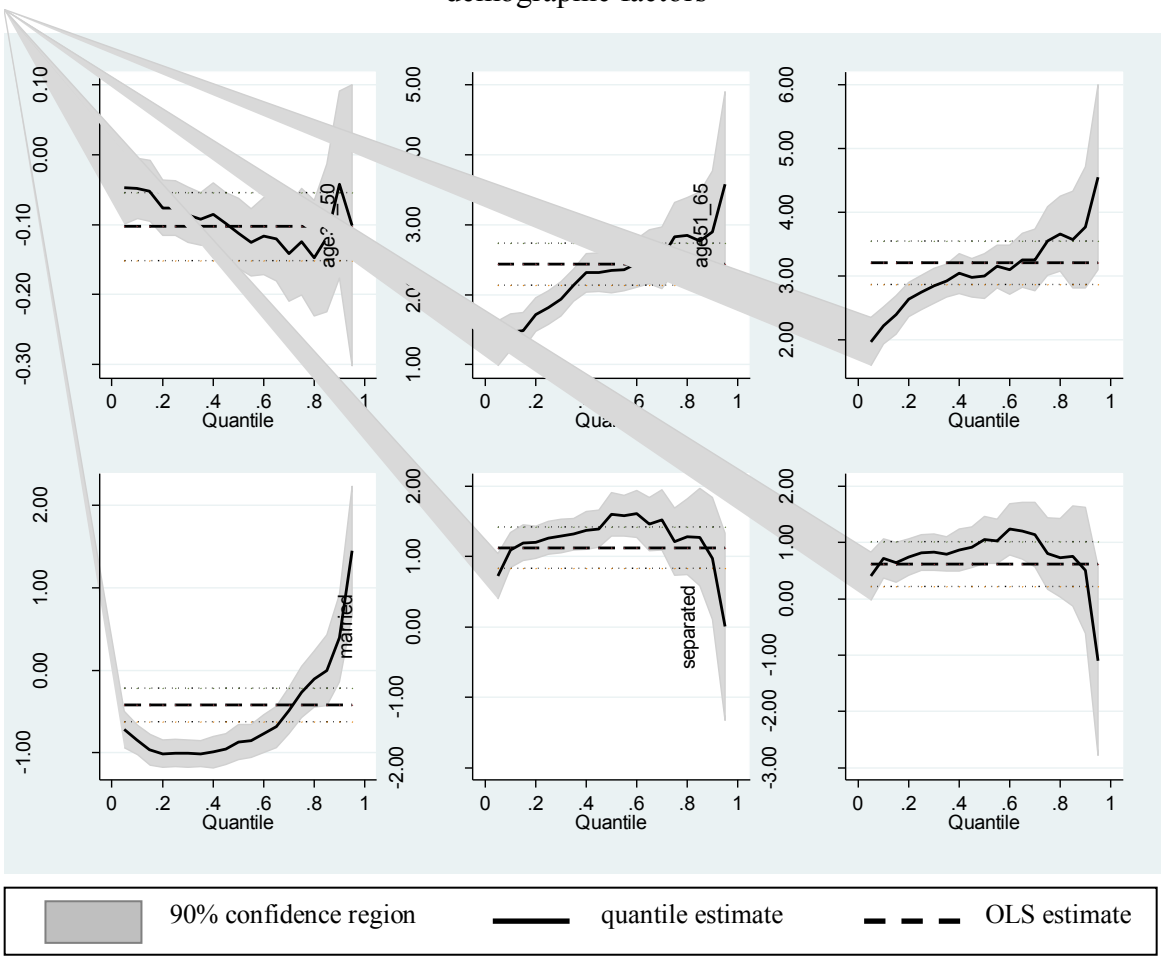


Figure 3.3.

OLS and quantile regression estimates for BMI determinants: whole sample, socio-economic status

