CONSEQUENCES AND CONTROL OF TOBACCO USE AMONG SOME CANADIAN POPULATIONS

By

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ABSTRACT

Smoking continues to be a major public health issue worldwide. It is associated with elevated rates of potential years of life lost, mortality, reduced life expectancy and chronic diseases. This dissertation contains three essays on the consequences and control of tobacco in Canada.

Essay one (Chapter 2) used the 2009/10 Canadian Community Health Survey (CCHS) to examine the prevalence and the factors associated with smoking behavior during pregnancy. Results from multivariable logistic regression revealed that the odds of smoking during pregnancy were decreased with increasing age, having a regular family doctor, and having highest level of family income. Mothers who reported poor or fair self-perceived health and those who had at least one mental illness had greater odds of smoking during pregnancy.

Essay two (Chapter 3) used data from the 2012/13 Canadian Youth Smoking Survey to estimate the elasticity of smoking initiation and intensity. We found that a 1% increase in price leads to a 1.13% reduction in initiation and a 1.02% reduction in intensity; while 1% increase in income leads to a 0.07% increase in initiation and a 0.06% increase in intensity. The effects of pocket money are much smaller in magnitude than the response of smoking to the price of cigarettes.

Essay three (Chapter 4) used data from the 2015 Canadian Community Health Survey to examine whether smoking status is associated with a reduction in health related quality of life (HRQoL) as measured by the Health Utility Index (HUI3); to calculate the overall loss of HRQoL over a lifetime and economic burden of loss; and to compare smoking related losses in HRQoL by age and gender. The results demonstrated that smoking was significantly and

negatively associated with HRQoL loss and also is associated with substantial individual and societal economic cost.

In summary, the findings from this research not only can guide public healthcare providers to promote health within the target population, but also has important implications for tobacco control policies. Enhanced tobacco prevention will not only improve HRQoL but also will generate returns on investment from smoking cessation programs.

ACKNOWLEDGEMENTS

DEDICATION

This thesis work is dedicated to my husband Agassi and my daughter Alicia. I am truly thankful

for having you in my life.

PREFACE

Chapter two of this thesis was published as: Cui Y, Shooshtari S, Forget EL, Clara I, Cheung KF (2014) Smoking during Pregnancy: Findings from the 2009–2010 Canadian Community Health Survey. *PLoS ONE* 9(1): e84640. doi:10.1371/journal.pone.0084640.

Chapter three of this thesis has been accepted by the Canadian Journal of Public Health: Cui Y, Forget EL, Zhu YF, Torabi M, Oguzoglu U. The effects of cigarette price and the amount of pocket money on youth smoking initiation and intensity in Canada. *Canadian Journal of Public Health* [Accepted 2018].

I was the lead author in these two papers and responsible for identifying the research questions, literature review, data analysis and writing the manuscript. The rest of authors reviewed the manuscript and offered advice. Chapter four is original work and has not been previously published.

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CHAPTER ONE: INTRODUCTION

1.1 Background

Five decades ago, Luther L. Terry, M.D., Surgeon General of the United States, released

Smoking and Health: Report of the Advisory Committee of the Surgeon General of the Public

Health Service (United States Public Health Service, 1964). This was the first in the series that

is now generally referred to as the Surgeon General's reports. This report reviewed over 7,000

research articles on the topic of smoking and health, and concluded that cigarette smoking is a

cause of various diseases, for example, a cause of lung cancer and laryngeal cancer in men, a

probable cause of lung cancer in women, as well as the most important cause of chronic

bronchitis. Over the next fifty years, a large body of research continues to document the strong

association of tobacco use with a variety of common diseases, such as lung cancer, diabetes

mellitus, chronic obstructive pulmonary disease (COPD), stoke, and cardiovascular disease

(Martens et al., 2015; Surgeon General, 1989; U.S. Department of Health and Human Services,

2004; Shah & Cole, 2010; Cunningham, Ford, Rolle, Wheaton, & Croft, 2014; Berstad et al.,

2014). Smoking is the leading cause of death worldwide (World Health Organization, 2009).

According to the Canadian Tobacco, Alcohol and Drug Survey (2015), 13% of the Canadian

population were smokers in 2015. Among 3.9 million Canadian smokers, 2.8 million were daily

smokers and 1.1 million were non-daily smokers. In 2015, 15.6% of males (2.3 million people)

and 10.4% of females (1.6 million) were current smokers. According to the Canadian Tobacco

Use Monitoring Survey, from 1999 to 2015, smoking prevalence was higher among males than

females, although the magnitude of this difference varied over time. Current smoking prevalence

also varied significantly by age group: prevalence was highest among young adults aged 20-24

and lowest among youth aged 15-19. Average cigarette consumption among daily smokers was 13.8 cigarettes per day (CPD) in 2015, almost unchanged from the 2013 rate of 13.9 CPD. Between 1999 and 2015, cigarette consumption declined significantly, by more than 3 cigarettes per day. The average rate of decline in cigarette consumption during this time period was 1.3% per year. Not surprisingly, the survey also revealed that average daily cigarette consumption was significantly higher among male smokers, at 15.2, than among female smokers. Also, findings from this survey indicated that fewer current smokers rated their general and mental health "excellent" or "very good" than did former smokers and non-smokers (Reid, Hammond, Rynard, Madill, Burkhalter, 2017).

Figure 1.1 shows historical trends in smoking prevalence in Canada since 1965. Over the past five decades, there has been a remarkable decrease on smoking prevalence. Smoking rates have decreased by more than 50%, possibly because strong policies of tobacco control ban smoking in all workplaces and public places, including bars, bingo halls, and restaurants. However, tobacco is still the most important cause of premature death in Canada, and affects the life expectancy and quality of life of smokers (Canadian Lung Association, 2012). For example, smoking kills 37,000 Canadians every year. A Canadian study estimated that a number of 37,209 deaths and 515,608 years of life were lost prematurely due to smoking in 2002 (Baliunas et al., 2007).

The economic burden attributable to tobacco related diseases and society is enormous. The total costs of tobacco use were $16.2 billion, with indirect costs accounting for over half of total costs (58.5 per cent) and direct costs accounting for the remainder (41.5 per cent). Healthcare costs were the largest component of direct costs attributable to smoking, coming in at roughly

$6.5 billion in 2012. The indirect costs related to smoking, which reflect production losses (i.e., foregone earnings) as a result of smoking-attributable morbidity and premature mortality were estimated at $9.5 billion overall, of which almost $2.5 billion were due to premature mortality and $7.0 billion were due to short- and long-term disability (Health Canada, 2012).

Smoking particularly has severely harmful effects for specific populations, such as pregnant women and youth. For example, smoking during pregnancy can affect the baby's health before and after birth. The most serious complications include stillbirth, preterm labor, low birth weight and sudden infant death syndrome (Centers for disease control and prevention, 2014). Smoking behavior also has short-term and long-term harmful health effects among young people. Studies have shown that early signs of heart disease and stroke can be found in adolescents who smoke (Centers for disease control and prevention, 1994). Effective prevention programs against smoking will not only benefit smokers' long-term health conditions, but reduce the disease burden to the healthcare system. Therefore, it is important to understand and predict smoking behaviors among the specific populations.

Figure 1.1: Smoking prevalence (daily and non-daily smokers), Canada, aged 15+, 1965-2015
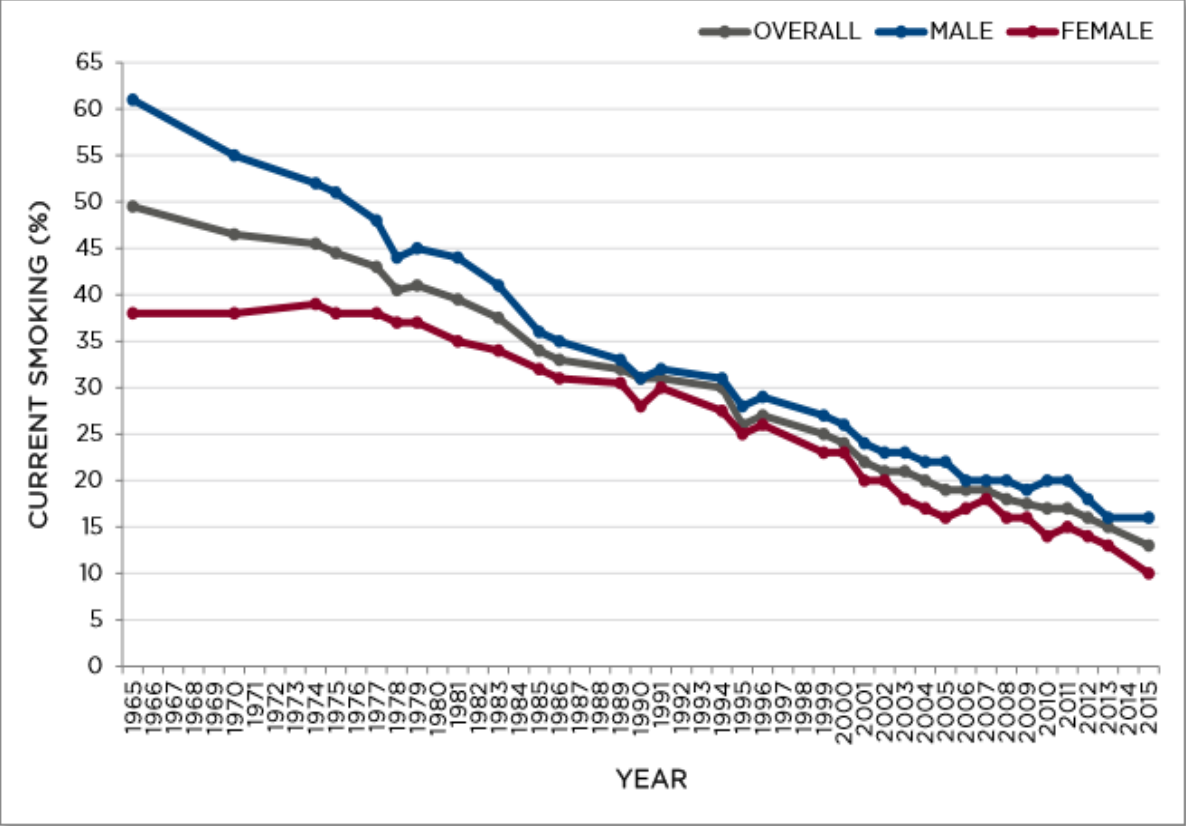
Source: Tobacco Use in Canada: Patterns and Trends, 2017 Edition.

1.2 Study objectives

This thesis contains three essays on smoking behavior. The main specific study objectives in this thesis were:

1. To estimate the prevalence of smoking during pregnancy and examine the demographic, socioeconomic, health-related and behavioral determinants of this behavior using the Canadian Community Health Survey 2009-10.

2. To investigate the price and income elasticity of adolescent cigarette smoking initiation and intensity using Canadian Youth Smoking Survey. If a youth has more pocket money, does that lead to more smoking (conditional on initiation), or even higher initiation rates? Do higher tobacco taxes work to reduce the initiation and intensity of youth smoking? To what extent can economic tools be used to control smoking among this vulnerable population?

3. To examine whether the smoking status of the general Canadian population is associated with the variations in health-related quality of life (HRQoL) as measured by the Health Utility Index Mark 3 (HUI3) once socioeconomic, chronic conditions and life style factors are controlled for, and to calculate the overall lifetime economic burden of loss in HRQoL using a commonly accepted $100,000 Willingness-to-Pay (WTP) threshold to gain one QALY. How do smoking related losses in HRQoL vary by age and gender?

Essay one used the 2009/10 Canadian Community Health Survey (CCHS) to examine the prevalence and the factors associated with smoking behavior during pregnancy. The findings demonstrate that women living in the Northern Territories had a high rate of smoking during

pregnancy compared to other provinces. The prevalence of smoking during pregnancy was also high among women under 25 years old, of low socioeconomic status, among those who reported not having a regular medical doctor, being fair to poor in self-perceived health, having at least one chronic disease, having at least one mental illness, being heavy smokers, and being regular alcohol drinkers. Results from multivariable logistic regression revealed that the odds of smoking during pregnancy were decreased with increasing age, having a regular family doctor, and having highest level of family income. Mothers who reported poor or fair self-perceived health and those who had at least one mental illness had greater odds of smoking during pregnancy. This study can guide public healthcare providers to promote health within the target population. By doing so, more effective and efficient smoking cessation interventions can be tailored to their needs.

Essay two used data from the 2012/13 Canadian Youth Smoking Survey, a national survey among students in grades 7-12, to estimate the elasticity of smoking initiation and intensity. Since no study has simultaneously examined the effects of both price and pocket money on youth smoking initiation and intensity, we report the price and income elasticity of adolescent cigarette smoking initiation and intensity. We found that a 1% increase in price is associated with a 1.13% decline in initiation and a 1.02% decline in intensity; while a 1% increase in pocket money is associated with a 0.07% increase in initiation and a 0.06% increase in intensity. The effects of pocket money are much smaller in magnitude than the response of smoking to the price of cigarettes. In addition, we also confirmed that factors such as school performance, life style, physical activity and home smoking environment are also associated with smoking behaviour. This study is important because the results have policy implications for reducing smoking

initiation and consumption among Canadian youth, and particularly for youth in grade 7-9. Standard economic tools, such as tobacco taxes, can be very effective with this vulnerable population, but we could also use behavioral economic techniques ("nudges") to influence school performance, lifestyle, and physical activity (Sunstein, 2013).

Essay three used data from the 2015 Canadian Community Health Survey to examine whether the smoking status is associated with a reduction in health related quality of life (HRQoL) as measured by the Health Utility Index (HUI3); to calculate the overall loss of HUI3 over a lifetime and economic burden of loss; and to compare smoking related losses in HRQoL by age and gender. Smoking was significantly and negatively associated with HRQoL loss. This essay demonstrated that smoking was associated with a 0.05 and 0.01 reduction in HUI3 score for current and former smokers, which also corresponds to a loss of 0.66 quality-adjusted life years in average, and also is associated with substantial individual and societal economic cost. When we adjusted the remaining years to life-expectancy, an average lifetime loss was 0.53 QALYs per smoker. Additionally, younger smokers are less likely to have vision, hearing, mobility, and pain impairment compared to older smokers but they are more likely to have cognition impairment. Compared to male smokers, female smokers are more likely to have vision, mobility, pain and cognition impairment, but they are less likely to have hearing speech and emotion problems.

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CHARPTER TWO: SMOKING DURING PREGNANCY: FINDINGS FROM THE 2009-2010 CANADIAN COMMUNITY HEALTH SURVEY[1]

2.1 Abstract

Objectives: Smoking during pregnancy may cause many health problems for pregnant women and their newborns. However, there is a paucity of research that has examined the predictors of smoking during pregnancy in Canada. This study used data from the 2009–2010 Canadian Community Health Survey (CCHS) to estimate the prevalence of smoking during pregnancy and examine the demographic, socioeconomic, health-related and behavioral determinants of this behavior.

