

Is implementing a provincial e-cigarette tax associated with a lower likelihood of e-cigarette initiation among high school students? Evaluating the experience in British Columbia using data from the COMPASS study, 2018-2021

By

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THESIS EXAMINATION INFORMATION

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Thesis title: Is implementing a provincial e-cigarette tax associated with a lower likelihood of e-cigarette initiation among high school students? Evaluating the experience in British Columbia using data from the COMPASS study, 2018-2021

An oral defence of this thesis took place on March 24, 2023, in front of the following examining committee:

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The above committee determined that the thesis is acceptable in form and content and that a satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate during an oral examination. A signed copy of the Certificate of Approval is available from the School of Graduate and Postdoctoral Studies

Abstract

Background: This study evaluated the impact of an e-cigarette tax in British Columbia (BC) on youth e-cigarette use.

Methods: This study used repeat cross-sectional and longitudinal samples of students attending high schools in four Canadian provinces in 2018/19 and 2020/21.

Results: A difference-in-difference (DID) analysis indicated that the change in prevalence of ever and current e-cigarette use over time in BC was not significantly different from that in other provinces. Multi-level regression models suggested that students in BC had a lower likelihood of initiating e-cigarette compared to students in other provinces (OR 0.41, 95%CI 0.28-0.59).

Conclusions: More research is required to understand the impact of tax policies on e-cigarette use changes among youth.

Keywords: youth, adolescents, young people, teen, e-cigarette, vaping, nicotine tax

AUTHOR'S DECLARATION

I hereby declare that this thesis consists of original work of which I have authored. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I authorize the University of Ontario Institute of Technology to lend this thesis to other institutions or individuals for the purpose of scholarly research. I further authorize University of Ontario Institute of Technology to reproduce this thesis by photocopying or by other means, in total or in part, at the request of other institutions or individuals for the purpose of scholarly research. I understand that my thesis will be made electronically available to the public. The research work in this thesis that was performed in compliance with the regulations of Ontario Tech's Research Ethics Board under REB Certificate number 16943.

Negin Aalaei

STATEMENT OF CONTRIBUTIONS

I hereby certify that I am the sole author of this thesis and that no part of this thesis has been published or submitted for publication. I have used standard referencing practices to acknowledge ideas, research techniques, or other materials that belong to others. Furthermore, I hereby certify that I am the sole source of the creative works and/or inventive knowledge described in this thesis.

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List of Abbreviations

Cq: COMPASS student questionnaire designed to examine health outcomes such as tobacco and substance use, mental health, and physical activity.

CTNS: Canadian Tobacco and Nicotine Survey

FDA: Food and Drug Administration

TVPA: Tobacco and Vaping Products Act; the framework implemented in Canada to regulate the sale and marketing of e-cigarettes.

Glossary

In this section, all key terms used in the present study are well defined and illustrated.

Electronic cigarettes: Electronic cigarettes are also known as e-cigarettes, vapes, e-hookahs, vape pens, mods, and tank systems. E-cigarettes are nicotine delivery systems that contain a battery heating element and e-liquid. E-cigarettes do not directly burn tobacco, but rather heat e-liquid. E-liquids have chemicals such as glycerol, flavors, propylene glycol, and may contain nicotine. Various flavors of e-liquids such as candy, fruit, mint, and menthol are available (Dinardo & Rome, 2019).



Figure 1. Various types of vaping devices.

Natural experimental study: Natural experiments are a type of observational study. They are used when researchers cannot directly manipulate and control when or where the intervention, event, or policy is happening (Leatherdale, 2019). They are frequently used to evaluate public health interventions and policies or develop a new program (Leatherdale, 2019). Natural experimental studies are applicable when it is not possible to evaluate the impact of the intervention or policy because of ethical or practical reasons (Theatre, 2010). It is vital to

distinguish situations where natural experimental approaches are more likely to be useful compared to randomized controlled trials. For instance, in research related to smoking bans or cannabis legalization policies, it is unethical and impossible to control or manipulate those exposed to the policy in order to evaluate the impact of the policy on health outcomes. Natural experimental approaches are suitable in these cases because they seek to compare the intervention group with the control group on a large scale (Craig et al., 2011). The results of natural experimental studies can draw stronger conclusions about the impact of the intervention relative to other observational designs (Craig et al., 2011). The use of natural experimental studies to evaluate programs and interventions is increasing. The main strengths of natural experimental studies are that they can provide robust causal links and the results are highly generalizable (Leatherdale, 2019).