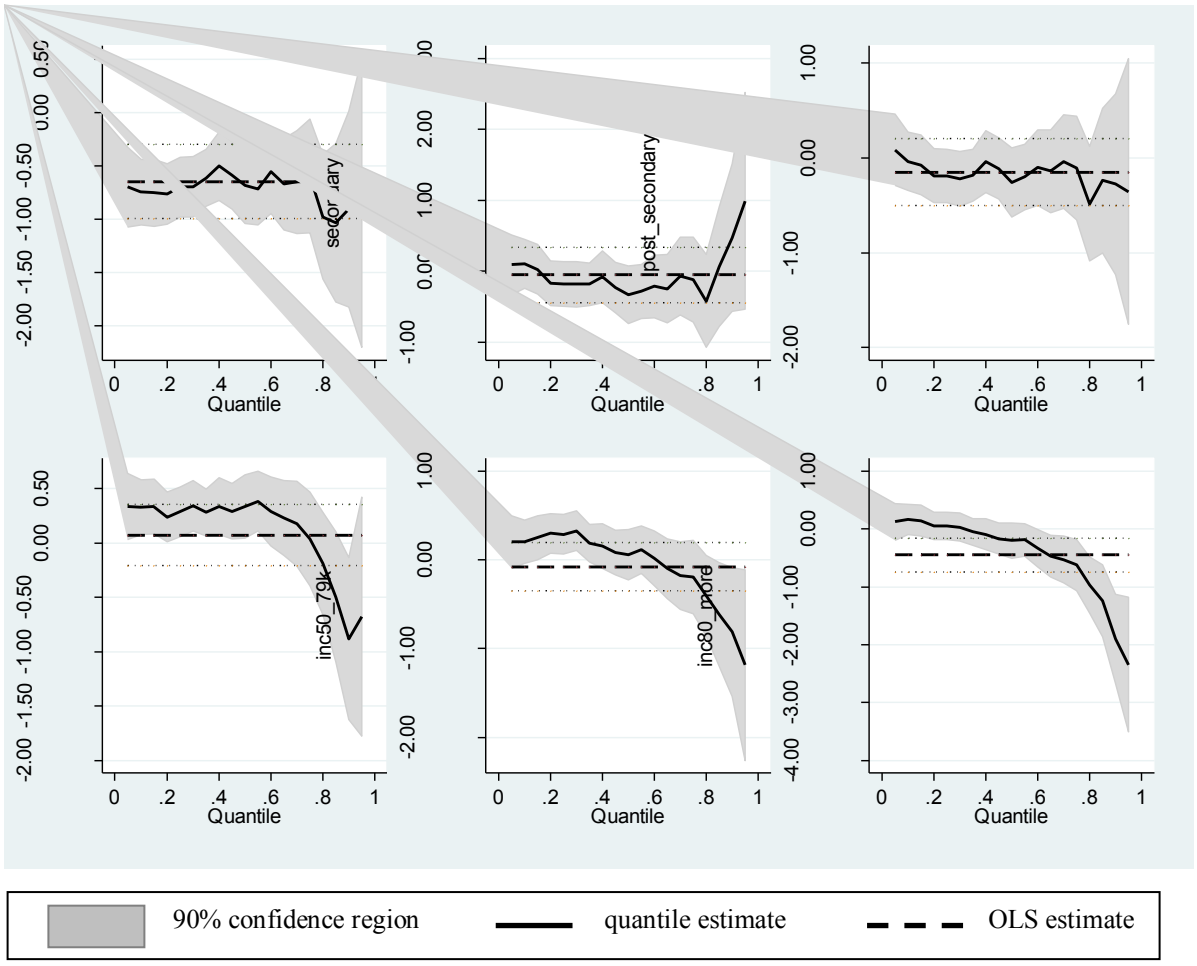


Figure 3.4.

OLS and quantile regression estimates for BMI determinants for whole sample: physical activity and smoking status

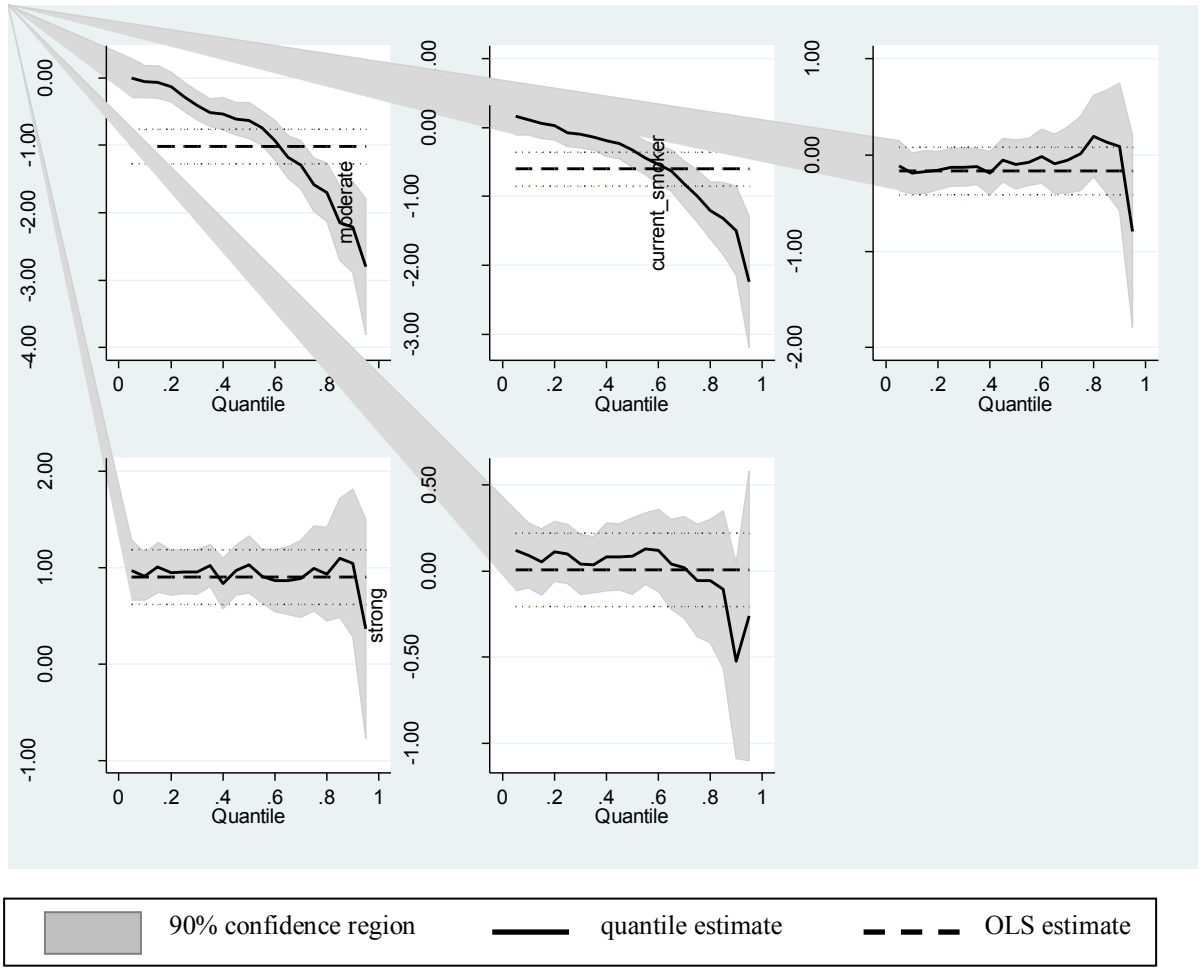


Figure 3.5.