Methods: The data were obtained from the 2009–2010 CCHS master data file. Weighted estimates of the prevalence were calculated. Multivariable logistic regression was used to determine demographic, socioeconomic, health related and behavioral characteristics associated with smoking behavior during pregnancy.

*Findings***:** Women living in the Northern Territories had a high rate of smoking during pregnancy (59.3%). The prevalence of smoking during pregnancy was also high among women under 25 years old, of low socioeconomic status, who reported not having a regular medical doctor, being fair to poor in self-perceived health, having at least one chronic disease, having at least one mental illness, being heavy smokers, and being regular alcohol drinkers. Results from multivariable logistic regression revealed that the odds of smoking during pregnancy were decreased with increasing age (odds ratio [OR], 0.95; 95% confidence interval [CI], 0.91–0.99), having a regular family doctor [OR, 0.24; 95% CI, 0.11–0.52], having highest level of family

income [OR, 0.09; 95% CI, 0.03–0.29]. Mothers who reported poor or fair self-perceived health

[OR, 2.13; 95% CI, 0.96–4.71] and those who had at least one mental illness [OR, 1.81; 95% CI,

1.00–3.28] had greater odds of smoking during pregnancy.

Conclusions: There are a number of demographic, socio-economic, health-related and

behavioral characteristics that should be considered in developing and implementing effective

population health promotional strategies to prevent smoking during pregnancy, promoting health

and well-being of pregnant women and their newborns.

2.2 Introduction

Addiction to smoking is a behavior-dependent disease with deferred adverse consequences for both a pregnant woman and her child. The prevalence of smoking among pregnant women has been shown to vary internationally. For example, the smoking rate among pregnant women ranged from 9.9% in Japan (Kaneita et al., 2007), 28% in Sweden (Lu, Tong, & Oldenburg, 2001) to 32% in England (The Information Centre, Lifestyle Statistics, 2006). In Canada, the prevalence of smoking while pregnant was estimated at 10.5% in 2005/2006 based on a Maternity Experience Survey (AI-Sahab, Saqib, Hauser, & Tamim, 2010). According to 2009/2010 Winnipeg Community Health Assessment report, 20% of Winnipeg Mothers of newborns reported smoking during pregnancy. The percentage of mothers who smoked varied depending on the community area in which they lived (Winnipeg Regional Health Authority, 2010).

There are growing public health concerns about the transfer of contamination such as nicotine monoxide and other chemicals from smoking pregnant women to the growing fetus. In particular, harmful substances in tobacco can affect the function of placental vascular and umbilical artery blood flow. They can also pass directly into the fetal bloodstream. As shown in accumulated epidemiological evidence, smoking by the mother during pregnancy is associated with adverse physiological effects in their children including congenital heart defects (Alverson, Strickland, Gilboa, & Correa, 2011); adverse effects on growth, abnormal neurodevelopment (including a propensity to addiction and decreased cognitive and learning skills) as well as lasting adverse effects on the respiratory system (Shea & Steiner, 2008). Children also suffer

long term effects of pregnant smoking, including a higher risk of obesity (Toschke, Montgomery, & Von Kries, 2003).

Smoking during pregnancy imposes a considerable economic burden on the healthcare system. In the United States, it was estimated that 21-39% of low weight births were attributable to smoking during pregnancy. Costs for intensive neonatal care of low-birth weight infants were $272 million, of which $267 million would not be incurred if maternal smoking was prevented (Oster, Delea, & Colditz, 1988). Likewise, in the United Kingdom, costs of smoking during pregnancy related to preterm birth, ectopic pregnancy, placenta previa, preterm rupture of membranes were estimated at £8-64 million per year (The University of York, 2010). In addition, according to American studies, every $1 spent on smoking cessation for pregnant women could save about $3 in reduce neonatal intensive care costs and $6 in long-term health costs (Erhoff et al., 1990; Marks, Koplan, Hogue, & Dalmat, 1990).

Some international research studies have shown that demographic and socio-economic factors, alcohol consumption, the mother's reproductive history and depression are associated with smoking during pregnancy (Mohsin & Bauman, 2005; Eriksson et al, 1998, Sevenson et al, 1995; Jané et al, 2000). To my knowledge, data on the prevalence and predictors of smoking during pregnancy is limited in Canada. Only three Canadian studies (AI-Sahab et al., 2010, Millar & Hill, 2004; Connor & Mclntyre, 1999) assessed smoking during pregnancy nationally up to now. However, none of these studies examined how health-related characteristics affect smoking behavior during pregnancy. To develop effective programs for smoking cessation during pregnancy, we need to know more about the determinants of this behavior. For example, what

kind of populations is more likely to smoke during pregnancy and where are their health conditions?

The CCHS collected information on socio-economic, demographic and behavioral and health related characteristics, which will help us to examine the determinants of the behavior of smoking during pregnancy.

2.2.1 Research questions

This study proposes to answer the following questions:

1. What is the proportion of Canadian women 15-55 years of age reported smoking during their previous pregnancy?

2. What are the demographic, socioeconomic, health- related and behavioral characteristics associated with smoking during pregnancy among women 15 to 55 years of age?

3. How do individuals' demographic, socioeconomic, health-related and behavioral characteristics affect their smoking behavior during pregnancy?

2.3 Methods

This is a secondary analysis designed to analyze a cross-sectional survey based on the 2009/10 CCHS.

2.3.1 Data source

The data were obtained from the 2009–2010 Canadian Community Health Survey (CCHS). This survey is a cross-sectional survey that collects information related to health status, healthcare utilization and health determinants for the Canadian population. The CCHS covers

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approximately 98% of the Canadian population aged 12 and older living in ten provinces and three territories. It excludes those persons living on reserves or crown lands, residing in institutions, and full-time member of the Canadian forces.

The 2009–2010 CCHS consisted of 172,761 selected households, of which 139,841 households agreed to participate in the survey, resulting in an overall household-level response rate of 81.0%. Among these responding households, 139,841 individuals (one per household) were selected to participate in the survey, out of which a response was obtained from 124,870 individuals, resulting in an overall person-level response rate of 89.3%. At the Canadian level, this yields a combined response rate of 72.3% for the CCHS 2009–2010 (Statistics Canada 2011). However, in some cases (2%) (Statistics Canada, 2011), the randomly selected respondents were incapable of completing an interview, so proxy responses were allowed. These responses were excluded from the analysis, because proxy respondents may answer differently from self-respondents resulting in potentially biased population estimates.

In the CCHS 2009–2010 questionnaires, in addition to core content that all provinces and territories included, there were optional content modules chosen by individual provinces and territories. The optional content fulfills the need for data at the health region level. This content, while often harmonized across the province, is unique to each region or province and may vary from year to year. One of the optional content modules in 2009–2010 was about smoking during last pregnancy; this module was chosen by two provinces (Ontario and Alberta) and two territories (Yukon and Nunavut) which together represent approximately 50% of the Canadian

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population. The analysis for this study was based on the responses from these two provinces and two territories.

2.3.2 Study population

The target population of the CCHS is all Canadians aged 12 and over in ten provinces and three territories. The CCHS covers approximately 98% of the target population. The CCHS uses both English and French to minimize the language barrier.

2.3.3 Study sample

For the purpose of this study, those who have ever been pregnant among all women aged 15 to 55 in the survey are included.

2.3.4 Study Measures

2.3.4.1 Smoking during pregnancy.

Based on the survey questions, the dependent variable is defined based on responses to a single question. The question asked was: "During last pregnancy, did you smoke daily, occasionally or not at all?" Those who responded "daily" and "occasionally" to this question were classified as smokers during the pregnancy. Those who responded "not at all" to this question were classified as non-smokers during the pregnancy. A binary variable distinguished respondents who reported smoking from respondents who reported not smoking during the last pregnancy. The first group was assigned a code of 1; the other group was assigned a code of 0.

2.3.4.2 Socioeconomic and demographic factors.

Many research studies have found clear socioeconomic gradients with smoking, such as employment, education, income and marital status (The Canadian Institute for Health

Information, 2003). Thus, a number of socioeconomic factors were included in this study. For the analysis, respondents are grouped by age and race as follows: 1) 15-24 years old; 25-34 years old; 35 and older. 2) race (Caucasian/non Caucasian).

Self-reported household income was classified into five categories in this study, based on the number of people in the household and total household income from all sources in the past 12 months (Statistics Canada, 2010): lowest income, lower-middle income, middle income, upper income and highest income. Other socioeconomic and demographic variables included were: education level (<university/university graduate), employment status (had a job last week/did not have a job last week), marital status (married or living as a couple/not living as a couple, who are divorced, separated, or widowed).

2.3.4.3 Health-Related factors.

A number of studies have determined that smoking has causal relationship with mental disorders (Lawrence, Mitrou, Zubrick 2009; Leonard, et al., 2001), chronic diseases such as diabetes, asthma, heart disease (The Public Health Agency of Canada, 2007), as well as healthcare utilizations (Kahende et al., 2009). Therefore, based on these literatures and the availability of data from the source survey, the following health-related determinants of smoking during pregnancy were included: self-perceived health (good/poor); self-perceived mental health (good/poor), feeling stressed (not at all to not very stressed versus a bit to extremely stressed), presence of a chronic disease (i.e. had at least one of asthma, heart disease, diabetes, hypertension, arthritis, migraine headache versus no chronic condition); has chronic mental

condition (presence of either a mood or anxiety disorder versus no disorder); has regular medical doctor (yes/no).

Two substance-related variables were included in the analysis. A smoking behavior variable was created by classifying respondents into two groups based on the frequency of smoking in 2009–2010. Those who usually smoked 20 or more cigarettes a day were defined as heavy smokers. Those who smoked less than 20 cigarettes were classified as light smokers. A drinking behavior variable: regular alcohol drinker (yes/no) was created by grouping individuals into two groups based on the frequency of their drinking behavior.

2.3.5 Statistical Techniques

To address the research objectives, the following analyses were conducted: 1) The prevalence of smoking during the pregnancy was estimated using weighted frequencies; 2) A series of bivariate analyses examined the cross-sectional association between each characteristic listed above and smoking behavior during the pregnancy. Results of these bivariate analyses informed the multivariable analyses which involved the development of a multivariable logistic regression model. 3) Multivariable logistic regression examined the extent to which individuals' socioeconomic, demographic, health-related, and behavioral factors were associated with smoking behavior during pregnancy of the target population. Significant predictors were identified based on the adjusted odds ratios and their 95% confidence intervals (CIs). Data analyses were performed using SAS v9.2 statistical software and SUDAAN version 10.0.1. For all analyses, the bootstrapping procedure was performed in SUDAAN to obtain design-based

estimates for all model parameters. These analyses used the bootstrap weights that were provided by Statistics Canada and contained in the CCHS master data file.

2.4 Ethical Consideration

The University of Manitoba Research Ethics Board expedites approval for secondary analysis of Statistics Canada data conducted in the Manitoba Research Data Centre. It has waived the need for written informed consent. This study was submitted to Statistics Canada for approval to access National Community Health Survey master data files at the Manitoba Research Data Centre. A number of measures employed to protect the confidentiality of the data; for example, disclosure avoidance analysis was conducted by the data analyst from Statistics Canada on all data released.

2.5 Results

The study population consisted of 369,547 women aged 15 to 55 who gave birth in the last five years and answered yes or no to the question "During your last pregnancy, did you smoke daily, occasionally or not at all?". The estimated prevalence of smoking during pregnancy was 23% overall (Table 2.1). The estimated prevalence of smoking during pregnancy was higher in the Northern Territories (59.3%) compared to the rates in Alberta (34.8%) and Ontario (18.5%).

Table 2.2 displays the weighted prevalence of smoking during pregnancy in terms of the selected socioeconomic, demographic, health-related and behavioral characteristics. The prevalence of smoking during pregnancy was higher for women who were under 25 years old (38.6%), having lowest household income (59.6%), less than university educated (18.8%), not living as a couple

(42.1%), and who did not have a job recently (24.9%). These findings suggest that individuals in lower socioeconomic groups are at an increased risk for unhealthy behaviors such as smoking during pregnancy. In addition, smoking during pregnancy was more prevalent among women who did not have a regular medical doctor (50.5%), rated their overall health as being fair to poor (43.1%), rated their mental health as being fair, or poor (37.7%), had at least one chronic disease (30.8%), had at least one mental disease (35.3%), felt stressed (23.2%), were heavy smokers (86%) and regular alcohol drinkers (27.8%).

Given the binary nature of the dependent variable (smoking during pregnancy: yes/no) multivariable logistic regression modeling was performed to determine the significant predictors of the outcome variable. All of the factors that showed a significant bivariate association with the outcome variable were included in the regression model. Controlling for the effects of all the other factors, five factors remained statistically significant in the multivariable logistic regression model: age, total household income, self-perceived health, having a regular medical doctor, and having a chronic mental illness. The adjusted odds ratios and their 95% CIs are presented in Table 2.3.

Total household income, which is considered to reflect socioeconomic status, was negatively associated with smoking during pregnancy. Women were less likely to smoke during pregnancy with increasing age [OR=0.95, 95% CI: 0.91, 0.99], or if they have a regular family physician [OR=0.24, 95% CI: 0.11, 0.52]. The results also revealed that poor self-perceived health was associated with an increased risk of smoking during pregnancy. In fact, women who reported poor to fair self-perceived health were more than twice as likely to smoke during pregnancy

[OR=2.13, 95% CI: 0.96, 4.71] compared to those with good to excellent self-perceived health. Furthermore, health-related conditions such as suffering a chronic mental condition including depression and/or anxiety were found to be associated with smoking during pregnancy [OR=1.81, 95% CI: 1.00, 3.28].

2.6 Discussion

This study examined the prevalence and characteristics of smoking during pregnancy among women in two provinces and two territories. The results showed the prevalence rate of maternal smoking was relatively high in Northern Territories (59.3%). This high prevalence may be partly due to the fact that tobacco has traditionally been used in many ceremonies, rituals and medicine in First Nations (Health Canada, 2010). This finding may also indicate that there is insufficient investment in public health campaigns such as tobacco harm reduction in the remote territories compared to the other provinces. Therefore, cost-effective interventions should be tailored to meet the needs of pregnant women in the Northern Territories.

Since previous research only investigated socioeconomic and demographic factors related to smoking during pregnancy, this study attempted to fill a gap in the literature by examining how health-related and behavioral factors are associated with the behavior of smoking during pregnancy. This study found that having a regular medical provider was associated with a decreased risk of smoking during pregnancy. This result illustrates that healthcare providers, such as family physicians, may play a vital role in helping their patients to stop smoking. Therefore, the increased use of family physicians or general practitioner services in remote areas might be effective in raising awareness of harmful tobacco use and reducing the risk of smoking

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during pregnancy. As an example, smoking cessation programs in clinics can provide education on the effects of smoking during pregnancy, and smoking cessation counseling by healthcare professionals can bolster the effects of such programs and raise awareness about the risks associated with smoking during pregnancy. In addition, this study found that mental health and poor self-perceived health are significant factors that affect the smoking behavior during pregnancy. Therefore, any intervention should ensure that pregnant women with mental illness can access the anti-smoking services.