Never e-cigarette users: Refers to students who reported they have never used e-cigarettes.

Ever e-cigarette users: Refers to students who reported they have ever used e-cigarettes.

Current e-cigarette users: Refers to students who reported they have used e-cigarettes in the last 30 days.

E-cigarette initiators: Refers to students who reported they have never used e-cigarettes at baseline but they have used e-cigarettes at follow-up.

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Chapter 1. Introduction

1.1. Background

E-cigarettes are non-combustible nicotine delivery systems that contain flavorings, nicotine, and other chemical compounds (U.S. Department of Health and Human Services, 2016). In 2004, e-cigarette devices were introduced to China's market as a cessation aid for quitting combustible cigarettes (Milicic et al., 2018). In 2008, the Food and Drug Administration (FDA) in the United States (US) regulated e-cigarettes as an alternative to combustible cigarettes which aimed to reduce tobacco exposure, consumption, and nicotine dependency (Gottlieb, 2019).

There are concerns about an increase in e-cigarette use among youth across Canada. In 2012, the results of an online survey indicated that about 6% of Canadians between 16 and 30 years old had used e-cigarettes in the last 30 days (Czoli et al., 2015). Results of a repeat cross-sectional study indicated that between 2016-2017 and 2018-2019, the prevalence of current e-cigarette users doubled in Alberta, Ontario, and Quebec (Cole et al., 2021).

The Canadian Student Tobacco, Alcohol, and Drug Survey indicated that in 2018-19, the prevalence of using e-cigarettes in the past 30 days increased from 10% to 20% and the majority of students stated that they used e-cigarettes with nicotine in the last 30 days (Health Canada, 2019). Students in grades 10 to 12 were more likely to use e-cigarettes than students in grades 7 to 9 (Health Canada, 2019). Consistent with these findings, the results of another study indicate that the prevalence of e-cigarette use among youth aged 16 to 19 years rapidly increased between 2017 and 2018 (Hammond et al., 2019). In 2020, the Canadian Tobacco and Nicotine Survey (CTNS) reported that approximately 14% of adolescents aged 15 to 19 years reported that they used e-cigarettes, and 35% had tried e-cigarettes in the last month (Statistics Canada, 2021). Male adolescents were more likely to try e-cigarettes than females (Statistics Canada, 2021). One

possible reason for the rapid increase of e-cigarette use among youth during this time is that the accessibility of e-cigarettes containing nicotine, including brands such as Juul and Vype, significantly increased (Cole et al., 2021, Hammond et al., 2020).

Data from the national Youth Risk Behaviour Survey in the US indicate that the prevalence of current frequent e-cigarette use and current daily e-cigarette use significantly increased from 2015 to 2019 (Centers for Disease Control and Prevention, 2020). Other recent data from the US indicate that the prevalence of using e-cigarettes among high school students increased from 11.7% to 20.8% between 2017 and 2018 (Roditis et al., 2020). Another study evaluated changes in the prevalence of e-cigarette use among youth in the US, Canada, and England (Hammond et al., 2020). Overall, these results indicated that the prevalence of using e-cigarettes increased over time among youth aged 16 to 19 years old in the US and Canada but not in England (Hammond et al., 2020). It has been suggested that the increasing popularity of e-cigarettes among youth in Canada and the US was consistent with increased accessibility of the e-cigarette brand JUUL, which delivers a high level of nicotine and gained favour among middle school and high school students (Miech et al., 2021, Hammond et al., 2020).