OLS and quantile regression estimates for BMI determinants for whole sample: immigration status and province of residence

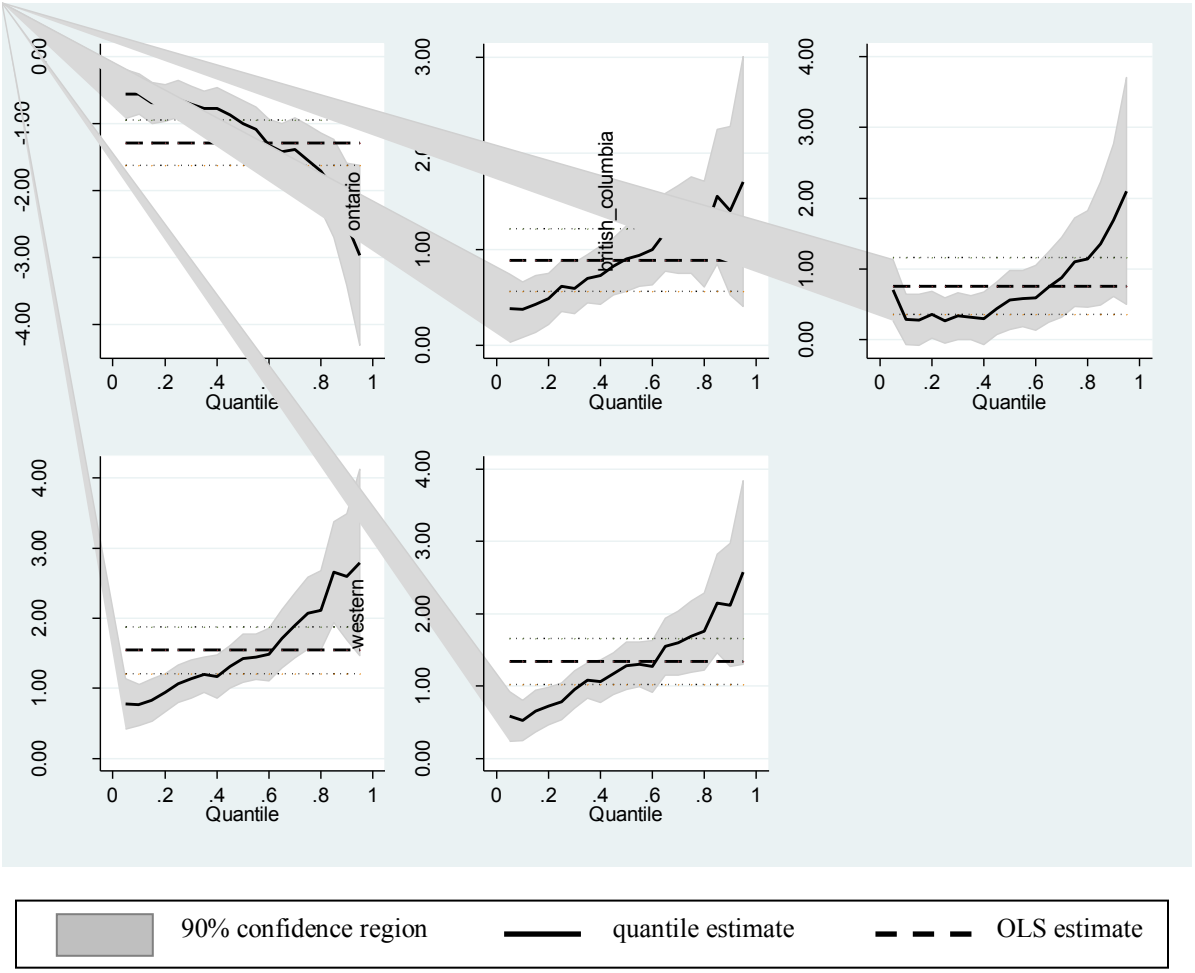


Figure 3.6.

OLS and quantile regression estimates for BMI determinants for males: demographic factors