The findings from this study are comparable with the previous Canadian studies. Compared to other studies, the overall prevalence rate of smoking during pregnancy was relatively stable. For example, Connor and MccIntyre (1999) estimated the prevalence rate of smoking during pregnancy in 1994 was 23.7%, while Millar and Hill (2004) estimated the prevalence to be 17% using data from the 2000/01 CCHS. These authors also found that rates of smoking during pregnancy varied by province, with lowest rates in Ontario (14%) and British Columbia (14%). Al-Sahab et al. (2010) used the Maternal Experience Survey (MES) to estimate the prevalence rate of smoking during pregnancy (10.5%) among Canadian women who had singleton live births in 2006. They also found that the Northern Territories had the highest prevalence rate (39.4%) among pregnant women. The findings also are consistent with other studies that reported age (<25), low income status, having mental illness, and self-perceived health to be associated with higher smoking prevalence in Canada (Millar & Hill, 2004; Al-Sahab, Saqib, Hauser & Tamim, 2010; Lawrence, Mitrou, Zubrick, 2009; Leonard et al., 2001; Nagahawatte & Goldenberg, 2008; Schneider & Schütz, 2008; Heaman & Chalmers, 2005; Muhajarine, D'Arcy, & Edouard, 1997). However, the limitations of comparing the results from different surveys

should be acknowledged. For example, MES had response rate of 75.2% and targeted Canadian women who had singleton live births within three months in 2006. The 2009–2010 CCHS had 89.3% response rate, but only four provinces and territories performed the optional content on smoking during pregnancy.

The findings of this study have several limitations that can affect their interpretation. First, the CCHS data are self-reported; thus recall bias is unknown. A related limitation is that, for many of the items in the survey, individuals are asked to remember if they have ever had a chronic condition or mood/anxiety disorder, and their recall could be incorrect. Second, the CCHS survey covers 98% of the total population, but information from the other 2% population was excluded. This missed population may include women residing in shelters or the homeless who are at a high risk of drug abuse problems and a high risk of smoking during pregnancy (Fischer & Breakey, 1991). This may result in an underestimate of the true prevalence of smoking during pregnancy in the population. Third, the survey questions regarding smoking during pregnancy do not differentiate levels of exposure to smoking during the trimesters of pregnancy. This prevents a further analysis on patterns of smoking during pregnancy. Finally, the CCHS survey module on smoking during pregnancy was an optional module, and only four provinces and territories opted in to this module. As a result, the estimated prevalence rate cannot represent the whole country.

2.7 Conclusions

In short, findings from this study might enhance the current knowledge of personal characteristics that are associated with increased likelihood of smoking during pregnancy. This is important information which can be used by those involved in public health education and

promotion to develop effective strategies for prevention of smoking during pregnancy or

promoting smoking-cession among pregnant women. On the basis of these findings, this study

can guide healthcare providers and policy makers to promote health within the target population.

By doing so, more effective and efficient interventions can be tailored to their needs.

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Table 2. 1: Weighed prevalence (%) of smoking during pregnancy by Provinces and Territories.

	Weighted prevalence	Low 95% CI	Upper 95% CI
Ontario	18.5	15.4	22.2
Alberta	34.8	28.2	42.0
Northern Territories	59.3	48.6	69.2
Overall	23.0	19.2	26.5

Data source: 2009-2010 Canadian Community Health Survey

Table 2. 2: Weighed prevalence (%) of smoking during pregnancy according to socioeconomic, demographic, behavioral, health-related factors.

	Factor	Weighted prevalence (%)	Lower 95% CI	Upper 95% CI	*p*
Demographic					
Age group	15-24	38.6	30.3	47.5	<.001
	25-34	24.7	20.6	29.2	
	35 and older	15.4	15.1	22.0	
Race	Caucasian	21.1	18.0	24.5	0.04
	Visible minority*	31.4	22.8	41.4	
Socioeconomics					
Total household income	Lowest income	59.6	34.6	80.4	<.001
	Lower-middle income	45.9	31.4	61.2	
	Middle income	36.2	26.1	47.7	
	Upper income	22.7	17.0	29.7	
	Highest income	9.1	6.6	12.6	
	Missing	29.5			

Education	<University	18.8	15.6	22.5	<.001
	>=University	5.1	1.8	13.5	
	Missing	29.8			
Employment	Did not have a job last week	24.9	20.9	29.3	0.30
	Had a job last week	21.4	16.8	26.9	
Marital status	Married or living as a couple	17.0	14.4	19.9	<.001
	Not living as a couple	42.1	33.9	50.8	
Health related					
Has a regular medical doctor	Yes	20.6	17.5	24.1	<.001
	No	50.5	37.4	63.6	
Self-perceived health	Good to excellent	21.7	18.4	25.3	0.002
	Fair to poor	43.1	31.5	55.5	
Self-perceived mental health	Good to excellent	22.2	19.1	26.5	0.03
	Fair to poor	37.7	25.8	51.2	
Has chronic	At least one	30.8	24.6	37.9	0.004

disease[+]	No	19.4	16.3	22.9	
Stress	Not at all to not very stressful	22.5	16.5	29.8	0.85
	A bit to extremely stressful	23.2	19.7	27.1	
Has chronic mental disease[‡]	At least one	35.3	27.8	43.5	<.001
	No	21.0	17.6	24.7	
Behavioral					
Frequency of smoking	Light smoker	61.3	54.2	68.0	<.001
	Heavy smoker	86.0	74.1	92.8	
Regular alcohol drinker	Yes	27.8	22.6	33.6	0.02
	No	19.6	15.9	23.8	

Data source: 2009-2010 Canadian Community Health Survey
* Including Indigenous Population
+One of Heart disease, Asthma, Diabetes, Arthritis, Hypertension, Migraine headache;
‡One of Depression, Anxiety.

Table 2. 3: Weighted multivariable logistic regression

	Factor	OR (95% CI)	*p*
Age		0.95 (0.91, 0.99)	0.01
Has a regular medical doctor	Yes	0.24 (0.11, 0.52)	<.001
	No	1.00	
Self-perceived health	Good to excellent	1.00	0.06
	Fair to poor	2.13 (0.96, 4.71)	
Has chronic disease	Yes	1.81 (1.00, 3.28)	0.05
	No	1.00	
Total household income	Lowest income	1.00	<.001
	Low-middle income	0.44 (0.12, 1.62)	
	Middle income	0.34 (0.10, 1.13)	
	Upper-middle income	0.20 (0.06, 0.69)	
	Highest income	0.09 (0.03, 0.29)	

Data source: 2009-2010 Canadian Community Health Survey
*One of Heart disease, Asthma, Diabetes, Arthritis, Hypertension, Migraine headache
+One of Depression, Anxiety

CHARPTER THREE: THE EFFECTS OF CIGARETTE PRICE AND THE AMOUNT OF POCKET MONEY ON YOUTH SMOKING INITIATION AND INTENSITY IN CANADA

3.1 Abstract

Objectives: To investigate the price and income elasticities of adolescent smoking initiation and intensity to determine the extent to which increased pocket money leads to greater smoking among youth, and whether higher taxes can mitigate this effect.

Methods: We used the 2012/13 Canadian Youth Smoking Survey including students in grades 7-12. Multivariable logistic regression was used to examine the probability of smoking initiation, and a linear regression to examine the smoking intensity determined by province-level prices of cigarettes, pocket money and a vector of individual characteristics including age, sex, race, school-related and psychosocial factors.

Results: 28.8% of respondents have tried cigarette smoking. More than 90% of these initiated smoking between age 9 and 17. Male smokers consumed a higher average number of whole cigarettes daily than did females. The price elasticity of smoking initiation and intensity for youth in the full sample were -1.13 and -1.02 respectively, which means that a 10% increase in price leads to a 11.3% reduction in initiation and a 10.2% reduction in intensity. The income elasticity of smoking initiation and intensity for youth in the full sample were 0.07 and 0.06 respectively, which means that a 10% increase in income leads to a 0.7% increase in initiation and a 0.6% increase in intensity.

Conclusions: Economic measures such as taxation that raise the price of cigarettes may be a useful policy tool to limit smoking initiation and intensity.

3.2 Introduction

Despite strong suggestions from economic theory that higher prices will lead to less consumption of cigarettes, decades of empirical studies from around the world have not shown conclusively that higher prices will lead to lower rates of smoking initiation or less consumption among young people (Bader, Boisclair, Ferrence, 2011; Azagba& Sharaf, 2011). A large body of research has investigated the impact of either an increased cigarette tax or income on smoking behavior. However, to our knowledge, no studies have examined the relative sizes of both price and pocket money effects on youth smoking initiation and intensity. Given that little is known about the relative sizes of the effects, the purpose of this paper is to use the National Youth Smoking Survey (YSS) (2012/13) in Canada to answer the following questions: 1). what is the proportion and characteristics of Canadian youth in grades 7-12 who reported smoking initiation in Canada and each province? 2). what is the price and income elasticity of cigarette smoking initiation and intensity? and 3) what is the effect of more pocket money, on the amount smoked (conditional on initiation), and on smoking initiation rates?

Cigarette smoking among youth is a critical public health issue because it has a number of negative health effects on young people. A majority of smokers initiated smoking when they were teenagers. Cigarette smoking during childhood and adolescence poses a clear risk for respiratory symptoms and problems during adolescence; these health problems are risk factors for other chronic conditions in adulthood, including chronic obstructive pulmonary disease (Centers for Disease Control and Prevention, 1994). Research shows that the earlier adolescents begin smoking cigarettes, the more likely they are to become addicted to nicotine. According to results from a nationally representative health survey, nearly 90 percent of adult smokers begin

smoking in their teens or earlier (U.S. Department of Health and Human Services, 2014).

Therefore, youth smoking is a significant public health issue globally. Preventing or delaying

tobacco use by youth can lower short- and long-term health risks.

Price elasticity of demand is a term in economics that is used to measure the relationship

between a change in the quantity demanded of a particular good and a change in its price. Price

elasticity of demand is very important for policy makers to understand when they are thinking

about the effects of tobacco price and taxes, because it measures how much demand is likely to

decline if the price paid by consumers increases due to an increase in taxation. Several empirical

studies have found that young smokers are more sensitive to tobacco price fluctuation than adult

smokers (Azagba & Sharaf , 2011; Zhang, Cohen, Ferrence, & Rehm, 2006; Nargis et al., 2014).

Much existing research suggests that tobacco taxation or increased price should be an effective

strategy to reduce smoking initiation and participation among youth. Two systematic reviews

(Wilson et al., 2012; Rice et al., 2009) found price to be negatively related to smoking initiation

and the total quantity of cigarette smoked. Evidence also suggests that gender and ethnicity

matter. Males are more responsive to price than females and black youth are more responsive to

price than white youth (Azagba & Sharaf , 2011). Canadian studies using different surveys also

found that decreased cigarette price was significantly associated with higher smoking initiation

(Azagba & Sharaf , 2011; Zhang, Cohen, Ferrence, & Rehm, 2006). The evidence in the

literature, however, is not uniform. For example, two recent studies found that price and tax

increases would have little effect on youth smoking initiation (Douglas & Hariharan, 1994;

Trauras, O'Malley, Johnston, 2001). DeCicca, et al. used longitudinal data to examine the

dynamics of young adults' decisions about smoking initiation and cessation. They concluded that

no evidence was found that higher taxes discourage smoking initiation, but they found some evidence that taxes encourage smoking cessation (DeCicca et al., 2008). A longitudinal study of adolescent health found heterogeneous price elasticities across adolescent groups and found that heavy smokers are unresponsive to cigarette taxes (Fletcher, Deb, & Sindelar, 2009).

Income elasticity of demand measures the responsiveness of quantity consumed to income available. If income elasticity of demand is positive, an increase in income leads to an increase in quantity consumed. Evidence shows that the level of personal income and family socioeconomic status (SES) are associated with smoking behavior among adolescents; that is, adolescents with more pocket money and from low SES background were more likely to be smokers (Perelman et al., 2017; Ma et al., 2013). However, one of these studies (Perelman et al., 2017) found that the intensity of smoking is not related to personal income among low SES adolescents. The authors found that adolescents from low SES were more exposed to smoking by exchanging cigarettes with their friends, weakening the income influence.

This essay investigates the price and income elasticity of demand to determine their relative impacts on smoking initiation and intensity among adolescents in Canada.

3.3 Ethical Consideration

Prior to conducting this research project, application for ethics approval was made to the University of Manitoba, Bannatyne Campus, Research Ethics Board. The Health Research Ethics Board (HREB) approved it on August 17, 2015 (Ethics reference number: H2015:332).

3.4 Methods

3.4.1. Data

This study used nationally representative data collected in 2012/13 Youth Smoking Survey (YSS). Detailed information on the survey development, sample design, data collection protocol, methods of the YSS has been presented elsewhere (Elton-Marshall et al., 2011). The YSS is a biennial, self-reported, nationally generalizable classroom-based, pencil and paper survey that is used to measure the determinants of smoking behavior among youth. The target population was students in grades 6 to 12 attending public and private schools in the ten Canadian provinces. The survey excludes those living on First Nations reserves, Canada's three northern Territories (Yukon, Nunavut, and Northwest Territories), and those attending special schools (e.g., schools for visually-impaired and hearing-impaired individuals) or schools on military bases. The main objective of the YSS is to provide benchmark data on national prevalence rates for students in grades 6 through 12. In addition, it provides a unique opportunity to advance our knowledge of the psychosocial correlates of smoking behavior, including initiation and cessation. Further, it can assist in exposing individual differences in the influence of tobacco marketing, purchasing controls, and other policy initiatives. The survey, conducted on behalf of Health Canada by the Propel Centre for Population Health Impact at the University of Waterloo, captured information mainly on tobacco, alcohol, and drug use (Government of Canada, 2016).

In the 2012/2013 YSS cycle, nine provinces participated in the survey. Overall, the average school participation rate was 64%, with about 72% of students in these schools completing the questionnaires. The 2012/2013 YSS was administered to 47,203 youths in grades 6 through 12 attending schools (in Quebec, secondary school ends at grade 11). Survey weights were used in the descriptive statistics of student-level characteristics to adjust for differential response rates

across regions or groups. As described previously (Elton-Marshall et al., 2011), the development of the survey weight was accomplished in two stages. In the first stage a weight (W_{1j}) was created to account for the school selection within health region and school strata. A second weight (W_{2jg}) was calculated to adjust for student non-response. The weights were then calibrated to the provincial gender and grade distribution so that the total of the survey weights by gender, grade and province would equal the actual enrolments in those groups.

3.4.2 Measures

3.4.2.1 Dependent variables

Students were grouped by Grade 7-9 and Grade 10-12. The outcome variables in this study included smoking initiation (defined as having ever tried cigarette smoking, even just a few puffs) and smoking intensity. Smoking initiation is a binary variable equal to 1 if the student describes him/herself having ever tried cigarette smoking even just a few puffs; and zero otherwise. Smoking intensity is assessed based on a survey question: "Average number of whole cigarettes smoked on the days that the respondent smoked." In this sample, the average number of whole cigarette smoked daily was 5.3 (S.D.=5.9).