The popularity of e-cigarette products and nicotine exposure among youth and young adults remains an acute concern for researchers and policymakers (Dinardo & Rome, 2019). The FDA was concerned about the popularity of using e-cigarettes among youth. On April 24, 2018, the FDA forced JUUL to change their advertisements to make them less appealing to youth (Dinardo & Rome, 2019).

Youth e-cigarette use was also a concern in Canada. On May 23, 2018, the federal government of Canada implemented the Tobacco and Vaping Products Act (TVPA) to reduce the accessibility of e-cigarette products among youth (Parliament of Canada, 2018). The TVPA was enacted to

protect adolescents and non-smokers from e-cigarette initiation, exposure to nicotine, and nicotine dependency, and to increase public awareness about the harmful consequences of using e-cigarettes (Parliament of Canada, 2018). Under the TVPA, nicotine-containing e-cigarettes are allowed to be sold. However, they cannot be advertised in a way that triggers or encourages youth to try them (Parliament of Canada, 2018).

1.2. E-cigarette use among youth during the COVID-19 pandemic

During the COVID-19 pandemic, youth had to study remotely. One study suggested that in early April 2020, youth reduced their e-cigarette use due to physical distance restrictions in place (Hopkins & Al-Hamdani, 2021). The Canadian Tobacco and Nicotine Survey (CTNS) is an annual survey conducted to measure the prevalence of smoking cigarettes and using e-cigarettes, cannabis, and alcohol among people aged 15 years and older (Statistics Canada, 2022). The results of the survey conducted during the COVID-19 pandemic period from mid-December 2021 to February 2022 indicate that the prevalence of using e-cigarettes continues to be higher among youth compared to adults (Statistics Canada, 2022). Approximately 29% of youth aged 15 to 19 years had used e-cigarettes in the last 30 days compared to 13% of adults (Statistics Canada, 2022). However, previous waves of this survey indicated that 36% of youth aged 15 to 19 years old had used e-cigarettes (Statistics Canada, 2022). According to these data, the prevalence of ever trying e-cigarettes decreased between 2019 and 2020 among Canadian youth aged 15 to 19 years old (Statistics Canada, 2022).

Longitudinal studies have also investigated the impact of the COVID-19 pandemic on the prevalence of using e-cigarettes among youth (Leatherdale et al., 2021). One study found that during the early stages of the COVID-19 pandemic, the prevalence of using e-cigarette did not increase among youth who were using e-cigarettes monthly or weekly (Leatherdale et al., 2021).

Notably, during the early pandemic period there was a larger reduction observed among those youth who reported less frequent e-cigarette use during the pre-pandemic period (Leatherdale et al., 2021). Similarly, results from a cross-sectional study from the US indicated that compared to before the pandemic, the number of days youth used e-cigarettes decreased during the early pandemic stage (States et al., 2021).

Consistent with these findings, another study evaluated changes in e-cigarette use before and during the pandemic among Canadian youth and young adults and observed changes in e-cigarette use, such as fewer days of using e-cigarettes per week and per day (Hopkins & Al-Hamdani, 2021). Their results suggest that there are several reasons why youth and young adults might use e-cigarettes less during the pandemic. First, it is well-known that youth tend to hide their e-cigarette use from their parents or guardians (Hopkins & Al-Hamdani, 2021). During the pandemic, students had to stay home, which reduced the opportunity to use e-cigarettes because their parents were with them at home (Gaiha et al., 2020). Second, restrictions related to the COVID-19 pandemic such as physical distancing reduced the interactions between youth as they were not able to socialize (Hopkins & Al-Hamdani, 2021). Lastly, youth who were underage were not able to meet their older friends, which reduced the accessibility of e-cigarettes (Hopkins & Al-Hamdani, 2021).

1.3. Reasons for e-cigarette use among youth

There are a variety of reasons why youth use e-cigarettes. One study using focus groups highlighted that the lack of information about the negative health issues caused by e-cigarettes influences youth e-cigarette use (Alexander et al., 2019). Adolescents in this study described that they enjoyed using e-cigarettes because of the attractive flavors and the ability to preform tricks with the vapour (Alexander et al., 2019). Another study used focus groups to examine the reasons for trying e-cigarettes among middle school, high school, and college students (Kong et al., 2015).