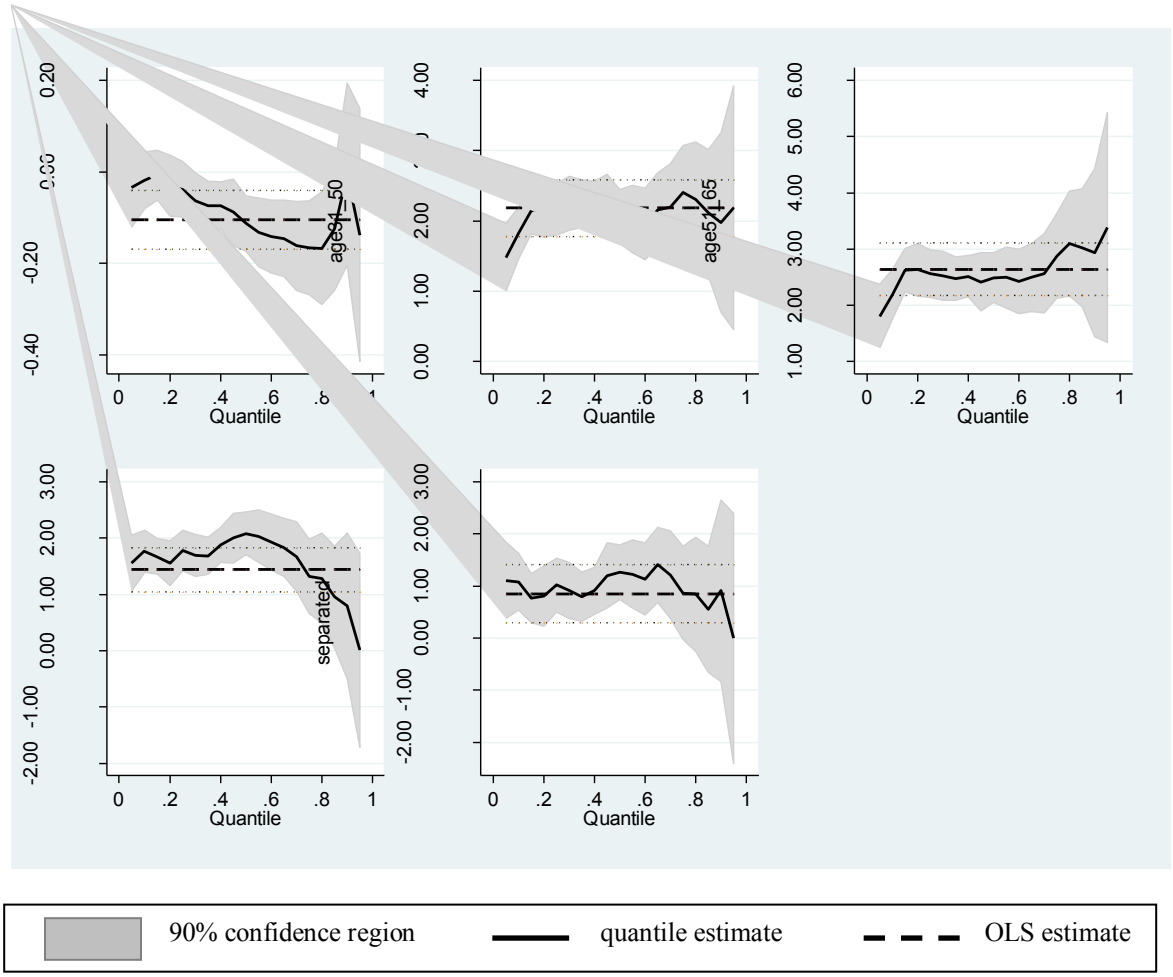


Figure 3.7.

OLS and quantile regression estimates for BMI determinants for males: socio-economic status

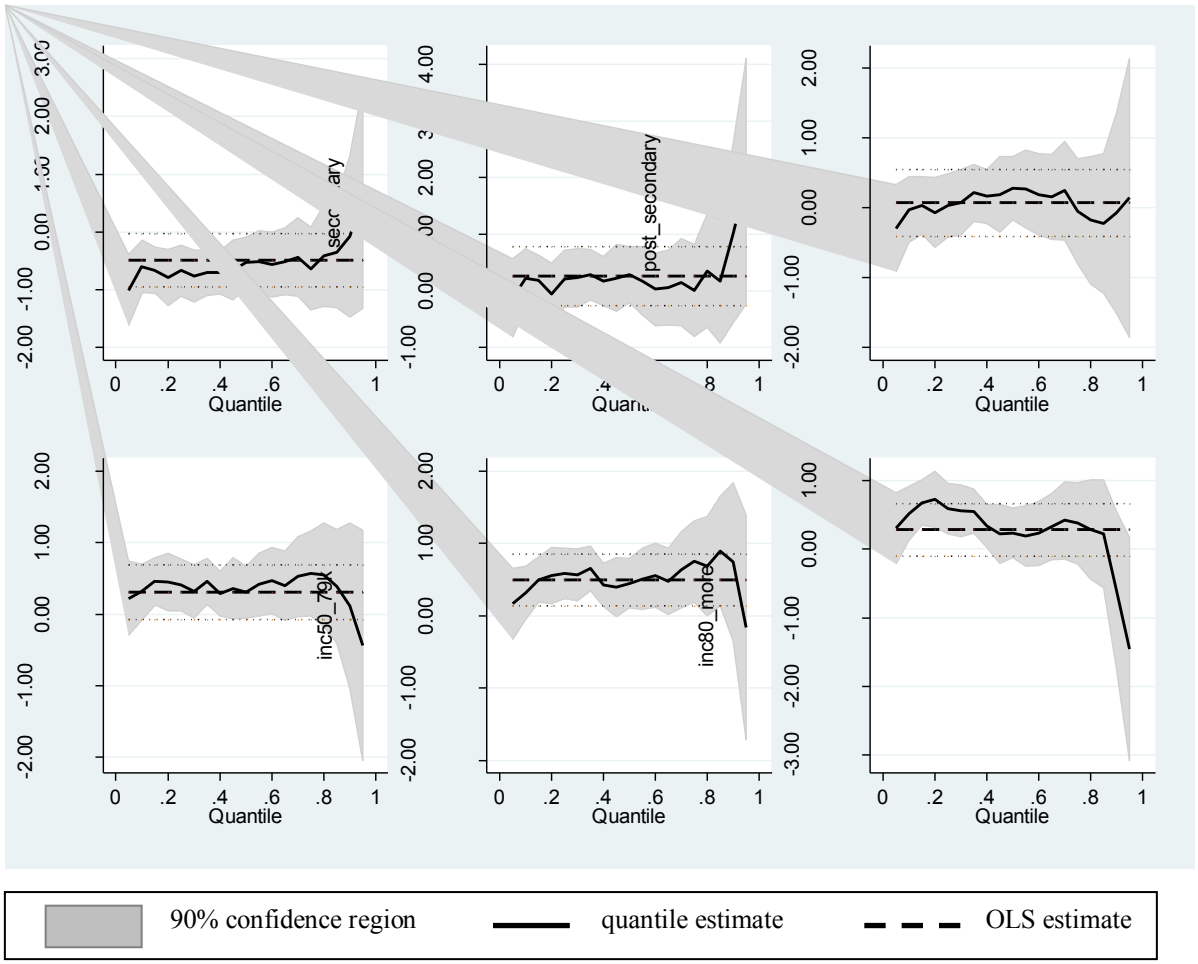


Figure 3.8.