3.4.2.2 Independent variables

In additional to cigarette price, a variety of individual-level explanatory variables were considered. These included sex (Male/Female), ethnicity (Caucasian/Visible Minority), province of residence, and weekly availability of pocket money usually a student get each week to spend on or to save (including all money from allowances and jobs like babysitting, delivering papers etc), days of school missed because of health in the last 4 weeks, school performance in terms of

grades in the past year [ranging from high (mostly A's and B's /level 3 and 4), to medium (mostly B's and C's/level 3), to low (mostly C's and below/level 1 and 2)], school attachment according to a student felt a part of the school community (agree/disagree), the rules about smoking at home (total home smoking ban/no home smoking ban), having at least one parent, sibling or close friend who smokes, frequency of having 5 drinks of alcohol or more on one occasion in the last 12 months. In addition, several other variables were also constructed to reflect the characteristics of each respondent. They are daily physical activity (<=1 hour/> 1 hour), daily food choice behavior (<=6 servings of fruits and vegetable/>6 servings of fruit and vegetable), a general score to reflect the student's overall self-esteem (greater or less than the median score of 8). YSS asked question: "*how many minutes of physical activity you did on each of the past 7 days?*" The Canadian Society for Exercise Physiology recommend that children and youth aged 5 to 17 accumulate at least 60 minutes of moderate-to-vigorous intensity aerobic physical activity (MVPA) per day in order to achieve health benefits (The Canadian Society for Exercise Physiology, 2015). According to the Guidelines, we categorized daily physical activity as <1 hours and >=1 hour at least 6 days a week. Additionally, YSS also collected information on how many servings of fruits and/or vegetables (FV) the respondent ate on a usual day.

The YSS data include the province of residence of each respondent. This information is used subsequently to obtain a match with cigarette price data. Unfortunately, the survey does not contain any cigarette price information directly. In order to find retail cigarette prices, the price of cigarettes in 2012 in Canada's province was obtained from the Non-Smokers' Rights Association (Smoking and Health Action Foundation, 2012). The retail price is the average price of a carton of 200 cigarettes, all provincial and federal taxes (including PST and GST) included.

3.4.3 Economic models

Firstly, we analyzed the elasticity of demand for smoking initiation based on the cigarette prices and the availability of weekly spending money. Equation (1) represents the probability of smoking initiation model based on the function (*f*) of cigarette prices and the amount of weekly spending money. The probability of smoking initiation of cigarette smoking by individual *i* is determined by the following independent variables: province-level prices of cigarettes (*Pt*), pocket money (*Mt*) and a vector of individual characteristics including age, sex, race, province, school-related and psychosocial factors (*Di*). Secondly, we analyzed the elasticity of demand for smoking intensity based on the price and the availability of weekly spending money. The dependent variable of equation (2) is the log of the average number of whole cigarettes smoked on the days that the respondent smoked (*Qt*) and it is estimated using a linear regression model. The explanatory variables are those described above.

PROB (smoking initiation=1)=f (log (Pt), M(t), Di) **(1)**

log(Qt)=f (log(Pt), M(t), Di) **(2)**

In order to calculate the elasticity for smoking initiation and intensity, firstly, we differentiated with respect to price and pocket money from the equations respectively, aiming to find dP/d(price). Then the price elasticity of demand for smoking initiation (*E$_p$*) is equal to:

E$_{p=}$ dP/d(price)*Average cigarette price/the population probability of smoking

The income elasticity for smoking initiation is:

E$_{inc=}$ dP/d(income)*Average income/the population probability of smoking

The elasticity of demand for smoking intensity (*E$_I$*), it is calculated by:

E$_{I1=}$d(smoking quantity)/smoking quantity/(d(price)/price)

The income elasticity for smoking intensity is:

$E_{I2=}d(smoking\ quantity)/smoking\ quantity/(d(income)/income)$

All regression results and the descriptive analysis are population weighted using the survey weights to produce population estimates and adjust for unequal probabilities of selection. All analyses were carried out using SAS version 9.3 (SAS Institute Inc., Cary, NC).

3.5 Results

A total of 41,057 students completed questionnaires in 2012/13 YSS. Of these, 28.8% have ever tried cigarette smoking, even just a few puffs. The estimated prevalence of current cigarette smoking among youth was 5.1% overall. The prevalence was higher in New Brunswick and Saskatchewan compared to the rates of British Columbia and Ontario (table 3.2). Table 3.3 shows the weighted descriptive statistics of smoking initiation by sex for the key variables used in this study. The weighted sample characteristics showed that 9.4% are current daily smokers and 9.8% are current occasional smokers. More than 90% initiated smoking between age 9 and 17. Male smokers have higher average number of whole cigarette smoking daily than the females. Approximately 63% reported having 5 or more drinks of alcohol on one occasion during the past 12 months. Compared to other province, Ontario has a higher smoking initiation rate.

The price and income elasticity of cigarette initiation is presented in Table 3.4. We presented the full model for the overall sample and two separate groups based on different school grades. The coefficient estimates for cigarette prices are statistically significant in all equations indicating

that the price of cigarettes has a significantly negative impact on smoking initiation. These estimates illustrate that higher cigarette prices will significantly reduce smoking initiation for youth. The price elasticity of smoking initiation for youth in the full sample is -1.13, showing that a ten percent increase in cigarette price would reduce smoking initiation by 11.3%. Compared to students in grade 10-12, the result reveals that students in grade 7-9 are more responsive to cigarette prices. If the price increases ten percent, it would lead to 15.7% reduction in smoking initiation among younger students.

With regard to pocket money, the coefficient estimates of pocket money for smoking initiation were also statistically significant for all equations. Therefore, the amount of pocket money is a significant predictor for youth smoking initiation. If a student has more pocket money, it will result in a slightly higher probability of smoking initiation. For example, for all students in grade 7-12, a ten percent increase in pocket money would increase the smoking initiation rate by 0.7%. The elasticity of students in grade 7-9 and grade 10-12 are the same, which means a 10% increase in pocket money would lead to 0.5% increase of smoking initiation for subgroups. While significant and positive, these effects are much smaller in magnitude than the response of smoking to the price of cigarettes. In addition, factors such as being females, Caucasians, having better school performance, no parent/guardian smokers, no sibling smokers, no close friend smokers, having a home smoking ban, missing fewer school days due to health, having more physical activity and having strong school attachment are found to be significantly associated with the reduction of smoking initiation for the full sample and subgroups.

Turning next to the smoking intensity model, Table 3.5 shows the price and income elasticity of smoking intensity. The coefficient estimate of price was also significantly negative for the subgroups and the full sample. The price elasticity of smoking intensity for students in grade 7-12 is -1.02, indicating that a 10% increase in price for a carton of 200 cigarettes would correspond to a 10.2% decrease in the average number of whole cigarettes smoked by smokers. We found greater price sensitivity among younger students, with price elasticity of -1.93 for students in grade 7-9, -0.76 for students in grade 10-12. This finding suggests that younger smokers are particularly affected by cigarette prices, which means that a higher price will encourage them to smoke fewer cigarettes. Furthermore, school performance, a home smoking ban, parent, sibling and close friend smoking status, school attachment, fruit and vegetable servings, frequency of excess alcohol consumption, and missed school days due to health are significant in determining smoking intensity in for the youth in grade 7-12.

Weekly pocket money is found to have a positive and significant impact on smoking intensity in the subgroup and the full sample. We found if individual young smokers have more money available, then they are likely to have higher initiation rates and to smoke more cigarettes ($p<.001$). The income elasticity is 0.06, suggesting a ten percent increase in pocket money will correspond to 0.6% increase in cigarette consumption. The income elasticity estimates for students in grade 7-9 and grade 10-12 are very close, ranging from 0.02 to 0.06.

3.6 Discussion

In this paper, we examined the effects of cigarette prices and the amount of pocket money on youth smoking initiation and intensity among students in grade 7 to 12 in Canada. Our price

elasticity measures the degree of responsiveness of cigarette demand with respect to the price

changes; our income elasticity measures the responsiveness of cigarette demand with respect to

the change in individual student's weekly pocket money. Consistent with several previous

studies (Zhang, Cohen, Ferrence, & Rehm, 2006; Nargis et al., 2014; Rudatsikira , Muula,

Siziya, 2009), our findings suggest that both cigarette prices and amount of pocket money will

have a significant impact on youth smoking onset and the quantity of cigarette smoke. The

negative price elasticity of smoking initiation suggests that increasing the price of cigarette

would significantly lower the rate of youth smoking initiation. Especially for younger students in

grade 7-9, a small change in cigarette price would also result in a big reduction in quantity

consumed. For example, the total elasticity of cigarette demand is -3.5 (sum of the elasticities of

smoking initiation and conditional demand intensity), implying that the demand is highly price

elastic for this subgroup.

Compared to the cigarette price, the amount of pocket money is relatively inelastic for cigarette

demand. Our findings show that the amount of pocket money is positively correlated with youth

smoking initiation and smoking intensity although the elasticity of smoking initiation and

intensity to pocket money is weak compared to price. This suggests that attempts to control

smoking among young people by curtailing their access to pocket money will have much less

impact on youth smoking rates than will the simple policy expedient of raising prices through

taxation.

Cigarette and alcohol consumption often develop concurrently, people who drink alcohol often

also smoke and vice versa. We found that the frequency of excessive alcohol consumption is

strongly associated with smoking behavior. Therefore, smoking cession intervention should also focus on youth with substance abuse problems. Previous studies (Middaugh, Fisk, Brunt, Rhee, 2011; Dubowitz et al., 2008) have shown that FV consumption is positively correlated with family income. We chose FV consumption as a proxy measure of family income because YSS did not contain this information. In addition, research has (Haibach, Homish, Giovino, 2013) suggested that higher FV consumption was associated with fewer cigarettes smoked per day and FV consumption may be protective against cigarette smoking. Not surprisingly, we found lifestyle factors such as unhealthy diet and inadequate daily physical activity were also associated with smoking initiation and intensity. These findings suggest that the relationship between lifestyle and smoking could be mediated through social economic status (Wardle & Steptoe, 2003; Soteriades & DiFranza, 2003). Our study also revealed that school performance and attachment are related to smoking initiation after controlling for individual characteristics and other factors. Those students who do well in school, have high academic performance and are committed to school are less likely to smoke than students who do not.

In line with other previous studies (Bricker et al., 2006; Bricker et al., 2009) besides controlling for individual characteristics, such as sex, race, this study found social influence is associated with youth smoking behavior. Having a parent, sibling and/or close friend who smoke is associated with a significantly higher risk of smoking initiation and intensity in youth. In particular, we found that having close friends who smoke is the strongest predictor of youth smoking initiation. Since the effect size of peer influence on individual's smoking initiation is large, population-based prevention/intervention programs for reducing the smoking burden in youth may need to focus on peer pressure.

There are limitations to this study. First, the YSS is self-reported; thus recall bias is unknown. For example, the students were asked about events occurring during the past months, and their recall could be incorrect. Second, the YSS does not collect information such as household income, parents' characteristics, student employment status, school tobacco prevention programs etc. which may be important factors not adjusted in the analysis. Third, this study used cross-sectional data; therefore the temporal relationship between the outcome and factors cannot be drawn. Fourth, the use of cross-sectional data to derive elasticities could also lead to biased results. Ideally, we would use longitudinal or repeated cross-sectional data to derive elasticities, but our data source was a single cross-section. Therefore, we derived price elasticities by exploiting provincial differences in prices at a point in time. However, there could be omitted variables related to cultural or other differences between provinces that are partly responsible for the observed differences. Despite the limitations, this study provides interesting insights that we should note. For example, the levels of physical activity, school performance and attachment, and fruit and vegetable servings are associated with youth tobacco use.

3.7 Conclusions

The findings from this study have important policy implications for smoking initiation and consumption among Canadian youth, and particularly for youth in grade 7-9. Our results suggest that the association between economic factors such as cigarette prices and tobacco use is particularly strong among young people. These results are consistent with other studies that focus on smoking initiation and consumption among youth (Zhang, Cohen, Ferrence, & Rehm, 2006; Nargis et al., 2014; Rudatsikira , Muula, Siziya, 2009). Since the onset of smoking behavior usually occurs during the teen years and younger smokers are more price sensitive,

economic measures, such as taxation, that raise the price of cigarettes may be a useful policy tool. In addition, since family and close friends who smoke are strong predictors for youth smoking behavior, smoking prevention in school and community should be designed to increase the awareness of healthy life style and help students manage pressure and influence on smoking.

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Table 3. 1: Cigarette price and tax rates per 200 cigarettes in Canada, as of November 2012

Province	Pre-tax price	Total tobacco tax*	Total retail price
Newfoundland and labrador	$27.90	$65.78	$93.68
Prince Edward Island	$28.11	$72.60	$100.71
Nova Scotia	$29.35	$73.45	$102.80
New Brunswick	$19.42	$60.15	$79.57
Quebec	$30.49	$46.46	$76.95
Ontario	$29.46	$50.95	$80.41
Saskatchewan	$29.17	$67.82	$96.99
Alberta	$27.48	$61.22	$88.70
British Columbia	$31.13	$64.22	$95.35

Source: Smoking and Health Action Foundation, Ottawa, 2012

*including: federal excise tax, provincial excise tax, provincial sale tax or harmonized sales tax and federal GST

Table 3. 2: Weighted prevalence (%) of current smoker among youth in grade 7-12 by Provinces and Territories.