Students in this study reported several reasons for trying e-cigarettes such as peer influence, easy accessibility, flavours, vapour tricks, and a positive perception towards using e-cigarettes (Kong et al., 2015). In 2020, according to the CTNS, the most common reasons for using e-cigarettes among youth aged 15 to 19 years who used e-cigarettes in the past 30 days were curiosity (26%), reducing stress (23%), as well as the pleasure they experienced while using e-cigarettes (27%) (Statistics Canada, 2021).

1.4. Factors associated with e-cigarette use among youth

Some studies have explored demographic factors associated with e-cigarette use among adolescents. Early onset of e-cigarette use among youth is a significant public health concern. A systematic review highlighted that age and grade are significantly associated with e-cigarette use among youth (Perikleous et al., 2018). The results of another study identified that age is a significant risk factor for using e-cigarettes among adolescents (Mehra et al., 2019). For instance, the highest prevalence of e-cigarette use in the past 30-days was among those between 15 to 20 years old compared to those 21 to 24 years old (Mehra et al., 2019). A similar pattern was seen among youth in the United States. (Carroll Chapman & Wu, 2014).

The association between ethnicity and e-cigarette use among youth is less certain and needs additional research. One study identified that the likelihood of e-cigarette polysubstance use was higher among White adolescents compared to other ethnicities (Gilbert et al., 2021). These findings are consistent with other studies that suggest that ethnicity might influence e-cigarette use among adolescents (Wills et al., 2015; Harlow et al., 2019; Cole et al., 2021; Felner et al., 2022). Studies suggest a gender difference in the likelihood of e-cigarette use among youth. A review of available studies from 2012 to 2017 investigated the association between gender and e-cigarette use among youth in the United States (Kong et al., 2017). The study identified that the

prevalence of nicotine use was higher among male compared to female adolescents, and male adolescents were more likely to use e-cigarettes compared to female adolescents (Kong et al., 2017). Another study suggested that males had a higher risk of nicotine addiction compared to females (Piñeiro et al., 2016). Furthermore, males were more likely to use e-cigarettes because of the positive reinforcement factors like pleasure, while females were more likely to use e-cigarettes due to negative reinforcement factors like anxiety management (Piñeiro et al., 2016). Consistent with these findings, another study identified that male students who were current e-cigarette users had higher odds of increasing e-cigarette use compared to female students (Cole et al., 2021). In addition to gender, several studies have identified an association between the amount of spending money and e-cigarette use among youth (Kong et al., 2015; Pesko et al., 2018; Cole et al., 2021; Williams et al., 2021).

Other studies have identified that other substance use is associated with an increased likelihood of e-cigarette use among youth. A systematic review identified that there is a significant association between using e-cigarettes and other tobacco product use among adolescents (Perikleous et al., 2018). Another recent systematic review and meta-analysis identified that there is a strong association between binge drinking and using e-cigarettes among high school students in the United States (Rothrock et al., 2020). Youth who used e-cigarettes were more likely to drink alcohol and binge drink compared to those who have never used e-cigarettes (Rothrock et al., 2020). Finally, other Canadian studies have found that youth who used e-cigarettes were more likely to use cannabis (Milicic & Leatherdale, 2017; Mehra et al., 2019). Given the associations between these demographic and behavioural factors and youth e-cigarette use, it is important to account for these factors when evaluating the impact of tax policies.

1.5. Adverse consequences of using e-cigarettes among youth

Given the novelty of e-cigarette devices and the increased prevalence of e-cigarette use among youth, public policymakers, school administrations, teachers, and parents are concerned about adolescents' health (U.S. Department of Health and Human Services, 2016). Since e-cigarettes contain nicotine, children and adolescents will be exposed to nicotine at an early stage of their life, and even a low level of nicotine can increase the risk of nicotine dependency (U.S. Department of Health and Human Services, 2016; Health Canada, 2019). Exposure to nicotine can also cause harm to brain development and the respiratory system and increase cardiovascular disease risk among adolescents (U.S. Department of Health and Human Services, 2016; Health Canada, 2019).