OLS and quantile regression estimates for BMI determinants for males: physical activity and smoking status

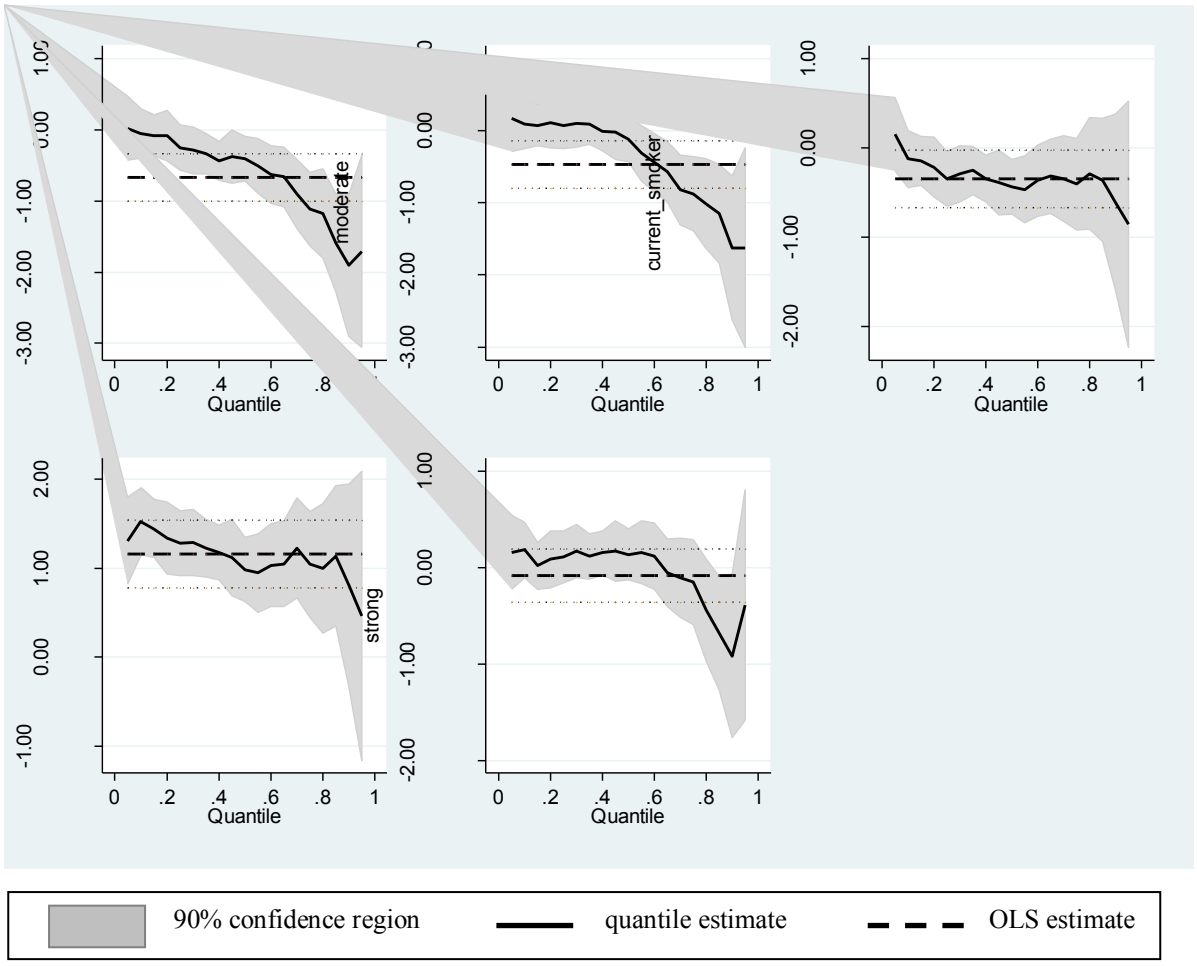


Figure 3.9.

OLS and quantile regression estimates for BMI determinants for males: immigration status and province of residence