	Weighted prevalence	Lower 95% CI	Upper 95% CI
Newfoundland and Labrador	7.15	4.07	10.22
Prince Edward Island	7.73	5.89	9.57
Nova Scotia	5.98	2.84	9.13
New Brunswick	10.24	7.84	12.65
Quebec	6.07	3.25	8.88
Ontario	4.53	2.19	6.88
Saskatchewan	8.56	3.75	13.36
Alberta	4.42	2.90	5.94
British Columbia	3.97	0.71	7.23
Canada	5.12	3.73	6.50

Data source: 2012/13 Canadian Youth Smoking Survey

Table 3. 3: Weighted percentage (95% CI) of sample characteristics of smoking initiation, 2012/13 YSS

Characteristics	Male	Female	Total
Demographic			
Grade			
7-9	31.00 (26.16-35.84)	30.18 (25.43-34.93)	30.63 (26.17-35.09)
10-12	69.00 (64.16-73.84)	69.82 (65.07-74.57)	69.37 (64.91-73.83)
Province of residence			
Newfoundland and Labrador	1.48 (1.09-1.87)	1.52 (1.06-1.98)	1.50 (1.10-1.89)
Prince Edward Island	0.58 (0.47-0.68)	0.52 (0.40-0.65)	0.55 (0.45-0.66)
Nova Scotia	2.56 (2.00-3.13)	2.85 (1.91-3.78)	2.69 (2.02-3.36)
New Brunswick	3.18 (2.64-3.71)	3.65 (2.94-4.36)	3.39 (2.83-3.95)
Quebec	25.62 (20.67-30.57)	25.85 (20.21-31.49)	25.72 (20.65-30.79)
Ontario	41.03 (34.85-47.22)	40.58 (32.38-48.78)	40.83 (34.05-47.61)

Saskatchewan	4.35 (3.28-5.42)	4.66 (3.13-6.20)	4.49 (3.24-5.73)
Alberta	10.44 (8.29-12.59)	10.12 (7.07-13.17)	10.30 (7.84-12.76)
British Columbia	10.77 (5.51-16.04)	10.25 (1.26-19.24)	10.54 (3.65-17.42)
Ethnicity/Race			
Caucasian	72.08 (66.18-77.97)	75.31 (69.16-81.45)	73.53 (67.84-79.21)
Visible minority	27.92 (22.03-33.82)	24.69 (18.55-30.84)	26.47 (20.79-32.16)
Weekly spending money			
$0	13.06 (11.19-14.92)	13.06 (11.43-14.68)	13.06 (11.73-14.38)
$1-$40	39.13 (36.40-41.85)	39.64 (35.48-43.81)	39.36 (36.49-42.22)
$41-$100	12.09 (9.39-14.80)	12.34 (10.70-13.97)	12.20 (10.24-14.17)
More than $100	21.34 (18.55-24.13)	17.61 (13.75-21.47)	19.67 (16.87-22.46)
Not stated	14.28 (12.10-16.67)	17.35 (15.32-19.34)	15.71 (14.04-17.39)
Smoking-related			

Cigarettes smoking status			
Current daily smoker	10.50 (8.21-12.80)	7.97 (5.85-10.08)	9.36 (7.50-11.23)
Current occasional smoker	10.82 (8.55-13.09)	8.47 (5.87-11.08)	9.77 (7.83-11.71)
Former daily smoker	2.45 (1.29-3.62)	2.22 (1.49-2.94)	2.35 (1.68-3.01)
Former occasional smoker	0.63 (0.12-1.14)	0.14 (0.01-0.28)	0.41 (0.11-0.71)
Experimental smoker	12.96 (11.42-14.51)	16.17 (14.07-18.27)	14.40 (13.01-15.79)
past experimental smoker	22.11 (20.39-23.82)	22.78 (18.60-26.97)	22.41 (20.43-24.39)
Puffer	40.52 (36.00-45.05)	42.25 (38.43-46.06)	41.30 (38.06-44.53)
Alcohol-related			
Frequency of having 5 drinks of alcohol or more on one occasion in the last 12 months			
Never	38.51 (33.49-43.54)	35.03 (29.26-40.81)	36.95 (31.95-41.96)
Daily	2.15 (1.19-3.12)	0.91 (0.19-1.62)	1.59 (0.93-2.26)
1-5 times a week	11.02 (7.24-14.80)	8.80 (7.19-10.40)	10.02 (7.53-12.52)

Less than once a month	19.28	25.34	21.99
	(16.73-21.82)	(21.44-29.23)	(20.12-23.86)
1-3 times a month	29.04	29.93	29.44
	(26.08-32.00)	(26.08-33.78)	(26.85-32.03)
Age of initiation (first tried smoking cigarettes, even just a few puffs)			
8 years or younger	8.67	4.73	6.86
	(7.12-10.23)	(3.48-5.99)	(5.66-8.06)
9-14	60.64	59.82	60.26
	(57.16-64.11)	(54.35-65.28)	(56.36-64.16)
15-17	30.08	34.81	32.26
	(26.74-33.42)	(29.46-40.15)	(28.45-36.07)
18 years and older	0.61	0.64	0.63
	(0.15-1.08)	(0.12-1.15)	(0.31-0.94)
Smoke 100 or more whole cigarette in your life			
Yes	24.41	18.80	21.89
	(20.83-27.98)	(14.90-22.70)	(18.68-25.10)
No	75.59	81.20	78.11
	(72.02-79.17)	(77.30-85.10)	(74.90-81.32)
Average number of whole cigarettes smoking daily			
Mean (SE)	5.29 (3.22)	4.17 (1.48)	4.84 (2.20)
School-related			
Days of school were missed in the last 4 weeks because of health			
0 days	65.44	51.63	59.23

	(62.62-68.23)	(46.67-56.59)	(56.46-62.00)
1-5days	30.36 (27.64-33.08)	42.55 (38.18-46.91)	35.84 (33.32-38.37)
6 or more days	4.20 (2.97-5.42)	5.82 (4.35-7.29)	4.93 (3.83-6.03)
School performance (grades)			
Level 4 and 5	54.83 (48.79-60.86)	65.07 (60.32-69.82)	59.43 (54.68-64.17)
Level 3	32.93 (27.38-38.47)	25.44 (22.00-28.89)	29.56 (25.71-33.42)
Level 1 and 2	12.25 (10.38-14.11)	9.49 (7.53-11.45)	11.01 (9.51-12.50)
Psychosocial			
Overall self-esteem score			
<=8 (median)	28.81 (25.23-32.38)	55.25 (52.09-58.41)	40.67 (37.90-43.44)
9-12	71.19 (67.62-74.77)	44.75 (41.59-47.91)	59.33 (56.56-62.10)
I feel I am part of my school			
Strongly agree/agree	71.25 (67.54-74.96)	77.67 (74.25-81.08)	74.75 (71.64-77.86)
Strongly disagree/disagree	28.75 (25.04-32.46)	22.33 (18.92-25.75)	25.25 (22.14-28.36)

The rules about smoking in your home			
Total home smoking ban	68.73 (63.31-74.14)	68.83 (64.89-72.78)	68.78 (64.60-72.97)
No total home smoking ban	31.27 (25.86-36.69)	31.17 (27.22-35.11)	31.22 (27.03-35.40)
At least one parent/guardian smokes			
Yes	55.57 (50.95-60.19)	57.48 (51.45-63.52)	56.44 (52.07-60.82)
No	44.43 (39.81-49.05)	42.58 (36.48-48.55)	43.56 (39.18-47.93)
At least one sibling smokes			
Yes	29.79 (25.13-34.46)	33.61 (30.14-37.07)	31.53 (27.74-35.32)
No	70.21 (65.54-74.87)	66.39 (62.93-69.86)	68.47 (64.78-72.26)
At least one close friend smokes			
Yes	66.16 (61.58-70.74)	67.21 (63.30-71.12)	66.64 (62.84-70.44)
No	33.84 (29.26-38.42)	32.79 (28.88-36.70)	33.36 (29.56-37.16)
Daily physical activity at least 6 days in a week (e.g. running, bike riding, soccer, skating, etc.)			
<1 hour	70.97	87.12	78.22

	(67.56-74.38)	(84.53-89.72)	(75.46-80.97)
>=1 hour	29.03 (25.62-32.44)	12.88 (10.28-15.47)	21.78 (19.03-24.54)
Food Choice behavior (servings of fruits and vegetables to eat daily)			
<=6	85.56 (82.66-88.46)	87.25 (84.92-89.59)	86.33 (84.37-88.29)
>6	14.44 (11.54-17.34)	12.75 (10.41-15.08)	13.67 (11.71-15.63)
Weighted Observations	326,591	265,801	592,392

Data source: 2012/13 Canadian Youth Smoking Survey

Table 3. 4: Odds ratio (95% CI) from Smoking Initiation Models

Regression Variables	Grade 7-9	Grade 10-12	All
	OR (95% CI)	OR (95% CI))	OR (95% CI)
Female	0.72*** (0.70-0.75)	0.83*** (0.80-0.86)	0.80*** (0.78-0.82)
Caucasian	0.71*** (0.66-0.76)	0.73*** (0.70-0.77)	0.72*** (0.69-0.74)
Log (Cigarette Prices)	0.15*** (0.11-0.21)	0.25*** (0.20-0.32)	0.21*** (0.16-0.26)
Weekly pocket money	1.07*** (1.05-1.08)	1.08*** (1.07-1.09)	1.10*** (1.09-1.11)
Province (British Columbia as reference)			
Ontario	1.25** (1.06-1.47)	1.09 (0.93-1.28)	1.10 (0.96-1.27)
Others+	2.05*** (1.77-2.38)	1.26*** (1.10-1.44)	1.40*** (1.25-1.58)
School performance (level 1 and 2 as reference)			
Level 3-4	0.43*** (0.38-0.49)	0.41*** (0.38-0.45)	0.42*** (0.40-0.45)
Level 3	0.77*** (0.65-0.90)	0.83*** (0.76-0.90)	0.81*** (0.75-0.89)
Self-esteem score <=8	1.39***	1.02	1.12***

	(1.32-1.46)	(0.97-1.07)	(1.08-1.16)

Frequency of having 5 drinks of alcohol or more on one occasion in the last 12 months (never as reference)

Daily	22.84***	9.17***	11.51***
	(16.33-31.95)	(6.36-13.22)	(8.43-15.82)
1-5 times a week	12.55***	9.77***	11.63***
	(9.52-16.53)	(8.51-11.22)	(10.15-13.33)
1-3 times a month	7.27**	6.17***	7.47***
	(6.50-8.13)	(5.80-6.57)	(7.16-7.80)
Less than once a month	4.21***	2.94***	3.71***
	(3.90-4.54)	(2.77-3.12)	(3.52-3.91)

Missing school days due to health (6 or more days as reference)

no missing school days	0.56***	0.58***	0.58***
	(0.46-0.67)	(0.50-0.68)	(0.52-0.65)
1-5 days	0.61***	0.66***	0.65***
	(0.51-0.72)	(0.57-0.77	(0.58-0.73)
Has home smoking ban	0.65***	0.63***	0.64***
	(0.60-0.70)	(0.59-0.67)	(0.61-0.68)
No parent/guardian smokes	0.59***	0.71***	0.68***
	(0.54-0.65)	(0.69-0.74)	(0.66-.70)
No one sibling smokes	0.46***	0.57***	0.52***
	(0.43-0.48)	(0.54-0.60)	(0.50-0.54)
No one close friend	0.16***	0.28***	0.22***

smokes	(0.15-0.17)	(0.27-0.30)	(0.21-0.23)
School attachment (strongly agree/agree)	0.68*** (0.64-0.74)	0.73*** (0.69-0.77)	0.68*** (0.65-0.71)
Daily physical activity<1 hour	1.19*** (1.11-1.28)	0.89*** (0.83-0.96)	0.97 (0.92-1.02)
Fruit and vegetable servings<=6	1.05 (0.99-1.12)	1.45*** (1.37-1.52)	1.32*** (1.26-1.38)
Price elasticity	-1.57	-0.82	-1.13
Income elasticity	0.05	0.05	0.07
Weighted Observations	674,610	717,533	1,392,143

Data source: 2012/13 Canadian Youth Smoking Survey
***Significance at 1% level, **significance at 5% level, *significance at 10% level
+Including Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Saskatchewan, Alberta

Table 3. 5: Parameter estimates from Smoking Intensity Models

Regression Variables	Grade 7-9	Grade 10-12	All
	Estimate (S.E.)	Estimate (S.E.)	Estimate (S.E.)
Female	-0.37*** (0.04)	-0.15*** (0.02)	-0.20*** (0.02)
Caucasian	-0.06 (0.07)	0.08*** (0.02)	0.08*** (0.02)
Log (Cigarette Prices)	-1.93*** (0.19)	-0.76 *** (0.12)	-1.02*** (0.14)
Weekly pocket money	0.02** (0.01)	0.06*** (0.01)	0.06*** (0.01)
Province (British Columbia as reference)			
Ontario	-0.42*** (0.08)	0.21*** (0.05)	0.10* (0.05)
Others+	-0.19*** (0.05)	0.21*** (0.04)	0.12*** (0.04)
School performance (level 1 and 2 as reference)			
Level 3-4	0.15* (0.08)	-0.33*** (0.03)	-0.21*** (0.03)
Level 3	0.04 (0.06)	-0.21*** (0.04)	-0.15 *** (0.03)

Self-esteem score <=8	-0.31***	0.01	-0.08***
	(0.05)	(0.02)	(0.02)
Frequency of having 5 drinks of alcohol or more on one occasion in the last 12 months (never as reference)			
Daily	0.12*	-0.01	-0.02
	(0.06)	(0.05)	(0.05)
1-5 times a week	-0.03	0.05	0.01
	(0.06)	(0.05)	(0.05)
1-3 times a month	0.48***	0.43***	0.42***
	(0.06)	(0.04)	(0.04)
Less than once a month	1.12***	0.94***	0.95***
	(0.17)	(0.04)	(0.06)
Missing school days due to health (6 or more days as reference)			
no missing school days	-0.13*	-0.23***	-0.24***
	(0.07)	(0.03)	(0.02)
1-5 days	-0.21***	-0.23***	-0.26 ***
	(0.07)	(0.04)	(0.04)
Has home smoking ban	0.05	-0.28***	-0.18***
	(0.05)	(0.03)	(0.02)
No parent/guardian smokes	-0.40***	-0.21***	-0.25***
	(0.05)	(0.03)	(0.02)
No one sibling smokes	-0.25***	-0.07***	-0.11***
	(0.06)	(0.02)	(0.02)

No one close friend smokes	0.03 (0.11)	-0.09*** (0.05)	-0.09** (0.05)
School attachment (strongly agree/agree)	0.04 (0.03)	-0.16*** (0.03)	-0.13*** (0.02)
Daily physical activity<1 hour	-0.22*** (0.05)	-0.01 (0.02)	-0.07** (0.02)
Fruit and vegetable servings<=6	024*** (0.07)	0.07** (0.03)	0.12 *** (0.03)
Price elasticity	-1.93	-0.76	-1.02
Income elasticity	0.02	0.06	0.06
Weighted Observations	19,338	64,297	83,635

Data source: 2012/13 Canadian Youth Smoking Survey
***Significance at 1% level, **significance at 5% level, *significance at 10% level
+Including Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Saskatchewan, Alberta

CHAPTER FOUR: HEALTH-RELATED QUALITY OF LIFE AND ECONOMIC BURDEN RELATED TO SMOKING BEHAVIOR AMONG CANADIANS

4.1 Abstract

Background: Little is known about the association between health related quality of life and the economic cost associated with its loss for individual smokers in Canada. We used data from the 2015 Canadian Community Health Survey to examine whether smoking status is associated with a reduction in HRQoL as measured by the Health Utility Index (HUI3); to calculate the overall loss of HRQoL over a lifetime and the economic burden of loss; and to compare smoking related losses in HRQoL by age and gender.

Methods: The variations in HRQoL were estimated using a multivariable generalized linear model. In order to compare smoking related losses in HRQoL by age and gender, separate multiple logistic regression models were generated for each domain. Total expected lifetime QALYs lost due to smoking were calculated across the study population by compounding the annual adjusted health utility loss associated with smoking across a respondent's remaining years of life-expectancy stratified by age. The adjusted remaining years of life-expectancy of smokers was also applied based on Statistics Canada. A discount rate of 1.5% was applied to the analysis based on recent analysis of the costs of borrowing in Canada.