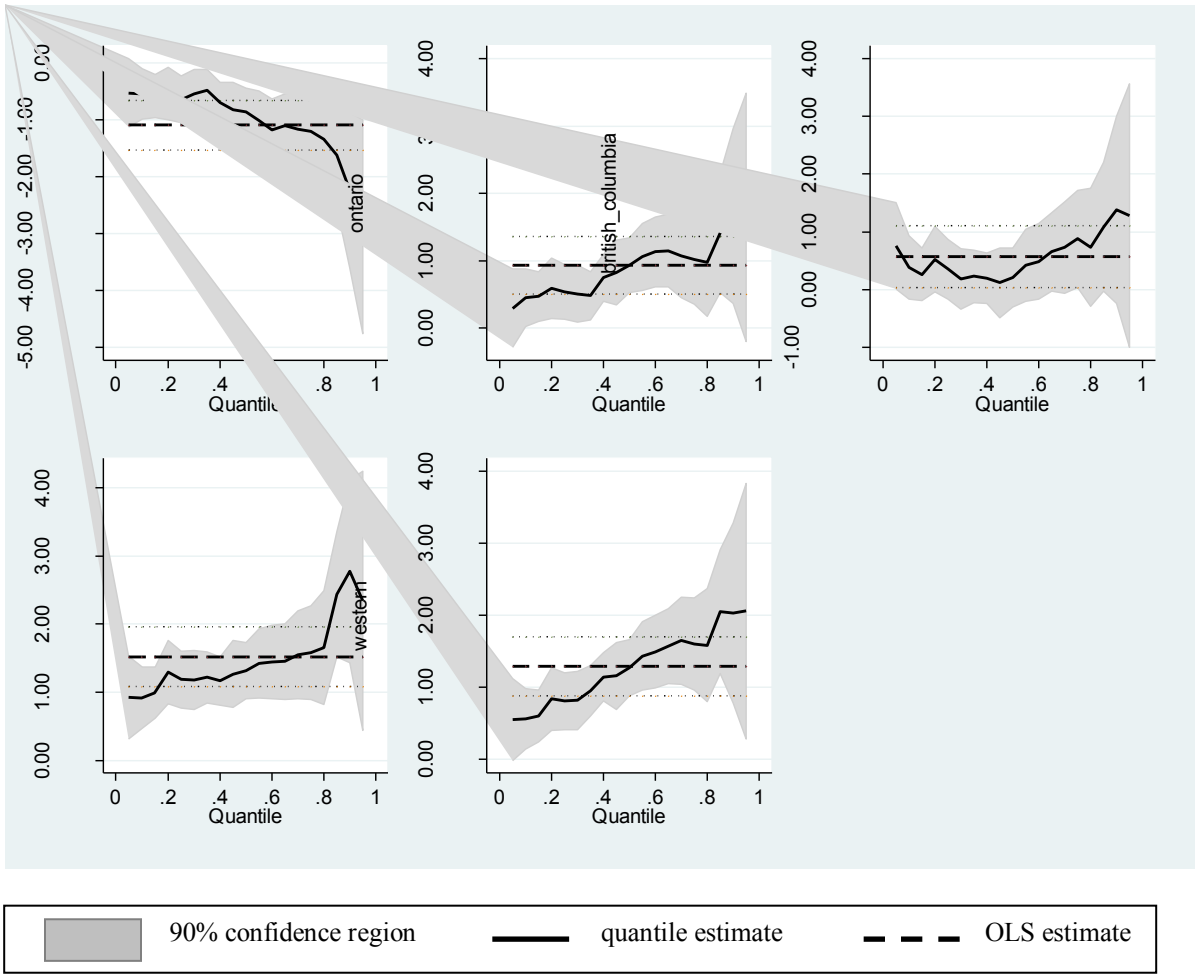


Figure 3.10.

OLS and quantile regression estimates for BMI determinants for females: demographic factors

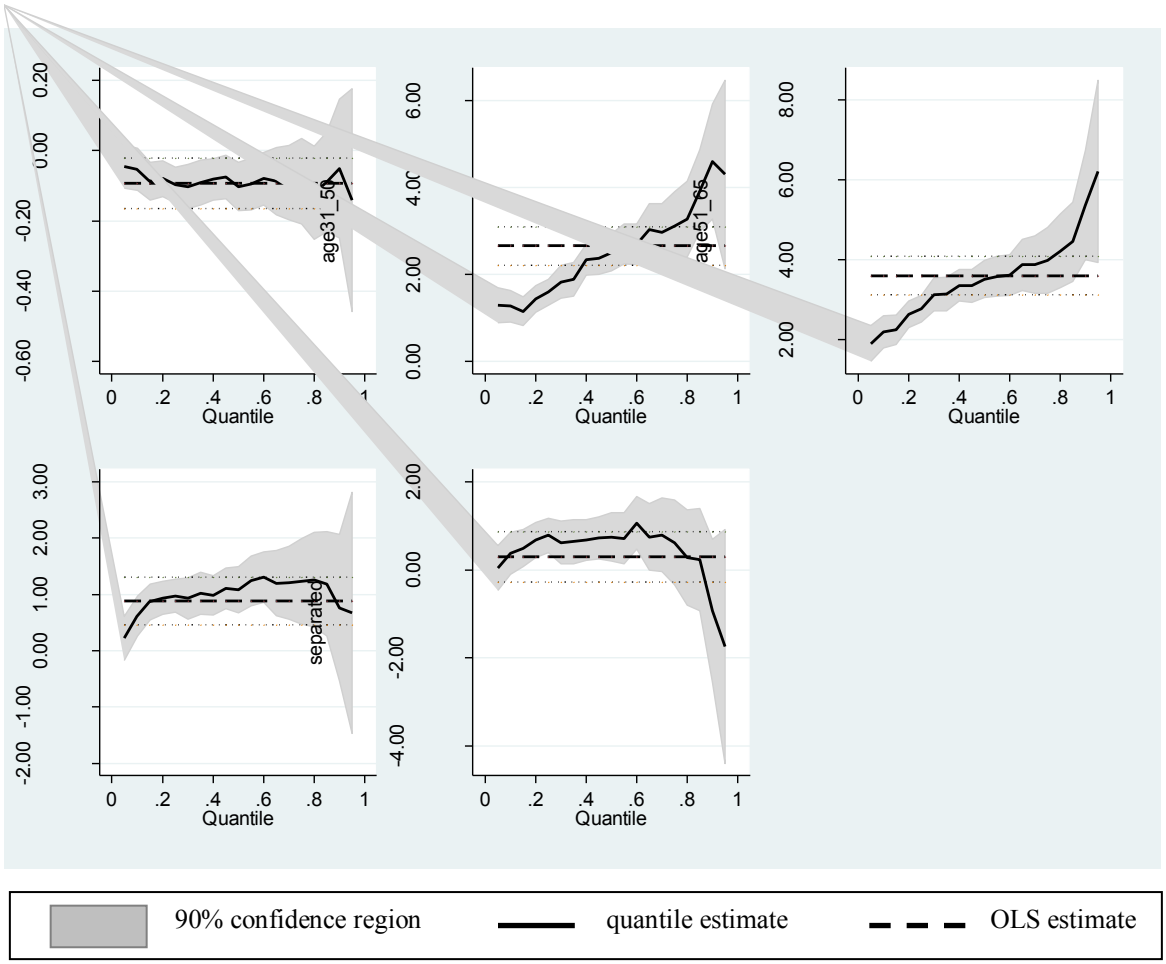


Figure 3.11.