Results: Smoking is significantly associated with HRQoL loss. This study demonstrated that smoking is associated with a 0.05 and 0.01 reduction in HUI3 score for current and former smokers, which also corresponds to a loss of 0.66 quality-adjusted life years in average, and also is associated with substantial individual and societal economic cost. The total lifetime economic burden of HUI3 loss per smoker was $65,935, yielding in an aggregate $1068.88 billion societal

burden in the study population. Younger smokers are less likely to have vision, hearing,

mobility, and pain impairment compared to older smokers but they are more likely to have

cognition impairment. Compared to male smokers, female smokers are more likely to have

vision, mobility, pain and cognition impairment, but they are less likely to have hearing, speech

and emotion problems. When the remaining years to life-expectancy was adjusted, the lifetime

individual economic burden is $52,505.

Conclusions: This study provides important implications for tobacco control policies; tobacco

prevention will not only improve HRQoL but also will generate returns on investment from

smoking cessation programs. Findings from this study also provide important information for

smoking intervention programs regarding which specific population should be targeted in terms

of improving population health.

4.2 Introduction

Cigarette smoking is one of the major public health issues worldwide. Despite a significant decrease in the prevalence of smoking in Canada, tobacco use is still one of the most harmful behaviors related to a number of preventable diseases and premature death. Furthermore, it poses enormous health and societal costs. Tobacco use causes substantial healthcare expenditures and lost productivity due to morbidity and mortality each year. Individuals who reported having ever smoked have significantly higher healthcare utilization rates, including physician visits, hospitalizations, hospital length of stay, pharmaceutical use than those reported never smoked, after controlling for demographic, morbidity and behavioral risk factors (Martens, 2015; Azagba, Sharaf, Liu, 2013). Smoking status is associated with elevated rates of potential years of life lost (PYLL), mortality, reduced life expectancy and cancer burden. In Canada, 21% of all deaths are attributable to tobacco use in the past decade (Statistics Canada, 2015). Tobacco kills three times more Canadians each year than alcohol, AIDS, illegal drugs, car accidents, suicide, and murder combined (Centre for Addition and Mental Health, 2012). In addition, current daily smokers had approximately 5.8 times the rate of PYLL compared to non-smokers; both male and female smokers have decreased life expectancy when compared with the group that had never smoked. (Martens, 2015).

The adverse effects of smoking on the health of individuals have been well established (Cunningham, Ford, Rolle, Wheaton, & Croft, 2014; Berstad et al., 2014). Smoking is highly associated with not only premature mortality, but also a worse subjective well-being and physical health such as pain/discomfort, a reduction in usual activities, increased anxiety, etc.

Health related Quality of Life (HRQoL) is a multidimensional concept that includes physical, mental, social and emotional functioning. It is closely related to the concept of "well-being". It goes beyond direct measures of population health, such as mortality and life expectancy, and attempts to measure the impact health status on quality of life. Different tools have been used to measure HRQoL and these differ mainly in terms of which dimensions are captured and how finely each is measured. HRQoL is an important way of measuring one aspect of the economic burden of smoking that is generally ignored – the reduction in quality of life realized by a smoker before chronic conditions and premature mortality occurs.

There are very few studies that explore the relationship between smoking and HRQoL in the general population; Vogl, Wenig, Leidl & Pokhrel (2012) is a rare exception. This paper measured the loss of HRQoL realized by English smokers (Vogl, Wenig, Leidl & Pokhrel, 2012). To our knowledge, there is no study focused on smoking and quality of life controlling for socioeconomic, chronic disease and lifestyle factors for the Canadian general population. The main objectives of this study are:

1) to examine whether the smoking status of the general Canadian population is associated with a reduction in HRQoL as measured by the Health Utility Index Mark 3 (HUI3) once socioeconomic, chronic disease and life style conditions are controlled for;

2) to calculate the overall economic burden of loss in HRQoL using a commonly accepted $100,000 Willingness-to-Pay (WTP) threshold to gain one QALY;

3) to calculate the loss of HRQoL over a lifetime;

4) to compare smoking related losses in HRQoL by age and gender.

4.3 Methods

4.3.1 Data source

We used the 2015 Canadian Community Health Survey (CCHS) for the analysis. CCHS is a cross-sectional survey that gathers health-related data, such as diseases and health conditions, health, healthcare services, lifestyle and social conditions, mental health and well-being, for the Canadian population. The CCHS represents more than 97% of the Canadian population aged 12 and over living in ten provinces and three territories. It excludes persons living on reserves and other Aboriginal settlements in the provinces; full-time members of the Canadian Forces; the institutionalized population, children aged 12-17 that are living in foster care, etc.

4.3.2 Study sample

Because studies have suggested substantial uptake of smoking occurs after 15 years of age (Edwards, Carter, Peace, Blakely, 2013), for the purpose of this study, individuals aged 15 and over are included. The 2015 CCHS collected individual responses to questions related to smoking status. A survey question asked the type of smoker; this allows us to assign the respondents to one of the following groups: current smokers, former smokers and non-smokers.

4.3.3 Study Measures

4.3.3.1 Health Utilities Index (HUI)

The HUI was developed by a multidisciplinary team at McMaster University, Hamilton, Canada (Feeny, Furlong, Torrance, Goldsmith, Zhu, DePauw, et al.,2002). HUI is a rating scale used to measure general health status and HRQoL.   HUI questionnaires are designed to map onto two classification systems, Health Utility Index Mark 2 and Health Utility Index Mark 3, measuring

24,000 and 972,000 unique health states respectively. HRQoL was assessed in this study using the HUI3, a generic preference-based measure that reflects the subjective values assigned to specific health-related outcomes. The HUI3 is a validated instrument and has been used in hundreds of studies and clinical settings (Raat, Bonsel, Essink-Bot, Landgraf, Gemke, 2002; Bosch& Hunink, 2000). HUI3 quantifies HRQoL based on an individual's functional status in eight domains (attributes)—vision, hearing, speech, mobility, dexterity, emotion, cognition, and pain—each of which has five or six levels allowing description of 972,000 health states. Overall HUI3 scores are calculated from a multiplicative, multi-attribute utility model based on preference scores obtained from a random sample of the Canadian population, using an interval scale in which dead = 0.00 and perfect health = 1.00; scores below zero could represent health states considered to be worse than dead. HUI3 scores meet or exceed the criteria for calculating quality-adjusted life years (QALY), and the requirements of published guidelines for economic evaluations of pharmaceutical and other healthcare services (Horsman, Furlong, Feeny, Torrance, 2003)

4.3.3.2 Socioeconomic and demographic factors.

The respondents are classified by four age groups: 1) 15-24 years old; 2) 25-44 years old; 3) 45-64 years old; and 4) 65 and older. A close link between smoking behavior and individual socioeconomic status has been well-documented (Laaksonen, Rahkonen, Karvonen, Lahelma, 2005; Huang & Ren, 2011). Thus, a number of socioeconomic factors were included in this study. For example, respondents are grouped by 1) education level (Less than secondary school, secondary school graduation, no post-secondary education, post-secondary certificate diploma or university degree); 2) marital status (married or living as a couple/not living as a couple, who are

divorced, separated, or widowed); 3) household income levels are determined based on a

combination of the number of people in the household, and the total household income from all

sources in the past 12 months (Region of Peel, 2017), including four categories: lowest income,

lower-middle income, middle-upper income and highest income (see table 4.1).

Table 4. 1: Income categories based on a combination of the number of people in the household and the total household income:

Household Income Level shown in CCHS tables	Number of people in the household	Total household income
Low-middle	1 or more	Less than $15,000
	3-4 people	$15,000 to $19,999
	5+ people	$15,000 to $29,999
Middle	1-2 people	$15,000 to $29,999
	3-4 people	$20,000 to $39,999
	5+ people	$30,000 to $59,999
Upper-middle	1-2 people	$30,000 to $59,999
	3-4 people	$40,000 to $79,999
	5+ people	$60,000 to $79,999
Highest	1-2 people	More than $60,000
	3 or more	More than $80,000

Source: Region of Peel, 2017

4.3.3.3 Health related factors

Evidence has revealed that smokers are more likely to develop heart disease, diabetes, and respiratory diseases (Centers for Disease Control and Prevention, 2018). However, the purpose of this paper is to measure the reduction in HRQoL that is not manifested in measurable morbidity. Therefore, based on the availability of data from the source survey, we controlled for the following health related factors: feeling stressed (not at all to not very stressed versus a bit to extremely stressed), presence of a chronic disease (i.e. had at least one of asthma, chronic bronchitis, emphysema or COPD, heart disease, diabetes, versus no chronic condition).

4.3.3.4 Behavioral and lifestyle factors

Drinking alcohol and smoking tobacco commonly occur together (Burton and Tiffany, 1997). However, excess drinking can also result in losses of HRQoL. Therefore, we included a drinking behavior variable: the type of alcohol drinker was created by grouping individuals into three groups: regular drinkers, occasional drinkers and no drink in the past 12 months.

Body mass index (BMI) is a method of classifying body weight according to health risk. Height and weight were self-reported questions in the survey. Thus, BMI was calculated according to age range. BMI for youths is different from that of adults as they are still maturing. This indicator classifies children aged 12 to 17 (except female respondents aged 15 to 17 who were pregnant or did not answer the pregnancy question) as "obese" or "overweight" or "neither obese nor overweight" according to the age- and sex-specific BMI cut-off points as defined by Cole and others. The Cole cut-off points have been applied to the Canadian Community Health Survey (CCHS) since 2005 and are based on pooled international data (Brazil, Great Britain,

Hong Kong, Netherlands, Singapore and United States) for BMI and linked to the internationally accepted adult BMI cut-off points of 25 (overweight) and 30 (obese). Respondents whose BMIs do not fall in these categories have been classified by CCHS as 'neither obese nor overweight'. This variable excludes respondents who are 18 years old or over (Statistics Canada, 2016). For adult respondents aged 18 and over (excluding pregnant women), BMI was calculated and also categorized into obese (BMI $\geq$30.0 kg/m^2), overweight (BMI 25.0–29.9 kg/m^2) and neither obese nor overweight (BMI <25.0 kg/m^2).

4.3.3.5 Economic burden analysis

4.3.3.5.1 Calculation of the expected lifetime loss in HUI3

Total individual expected lifetime QALYs loss due to smoking were calculated across the study population by compounding the annual adjusted health utility loss associated with smoking across a respondent's remaining years of life expectancy stratified by age. The unit for health utility from the HUI3 is the QALY. Data for "years to life expectancy" were derived from the life table indicating the average number of years of life remaining across a population at a specific age x (Statistics Canada, 2018).

The discount rate allows us to measure the present value of something that will be received in the future. Typically, this is associated with future payments or streams of payments; a dollar today is worth more than a dollar you expect to receive at some point in the future. As is typical in economic analysis, we discounted future QALYs. A discount rate of 1.5% was utilized in all QALY estimates, reflecting recent empirical evidence on the long-term cost of borrowing for Canadian provinces (Canadian Agency for Drug and Technologies in Health, 2017). In this case,

a 1.5% discount rate implies that the magnitude of the annual QALY losses due to smoking will decrease with every subsequent year by a factor of $(1+0.015)^{-1}$ of the prior year's value.

4.3.3.5.2 Perspective

We used a societal perspective to calculate the overall life time economic burden of HRQoL loss due to smoking using a commonly accepted $100,000 Willingness-to-Pay (WTP) threshold to gain one QALY (Neumann, Cohen, Weinstein, 2014). Sensitivity analyses were conducted to test the robustness of the results by examining the effect of varying discount rates and adjusting for reduced life expectancy by smoking behavior, according to Statistics Canada (2015), smokers could lose about 9 years of life expectancy.

4.3.4 Statistical Techniques

The demographic, socioeconomic, chronic disease and behavioral factors (Table 4.2) were presented by mean and standard error (S.E.) for continuous variables and by percentage (95% CI) of total for categorical variables. The variations in health utilities were measured using a multivariable generalized linear model, allowing for response variables that have both Gaussian and non-Gaussian distributions (e.g. the sample distribution is the beta distribution in this study). Covariates included age, gender, marital status, smoking status, alcohol use, household income, BMI, life stress, and suffering at least one chronic disease. In order to compare smoking related losses in HRQoL by age, gender and other factors, separate multiple logistic regression models were generated for each subgroup (current smokers, former smokers and non-smokers).

All regression results and descriptive analyses are population weighted using the survey weights provided by Statistics Canada to produce population estimates and adjust for unequal probabilities of selection. All analyses were carried out using SAS version 9.4 (SAS Institute Inc., Cary, NC).

4.4 Results

The descriptive statistics of the study sample is shown in Table 4.2. Demographic, socioeconomic, behavioral, chronic disease condition characteristics are presented according to smoking status. The mean age of all study population is 46 (S.E. 0.05), 18.3% were current smokers, 38.9% were former smokers and 42.8% were non-smokers. Of all survey participants, 49% were males. The smokers were more likely to live in lower socioeconomic status (e.g. lower income and lower educational level), be obese and overweight, not live as a couple, have at least one chronic disease, feel stressed, and be alcohol drinkers. The scale of HUI3 is from -0.329 to 1; the overall mean HUI 3 was 0.86 (S.D. 0.002). Mean HUI3 was 0.04 lower for current smokers compared to former smokers (0.82 vs 0.86), and the difference was even bigger between current smokers and non-smokers (0.82 vs 0.88). Both current and former smokers had a higher proportion of loss in specific domains of HRQoL compared to non-smokers.

Table 4.3 presents the results of the multivariable generalized linear model analysis of variables associated with the overall HUI3 score. After controlling for demographic, socioeconomic, behavioral and chronic disease factors, significant declines in HUI3 were observed among current and former smokers ($p<.0001$). Covariates are significantly associated with decreased overall HUI3 score, including people who were old, male, alcohol drinkers, not living as a

couple, overweight and obese, had at least one chronic disease, had lower household income, felt a bit to extremely stressful..

Life time QALY losses for the population were calculated by discounting the adjusted 0.05 and 0.01 decrease in health utility (in QALY units) for both current and former smokers from the linear model above across the unadjusted remaining years to life-expectancy of each individual, at an annual discount rate of 1.5%. The results demonstrated that a total of 10,688,839 QALYs lost across the expected remaining lifetime of the study population, and this total number of QALYs was divided by the number of study population resulting in an average lifetime loss of 0.66 QALYs per individual smoker (Table 4.4). Assuming a $100,000/QALY willingness-to-pay, the average individual's lifetime economic burden of HUI 3 loss due to smoking behavior was categorized into four age groups was $122,953, $90,896, $55,624 and $23,763 for 15-24, 25-44, 45-64 and 65+ years of age respectively. When aggregated across the entire study population, the lifetime societal economic burden was $167.36, $463.57, $360.10 and $77.85 billion across the above age groups. The total lifetime economic burden of HUI3 loss per smoker was $65,935 yielding in the aggregate a societal burden of $1068.88 billion in the study population.

Statistics Canada estimates that the life expectancy of smokers is 9 years less than that of non-smokers. However, much of the reduced life expectancy occurs through comorbidities such as chronic conditions or associated lifestyle factors such as low income, for which we controlled. Using CCHS data, it is difficult to attribute expected loss of life years to any single factor, including smoking. When the analysis was adjusted based on smokers reduced life-expectancy,

the total loss of QALYs was 8,511,748, resulting in an average lifetime loss of 0.53 QALYs per

smoker. The average individual's lifetime economic burden due to smoking behavior for each

age group was $111,087, $78,471, $41,074 and $10,335 (Table 4.6). That is, the reduced

HRQoL associated with smoking over a lifetime falls, somewhat paradoxically, when we adjust

for the shorter life expectancy of smokers. A complete estimate of the economic burden of

smoking would, however, include the economic costs associated with these 9 lost years, as well

as the smoking-attributable losses of HRQoL associated with chronic conditions.