OLS and quantile regression estimates for BMI determinants for females: socio-economic status

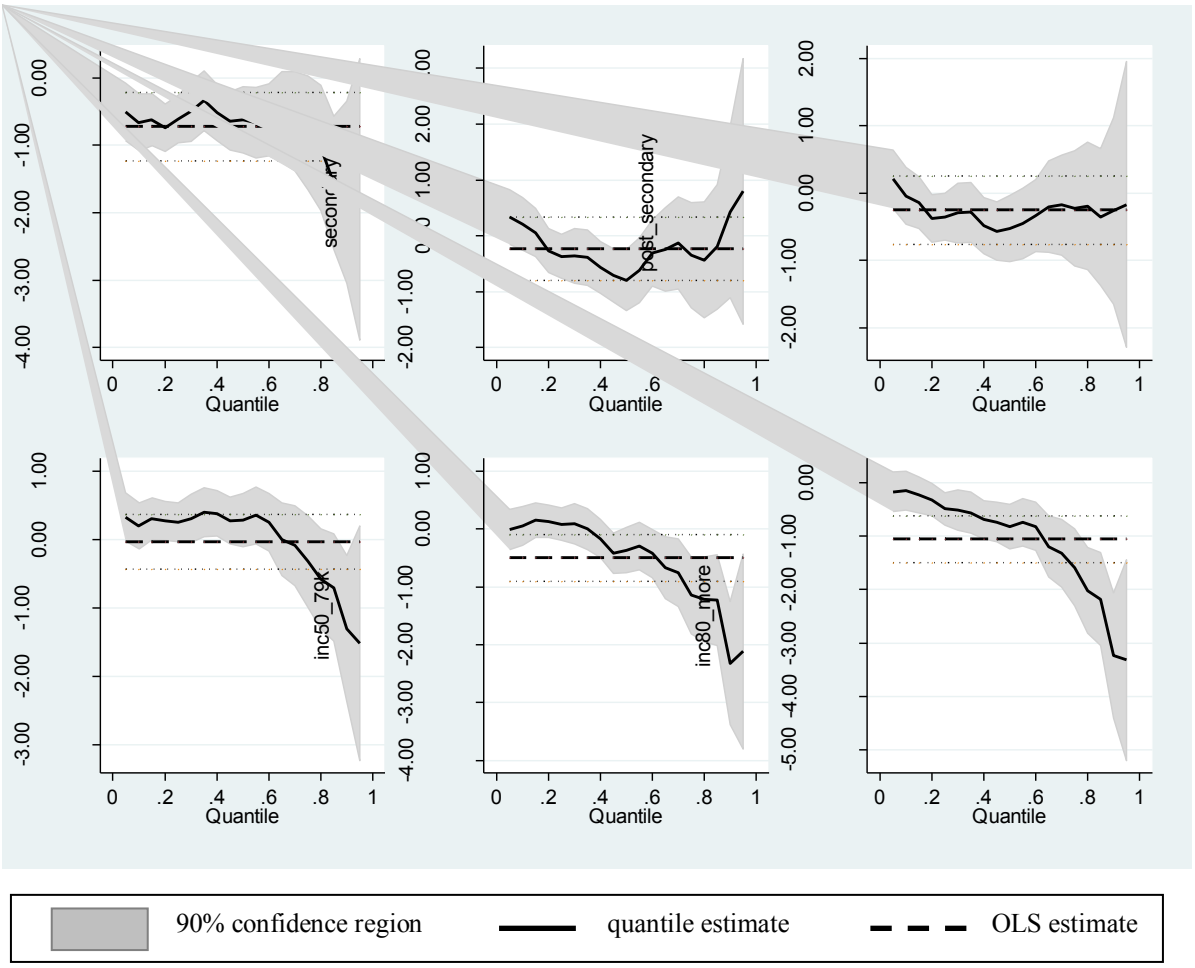


Figure 3.12.

OLS and quantile regression estimates for BMI determinants for females: physical activity and smoking status