In order to determine the robustness of the study findings, Table 4.5 and Table 4.7 shows

sensitivity analyses using different discount rates (0%-3%). Outcomes were very sensitive to

changes in the discount rate; the results based on unadjusted remaining years to life-expectancy

showed that the lifetime economic burden of the utility loss per smoker ranged from $50,787 to

$89,618. Altering these parameters yielded an overall societal lifetime economic burden due to

smoking ranging from $823.31 to $1,452.81 billion. When the reduced years of life-expectancy

of smokers was considered, the average lifetime economic burden for was in a range of $41,941

to $68,077.

Multivariable logistic regression and generalized linear models controlling for the effects of a

number of variables mentioned above that are expected to confound the observed values were

used to compare smoking related losses in HRQoL and each health domain. Odds Ratios (95%

CI) , coefficient estimates and standard error on smoking related losses in the HUI3 score and

each individual domain were shown in Table 4.8 and Table 4.9. The results indicated that a

significant decrease in HUI3 score among current smokers compared to former smokers

($p<.0001$). In addition, the adjusted multiple logistic regression analyses showed significant difference in odds ratios in eight health domains by factors such as age and gender. For example, younger smokers are less likely to have vision, hearing, mobility, and pain impairment compared to older smokers but they are more likely to have cognition impairment. Compared to male smokers, female smokers are more likely to have vision, mobility, pain and cognition impairment, but they are less likely to have hearing, speech and emotional problems.

4.5 Discussion

In this paper, we examined the relationship between smoking and the HRQoL in the general Canadian population; our analyses offered evidence of a strong association between smoking behavior and poor HRQoL outcomes and the magnitude of this association is determined by smoking status. For example, the loss in HRQoL is greater among current smokers than among former smokers. Our findings are consistent with some previous studies from other developed countries (Vogl, Wenig, Leidl & Pokhrel, 2012; Jia &Lubetkin, 2010; Laaksonen, Rahkonen, Marktikainen, Karvonen, Lahelma, 2006; Wilson, Parsons, &Wakefield, 1999; Strine et al., 2005). In addition, this study shows that smoking has a significant and independent impact on HRQoL after adjusting for a wide array of important covariates including socioeconomic variables which have been considered as having a greater impact on HRQoL than smoking status itself (Tillmann & Silcock, 1997). The 0.05 decrease in mean adjusted HUI3 score for current smokers is the largest HRQoL reduction observed from the generalized linear model regression.

The analysis for the individual HUI3 domains reveals that smoking related losses are different by age and gender. Younger smokers are less likely to have health problems in the domain of vision,

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hearing, mobility, and pain impairment compared to older smokers. However, they are more likely to have cognition impairment. This finding is consistent with a previous study that young smokers showed significant decline in their cognitive performances (Chamberlain, Odlaug, Schreiber & Grant, 2012). Furthermore, compared to male smokers, female smokers are more likely to have vision, mobility, pain and cognition impairment, but they are less likely to have hearing, speech and emotional problems. These findings provide new and valuable evidence for how to provide timely and targeted treatment or therapy for different smokers in order to reduce their further functional impairment. This is particularly relevant because further physical and emotion functional impairment will result in increased risk of disability and extensive healthcare needs.

Since smokers can expect to lose about 9 years of life expectancy, we estimated lifetime economic burden by using the remaining years of life expectancy for the general population and adjusted life expectancy which was 9 years shorter due to smoking. This, however, almost certainly over-adjusts for reduced life expectancy due to smoking alone, because many of the years of life lost are associated with the smoking-attributable portion of chronic conditions. Using lifetime QALYs loss, we estimate lifetime economic burden for each smoking status. The overall low HRQoL loss among individual smokers generates significant individual and societal economic implications. Even without taking into account the economic consequences from reduced work productivity (absence from labor force) and health expenditure to treat smoking-attributable disease, the loss in HRQoL is associated with an average $65,935 loss in individual welfare over the lifetime for the study population. When we adjusted the remaining years to life-expectancy, the lifetime individual economic burden is $52,505.

Our study is subject to several limitations. First, the CCHS is self-reported; thus recall bias may have particular impact on certain variables. For example, the respondents were asked about events (e.g. drinking alcohol) occurring during the past months, and their recall could be incorrect. Second, the CCHS survey covers 98% of the total population, but information from the other 2% population was excluded. This missed population may include those residing in shelters or the homeless who are at a high risk of drug abuse problems and a high risk of smoking. This may result in an underestimate of lifetime economic burden. Third, this study used cross-sectional data; therefore the causal inference between the HRQoL outcome and smoking was precluded. Further investigations may benefit from the inclusion of longitudinal data. Finally, we controlled for many health conditions that are exacerbated by smoking. In that sense, we are systematically underestimating the costs of smoking. However, our purpose was to estimate those costs of smoking that are usually omitted in estimates of the economic burden of smoking. The attributable costs of chronic conditions are typically included in these estimates. Despite these limitations, this study provides some estimates of the loss of HRQoL by smoking status using a large sample size. This is the first study in Canada to examine the association of HRQoL and smoking status using a well-validated tool of HUI3. In addition, we used economic modelling to estimate lifetime loss in QALY and the relevant economic burden. This study is novel because most studies in the literature estimate economic burden from the healthcare system perspective only, while our study focused on the economic burden borne by individual smokers.

4.6 Conclusions

The results confirm that smoking is significantly associated with HRQoL loss in Canadian general population. This study also demonstrated that smoking is associated with a 0.05 and 0.01 reduction in HUI3 score for current and former smokers, which also corresponds to a loss of 0.66 quality-adjusted life years on average over a lifetime. This is associated with substantial individual and societal economic cost. This information provides important additional justification for the tobacco control policies; tobacco prevention will not only improve HRQoL but also will generate social returns on investment from smoking cessation programs. Findings from this study also provide important information for smoking intervention programs about which health attributes might be targeted for specific populations.

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Table 4. 2: Weighted percentage (95% CI) of sample characteristics by smoking status

Characteristics	Factor	Current smoker	Former smoker	Non-smoker	*p*
Demographic					
Age	Mean, SE	43.25 (0.25)	51.96 (0.16)	41.67 (0.15)	<.0001
Age group	15-24	13.53 (12.20-14.86)	5.99 (5.40-6.58)	24.07 (23.11-25.02)	<.0001
	25-44	38.76 (37.11-40.41)	28.03 (27.06-29.01)	34.93 (33.84-36.02)	
	45-64	38.21 (36.68-39.75)	40.74 (39.80-41.69)	26.13 (25.27-26.99)	
	65+	9.50 (8.66-10.33)	25.34 (24.61-25.86)	14.87 (14.34-15.40)	
Gender	Male	56.79 (55.22-58.36)	53.97 (53.12-54.83)	41.90 (41.01-42.78)	<.0001
	Female	43.21 (41.64-44.78)	46.03 (45.17-46.88)	58.10 (57.22-58.99)	
Socioeconomic					
Total household income	lowest income	8.99 (7.99-9.98)	3.60 (3.20-4.00)	5.84 (5.23-6.44)	<.0001
	lower-middle income	17.23 (15.85-18.60)	12.23 (11.56-12.90)	14.18 (13.34-15.02)	
	middle-upper income	29.89 (28.33-31.45)	27.37 (26.38-28.37)	27.69 (26.56-28.82)	

	highest income	43.90 (42.24-45.56)	56.97 (55.69-57.90)	52.30 (51.02-53.58)	
Education level	Less than secondary school graduation	17.88 (16.64-19.11)	13.03 (12.33-13.72)	15.54 (14.85-16.23)	<.0001
	Secondary school graduation, no post-secondary education	27.07 (25.52-28.61)	21.00 (20.08-21.91)	18.81 (17.87-19.74)	
	Post-secondary certificate diploma or university Degree	55.06 (53.32-56.80)	65.98 (64.91-67.04)	65.65 (64.60-66.70)	
Marital status	Married or living as a couple	50.87 (49.10-52.65)	69.07 (67.96-70.18)	55.37 (54.22-56.51)	<.0001
	Not living as a couple	49.13 (47.35-50.90)	30.93 (29.82-32.04)	44.63 (43.49-45.78)	
Health-related					
Health Utility	Mean, SE	0.82 (0.003)	0.86 (0.002)	0.88 (0.002)	<.0001

Index					
Vision impairment	Yes	52.27 (50.53-54.01)	61.42 (60.34-62.49)	48.39 (47.18-49.61)	<.0001
	No	47.73 (45.99-49.47)	38.58 (37.51-39.66)	51.61 (50.39-52.82)	
Hearing impairment	Yes	2.62 (2.14-3.11)	4.63 (4.24-5.01)	2.58 (2.26-2.91)	<.0001
	No	97.38 (96.89-97.86)	95.37 (94.99-95.76)	97.42 (97.09-97.74)	
Speech impairment	Yes	1.49 (1.00-1.99)	0.71 (0.52-0.91)	0.98 (0.75-1.20)	<.0001
	No	98.51 (98.01-99.00)	99.29 (99.09-99.48)	99.02 (98.80-99.25)	
Mobility impairment	Yes	5.09 (4.44-5.74)	5.22 (4.82-5.62)	3.91 (3.51-4.32)	<.0001
	No	94.91 (94.26-95.56)	94.78 (94.38-95.18)	96.09 (95.68-96.49)	
Dexterity impairment	Yes	1.04 (0.68-1.39)	0.61 (0.44-0.79)	0.61 (0.42-0.80)	<.0001
	No	98.96 (98.61-99.32)	99.39 (99.21-99.56)	99.39 (99.20-99.58)	
Emotion impairment	Yes	28.50 (26.97-30.03)	21.08 (20.12-22.05)	18.75 (17.82-19.69)	<.0001
	No	71.50	78.92	81.25	

		(69.97-73.03)	(77.96-79.88)	(80.31-82.18)	
Cognition impairment	Yes	36.38 (34.75-38.02)	30.67 (29.62-31.72)	29.64 (28.61-30.67)	<.0001
	No	63.62 (61.98-65.25)	69.33 (68.28-70.38)	70.36 (69.33-71.39)	
Pain impairment	Yes	26.39 (25.01-27.77)	23.35 (22.38-24.31)	16.86 (15.96-17.76)	<.0001
	No	73.61 (72.23-74.99)	76.65 (75.69-77.62)	83.14 (82.24-84.04)	
Has chronic disease*	At least one	20.19 (18.85-21.52)	21.11 (20.17-22.04)	15.50 (14.59-16.40)	<.0001
	No	79.81 (78.48-81.15)	78.89 (77.96-79.83)	84.50 (83.60-85.41)	
Stress	Not at all to not very stressful	31.05 (29.32-32.77)	37.27 (36.20-38.34)	61.40 (60.18-62.62)	<.0001
	A bit to extremely stressful	68.95 (67.23-70.68)	62.73 (61.66-63.80)	38.60 (37.38-39.82)	
Life style and behavioral					
BMI	Neither obese nor overweight	48.58 (46.84-50.31)	40.61 (39.46-41.75)	53.56 (52.30-54.82)	<.0001
	Overweight	31.74 (30.12-33.36)	37.60 (36.44-38.76)	29.85 (28.73-30.97)	
	Obese	19.69	21.80	16.59	

		(18.31-21.06)	(20.87-22.72)	(15.72-17.45)	
Type of alcohol drinker	Regular drinker	17.88 (16.64-19.11)	13.03 (12.33-13.72)	15.54 (14.85-16.23)	<.0001
	Occasional drinker	27.07 (25.52-28.61)	21.00 (20.08-21.91)	18.81 (17.87-19.74)	
	No drink last 12 months	55.06 (53.32-56.80)	65.98 (64.91-67.04)	65.65 (64.60-66.70)	
Weighted observations		5,176,925	11,034,309	12,131,376	

Data Source: Statistics Canada, 2015

*One of Asthma, chronic bronchitis, emphysema or COPD, heart disease, diabetes

Table 4. 3: Multivariable adjusted generalized linear model on the association of overall HUI3 score with smoking status.

Regression variables	Coefficient Estimate (Standard Error)	p
Age 15-24	0.06 (0.005)	<.0001
Age 25-44	0.05 (0.004)	<.0001
Age 45-65	0.02 (0.005)	<.0001
Age 65+	Reference	--
Current smoker	-0.05 (0.004)	<.0001
Former smoker	-0.01 (0.003)	<.0001
Non-smoker	Reference	--
Male	0.02 (0003)	<.0001
Female	Reference	--
Regular alcohol drinker	-0.03 (0.005)	<.0001
Occasional alcohol drinker	-0.02 (0.004)	<.0001
No drink last 12 months	Reference	--
Living as a couple	0.02 (0.004)	<.0001
Not living as a couple	Reference	--
Neither overweight nor obese	Reference	--
Overweight	-0.01 (0.003)	.0007
Obese	-0.04 (0.004)	<.0001
lowest income	Reference	--
lower-middle income	0.03 (0.009)	.0003

middle-upper income	0.06 (0.008)	<.0001
Highest income	0.09 (0.009)	<.0001
Not at all to not very stressful	0.05 (0.003)	<.0001
A bit to extremely stressful	Reference	--
Not having a chronic disease	0.02 (0.004)	<.0001
At least having one chronic disease*	Reference	--

Data Source: Statistics Canada, 2015
*One of Asthma, chronic bronchitis, emphysema or COPD, heart disease, diabetes

Table 4. 4: Economic burden of loss in HRQoL by age-group

Age group	Weighted number of smokers	Average QALYs lost	Population QALYs lost*	Willingness-to-pay/QALY	Life time individual economic burden[+]	Life time societal economic burden (billion)[#]
15-24	1,361,174	1.23	1,673,611	$100,000	$122,953	$167.36
25-44	5,100,000	0.91	4,635,716	$100,000	$90,896	$463.57
45-65	6,473,885	0.56	3,601,009	$100,000	$55,624	$360.10
65+	3,276,175	0.24	778,503	$100,000	$23,763	$77.85
Overall	16,211,233	0.66	10,688,839	$100,000	$65,935	$1068.88

Data Source: Statistics Canada, 2015
*Discount rate:1.5%
[+]Product of Population QALYs Lost and $/QALY divided by number of smokers
[#]Product of Population QALYs Lost and $/QALY

Table 4. 5: Sensitivity analysis of economic burden of loss in HRQoL by age-group