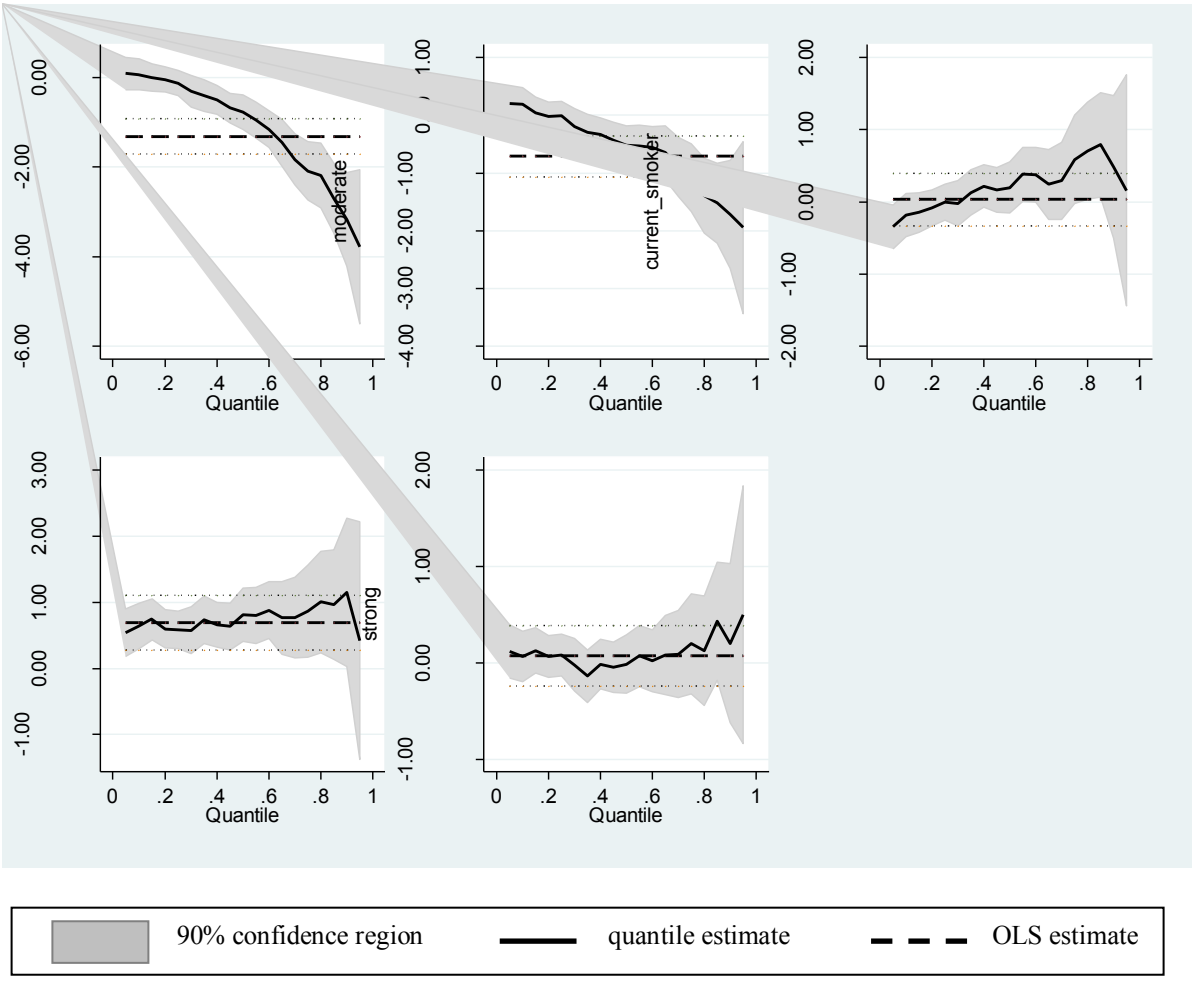
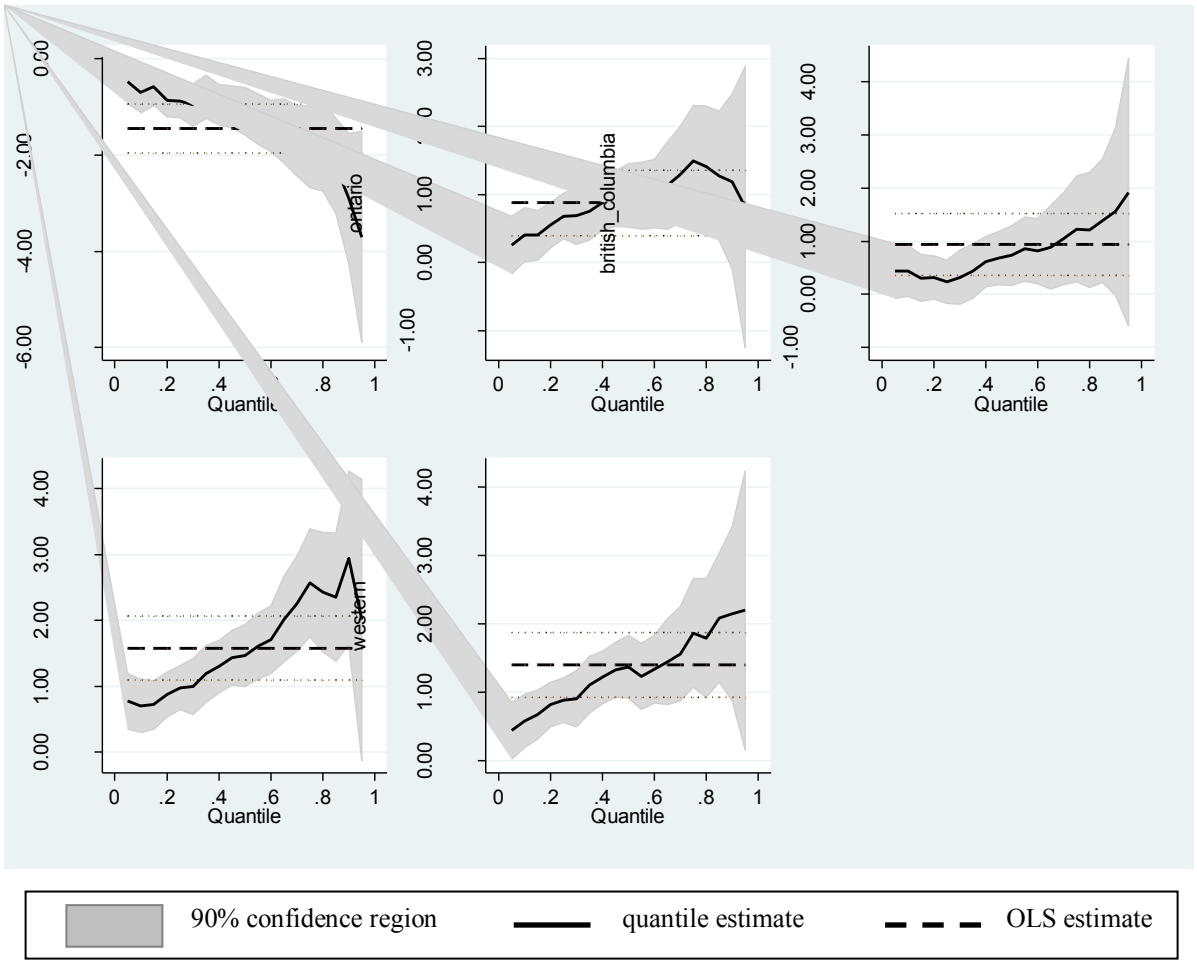


Figure 3.13.

OLS and quantile regression estimates for BMI determinants for females: immigration status and province of residence



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