Age group	Weighted number of smokers	Average QALYs lost*	Population QALYs lost*	Willingness-to-pay/QALY	Life time individual economic burden[+]	Life time societal economic burden (billion)[#]
15-24	1,361,174	0.86-1.89	1,170,098-2,570,640	$100,000	$85,962-$188,854	$117.00-$257.06
25-44	5,100,000	0.67-1.29	3,431,159-6,571,753	$100,000	$67,278-$128,858	$343.11-$657.17
45-65	6,473,885	0.45-0.70	2,939,182-4,504,517	$100,000	$45,401-$69,580	$293.91-$450.45
65+	3,276,175	0.21-0.27	692,699-881,269	$100,000	$21,144-$26,899	$69.26-$88.12
Overall	16,211,233	0.51-0.90	8,233,138-14,528,179	$100,000	$50,787-$89,618	$823.31-$1452.81

Data Source: Statistics Canada, 2015
* Discount rate: 0% -3%
[+] Product of population QALYs lost and $/QALY divided by number of smokers
[#] Product of population QALYs lost and $/QALY

Table 4. 6: Economic burden of loss in HRQoL by age-group (assuming life expectancy for smokers is 9 years shorter)

Age group	Weighted number of smokers	Average QALYs lost	Population QALYs lost*	Willingness-to-pay/QALY	Life time individual economic burden[†]	Life time societal economic burden (billion)[⌗]
15-24	1,361,174	1.11	1,512,091	$100,000	$111,087	$151.21
25-44	5,100,000	0.78	4,002,010	$100,000	$78,471	$400.20
45-65	6,473,885	0.41	2,659,054	$100,000	$41,074	$265.90
65+	3,276,175	0.10	338,594	$100,000	$10,335	$33.85
Overall	16,211,233	0.53	8,511,748	$100,000	$52,505	$851.17

Data Source: Statistics Canada, 2015
*Discount rate: 1.5%
[†] Product of Population QALYs Lost and $/QALY divided by number of smokers
[⌗] Product of Population QALYs Lost and $/QALY

Table 4. 7: Sensitivity analysis of economic burden of loss in HRQoL by age-group (assuming life expectancy for smokers is 9 years shorter)

Age group	Weighted number of smokers	Average QALYs lost*	Population QALYs lost*	Willingness-to-pay/QALY	Life time individual economic burden[+]	Life time societal economic burden (billion)[‡]
15-24	1,361,174	0.81-1.61	1,100,023- 2,192,633	$100,000	$80,814- $161,084	$110.00- $219.26
25-44	5,100,000	0.61-1.05	3,096,996- 5,349,304	$100,000	$60,725- $104,888	$309.69- $534.93
45-65	6,473,885	0.35-0.48	2,285,165- 3,131,541	$100,000	$35,298- $48,372	$228.51- $313.15
65+	3,276,175	0.09-0.11	316,958- 362,653	$100,000	$9,674- $11,069	$31.69- $36.26
Overall	16,211,233	0.42-0.68	6,799,142- 11,036,132	$100,000	$41,941- $68,077	$679.91- $1103.61

Data Source: Statistics Canada, 2015
* Discount rate: 0% -3%
[+] Product of population QALYs lost and $/QALY divided by number of smokers
[‡] Product of population QALYs lost and $/QALY

Table 4. 8: Odds Ratio (95% CI) on smoking related losses in HUI 3 individual domain

coefficient	HUI 3 individual domain							
	Vision	Hearing	Speech	Mobility	Dexterity	Emotion	Cognition	Pain
Age 15-24	0.10*** (0.08-0.12)	0.02** (0.01-0.23)	1.09 (0.47-2.55)	0.05*** (0.01-0.19)	0.04 (<.001-10.68)	1.09 (0.88-1.35)	1.95*** (1.60-2.38)	0.36*** (0.28-0.46)
Age 25-44	0.13*** (0.11-0.14)	0.08* (0.05-0.13)	1.17 (0.59-2.31)	0.15* (0.10-0.20)	0.31 (0.13-0.76)	1.01 (0.88-1.15)	1.23 (1.09-1.40)	0.52*** (0.45-0.60)
Age 45-65	0.94*** (0.83-1.06)	0.19 (0.15-0.25)	0.87 (044-1.70)	0.34** (0.28-0.43)	0.96 (0.57-1.61)	1.06 (0.94-1.20)	1.02*** (0.91-1.15)	0.88*** (0.78-0.99)
Age 65+	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Current smoker	0.99 (0.89-1.06)	1.04 (0.81-1.34)	2.05*** (1.22-3.46)	1.43*** (1.19-1.73)	1.57** (1.01-2.44)	1.23*** (1.10-1.37)	1.11** (1.00-1.22)	1.29*** (1.17-1.42)
Former smoker	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Female	1.64*** (1.49-1.79)	0.73** (0.60-0.90)	0.57* (0.33-1.00)	1.33*** (1.13-1.57)	1.08 (0.70-1.65)	0.84*** (0.76-0.92)	1.09** (1.00-1.19)	1.28*** (1.17-1.41)

Male	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Regular alcohol drinker	0.91 (0.81-1.03)	1.33** (1.06-1.68)	1.22 (0.56-2.64)	1.37** (1.12-1.67)	1.25 (0.74-2.13)	1.16* (1.00-1.34)	1.28** (1.12-1.45)	1.07 (0.94-1.22)
Occasional alcohol drinker	1.01 (0.91-1.13)	1.03 (0.81-1.31)	1.76 (0.89-3.49)	1.22 (0.99-1.51)	1.37 (0.74-2.54)	1.04 (0.92-1.17)	1.20 (1.07-1.34)	1.09 (0.98-1.21)
No drink last 12 months	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Living as a couple	1.04 (0.94-1.16)	0.85 (0.68-1.07)	0.90 (0.53-1.52)	0.77*** (0.65-0.92)	1.12 (0.72-1.73)	0.56*** (0.51-0.62)	0.96 (0.87-1.05)	0.96 (0.87-1.06)
Not living as a couple	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Neither overweight nor obese	0.91 (0.80-1.03)	0.80 (0.62-1.03)	0.84 (0.43-1.67)	0.46** (0.38-0.55)	0.84 (0.51-2.81)	0.85** (0.75-0.97)	0.91 (0.82-1.02)	0.57*** (0.51-0.64)

Overweight	0.83***	0.89	0.91	0.55***	0.84	0.89	0.86**	0.70*
	(0.73-0.94)	(0.69-1.15)	(0.41-2.01)	(0.45-0.68)	(0.51-1.38)	(0.78-1.02)	(0.77-097)	(0.63-0.78)
Obese	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
lowest income	1.14	0.84	3.40**	4.03***	3.22**	1.85***	1.86***	2.08***
	(0.91-1.43)	(0.56-1.26)	(1.42-8.11)	(2.78-5.83)	(1.49-6.94)	(1.53-2.24)	(1.55-2.24)	(1.68-2.58)
lower-middle income	1.18	0.85	2.06	2.66***	2.48**	1.48	1.62***	1.59**
	(1.02-1.37)	(0.62-1.17)	(0.87-4.88)	(2.00-3.53)	(1.32-4.63)	(1.28-1.72)	(1.42-1.89)	(1.37-1.84)
middle-upper income	1.12	1.04	1.35	1.67***	1.46	1.40	1.29**	1.22***
	(1.00-1.26)	(0.83-1.32)	(0.73-2.49)	(1.30-2.15)	(0.76-2.81)	(1.24-1.57)	(1.17-1.43)	(1.09-1.37)
Highest income	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Not at all to not very stressful	0.87	0.96	0.65	0.74***	0.73	0.38***	0.66***	0.59***
	(0.79-0.96)	(0.78-1.16)	(0.38-1.13)	(0.62-0.87)	(0.44-1.21)	(0.34-0.42)	(0.59-0.73)	(0.54-0.65)
A bit to extremely	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference

stressful								
Not having a chronic disease	0.83*** (0.74-0.93)	0.67*** (0.54-0.82)	0.58* (0.32-1.03)	0.34*** (0.31-0.42)	0.62* (0.38-1.04)	0.87** (0.77-0.97)	0.89** (0.79-0.99)	0.57*** (0.52-0.63)
At least having one chronic disease[+]	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference

Data Source: Statistics Canada, 2015
[+] One of Asthma, chronic bronchitis, emphysema or COPD, heart disease, diabetes
***Significance at 1% level, **significance at 5% level, *significance at 10% level

Table 4. 9: Coefficient estimate (S.E.) on smoking related losses in HUI 3 among smokers

Regression variables	Coefficient Estimate (S.E.)
Age 15-24	0.06 *** (0.008)
Age 25-44	0.05*** (0.005)
Age 45-65	0.02*** (0.005)
Age 65+	Reference
Current smoker	-0.03*** (0.004)
Former smoker	Reference
Female	Reference
Male	0.02*** (0.004)
Regular alcohol drinker	-0.03*** (0.007)
Occasional alcohol drinker	-0.02*** (0.005)
No drink last 12 months	Reference
Living as a couple	0.03*** (0.004)

Not living as a couple	Reference
Neither overweight nor obese	Reference
Overweight	-0.01 (0.004)
Obese	-0.05*** (0.005)
lowest income	Reference
lower-middle income	0.05*** (0.01)
middle-upper income	0.09*** (0.01)
Highest income	0.12*** (0.01)
Not at all to not very stressful	0.06*** (0.004)
A bit to extremely stressful	Reference
Not having a chronic disease	0.06*** (0.005)
At least having one chronic disease[†]	Reference

Data Source: Statistics Canada, 2015
[†]One of Asthma, chronic bronchitis, emphysema or COPD, heart disease, diabetes
***Significance at 1% level, **significance at 5% level, *significance at 10% lev

CHARPTER FIVE: GENERAL CONCLUSIONS

5.1 Summary of findings

The rates of smoking in Canada have fallen dramatically over the past several decades. Several

notable actions on tobacco control have contributed to this decline, including regulating the

manufacture, sale, labeling and promotion of tobacco products by administering the *Tobacco*

Act; the engagement of healthcare providers and systems in tobacco cessation efforts, and so on.

Despite of these efforts, 15% of Canadians still smoke and some forecast that 9% of Canadians

will still be smoking in 2036 (Health Canada, 2017). Furthermore, there are certain groups of

Canadians where rates of tobacco use are higher than in the general population. Canadians living

in rural and remote communities, those with low incomes, or people experiencing addictions or

poor mental health are much more likely to use tobacco products (Health Canada, 2017). In

addition, smoking rates for youth and young adults have also remained unchanged since 2013.

This thesis explored the characteristics of tobacco use in certain sub-populations (e.g. pregnant

women and youth). We still confront challenges in tobacco control for high risk populations in

order to improve the health status of all people.

Since maternal smoking is related to many detrimental effects on health for mothers and babies

and, moreover, smoking during pregnancy is still prevalent among Canadian women (Al-Sahab,

Saqib, Hauser, Tamim, 2010), Chapter 2 used data for a large sample from the Canadian

Community Health Survey to determine the demographic, socio-economic, behavioral and

health-related characteristics that are associated with smoking during pregnancy. For example,

women who smoke during pregnancy are more likely to be younger, single, unemployed, regular

smokers, have low levels of education and household income, suffer from mental disorders and chronic diseases. This study makes important contributions to our knowledge about factors related to smoking during pregnancy. Public health professionals can use this information and better design anti-smoking campaigns for this target population.

Chapter 3 examined how sensitive adolescent smoking is to the price of cigarettes and the amount of personal income, or pocket money, they can access. Our results show that increased cigarette prices are not limited to significant reductions in the number of cigarettes smoked, but also include significant reductions in smoking prevalence among the Canadian youth. Therefore, standard economic tools such as tobacco taxes can be very effective in limiting smoking initiation and intensity among this population subgroup. By contrast, even though personal income or pocket money is positively correlated with youth smoking behavior, the effect on youth smoking initiation and intensity is weak compared to increased prices. Therefore, attempts on the part of individual families to limit youth smoking by reducing allowances, for example, are bound to be less successful than collective responses such as tobacco taxes. Not surprisingly, we found that family and close friends who smoke have significant influence on adolescent tobacco use. Furthermore, lifestyle factors (e.g. unhealthy diet and inadequate daily physical activity) and school performance were also associated with smoking initiation and intensity. Public health policy makers and tobacco control advocates may be able to use these findings to help design other youth-focused tobacco control strategies based on, for example, behavioral economics that suggests a "nudge" can sometimes influence behavior and decisions as effectively as more common economic tools such as tobacco taxes.

In Chapter 4, we examined whether the smoking status of the general Canadian population is associated with reductions in HRQoL as measured by the Health Utility Index (HUI3) once socioeconomic, chronic disease and life style conditions are controlled for. We calculated the overall lifetime economic burden of loss in HRQoL using a commonly accepted $100,000 for the value of a QALY. Our results revealed that smoking status is associated with a reduction HRQoL. Smoking is associated with a 0.05 and 0.01 reduction in HUI3 score for current and former smokers. We found that smoking generated substantial lifetime economic burden for smokers and society as a whole. The total lifetime economic burden of HUI3 loss per smoker was $65,935, resulting in an aggregate $1068.88 billion societal burden in the study population over its expected lifetime. When the remaining years to life-expectancy was adjusted, the lifetime societal economic burden is $851.17 billion. In terms of each health domain, younger smokers are less likely to have vision, hearing, mobility, and pain impairment compared to older smokers but they are more likely to have cognition impairment. Compared to male smokers, female smokers are more likely to have vision, mobility, pain and cognition impairment, but they are less likely to have hearing, speech and emotional problems.

On the basis of these findings, this study can guide public healthcare providers and policy makers to promote health within the target populations. By doing so, more effective and efficient interventions can be tailored to the needs.

5.2 Further directions

The following recommendations are for future research and policy directions.

1. Preventing smoking in Adolescents and youth. Since evidence has identified that a single prevention approach such as using school based curricula alone was ineffective, prevention research should consider multiple approaches and the social conditions that influence the development of youth problem behaviors including tobacco use and dependence (Backinger, Fagan, Matthews, & Grana, 2003).

2. Addressing social inequality in tobacco use and exposure. The prevalence of smoking has decreased over the decades, however, social inequality in cigarette consumption and dependence has increased (Reid, Hammond, Driezen, 2010). Research is needed that more directly targets populations with high prevalence and/or intensity of use or who suffer disparate outcomes from tobacco use (e.g. low socio-economic status group).

3. Understanding the complexity of current patterns of tobacco use, tobacco landscape, associated health-related outcomes, economic burden on society as well as the healthcare system. Canadians' smoking habits have evolved to fewer smokers and lower tobacco consumption. There are, however, still disparities in tobacco-use patterns between the sexes and among different age groups, regions of Canada, and socio-economic and cultural groups. Little is known about how interventions have addressed the complexity of these patterns, health outcomes and individual's economic burden due to smoking. Research is needed to better understand tobacco use patterns, their short and long-term effects and health risks, and how they impact the broader goal of eliminating tobacco use.

4. Identifying innovative tobacco control strategies that further reduce smoking. Multiple tobacco control approaches (e.g., tax increases, regulations) have been shown to reduce tobacco use at the population level. However, local policy and environmental approaches are also needed (e.g., via communities; provincial and territorial, federal government). Research is needed to identify innovative local, provincial and territorial, federal approaches that will advance the goal of eliminating tobacco use, as well as effective strategies to disseminate these approaches in tobacco use prevention. One very promising area of research might lie in behavioral economic approaches to tobacco control.

5.3 References

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