Evidence about long-term impacts of e-cigarette use on youth is still growing. Some studies argue that e-cigarette use among youth can act as a gateway drug and lead to cigarette smoking initiation (Aleyan et al., 2018; Soneji et al., 2017). Given the addictive nature of cigarettes, it is worth considering this issue. A systematic review and meta-analysis explored the risk of cigarette initiation among adolescents who were e-cigarette users and had never smoked cigarettes between 2005 and 2019 (O'Brien et al., 2021). They reviewed 6619 studies, and 21 cohort and longitudinal studies were included (O'Brien et al., 2021). Fifteen studies were conducted in North America and six studies were conducted in Europe (O'Brien et al., 2021). The follow-up period among the cohort and longitudinal studies was between 4 months and 2.5 years (O'Brien et al., 2021). The data in these studies were collected from youth between the age of 13 and 19 years (O'Brien et al., 2021). The results indicated a positive relationship between using e-cigarettes and an increased likelihood of cigarette initiation among youth (O'Brien et al., 2021). The results of nine studies indicated that youth who ever used an e-cigarette at baseline had 4.06 times higher odds of initiating cigarette smoking in the follow-up year (O'Brien et al., 2021). Notably, participants who

used e-cigarettes in the past 30 days at baseline were also about twice as likely to initiate cigarette smoking at follow-up (O'Brien et al., 2021).

Similarly, another systematic review and meta-analysis investigated the likelihood of cigarette smoking among e-cigarette users compared to non-e-cigarette users (Khouja et al., 2021). They assessed 133 studies, and 17 studies were included (Khouja et al., 2021). Ten studies were conducted in the United States, three studies in the U.K., 1 in Canada, 1 in Mexico, 1 in Germany and 1 in the Netherlands (Khouja et al., 2021). The participants were under 18 years old and many of the studies were school-based (Khouja et al., 2021). Their results indicated that participants who initiated e-cigarettes and used e-cigarettes with no history of smoking cigarettes were about four times more likely to report smoking cigarettes than those who had not used e-cigarettes (Khouja et al., 2021). Hence, there is a positive relationship between using e-cigarettes and future cigarette smoking (Khouja et al., 2021; Baenziger et al., 2021). It appears that among the individual factors, accessibility of e-cigarette products, early exposure to nicotine, social influence, and positive norms about using e-cigarettes and nicotine might be relevant elements to subsequent cigarette initiation among youth (Hammond et al., 2017).

Another concern is that youth who use e-cigarettes can become dual users, which refers to using both e-cigarettes and smoking cigarettes. According to the Canadian Student Tobacco, Alcohol, and Drugs Survey, between 2016 and 2017, 6.3% of students in grades 9 to 12 were current dual users, 4.1% were exclusive cigarette smokers, and 12.6% were exclusive e-cigarette users (Shan et al., 2020). Evidence suggests that dual users are more likely to engage in risky behaviours such as using cigarettes, cannabis, and alcohol frequently (Aleyan et al., 2020; Demissie et al., 2017). The results of a longitudinal study have shown that youth who increased the frequency of using e-cigarettes between baseline and follow up were 15 times more likely to

report being dual users in the follow-up year (Aleyan et al., 2020). Peer influences maybe a significant risk factor for being a dual user because youth who use e-cigarettes are more likely to have greater access to cigarettes via their friends (Aleyan et al., 2020).

The main concern is that using different tobacco products might increase the risk of nicotine addiction among youth (Goniewicz et al., 2016). Cross-sectional evidence from Poland identified that youth dual users were more likely to increase their cigarette consumption (Goniewicz et al., 2016). A systematic review evaluated the existing studies conducted on dual users between 2009 and 2017 (Maglia et al., 2018). Seventy-six articles were included, and ten studies were focused on youth (Maglia et al., 2018). In one survey of 1,941 high school students, e-cigarette users and dual users described that e-cigarettes are healthier alternatives to cigarettes as a reason for shifting to e-cigarette use (Maglia et al., 2018). Notably, compared to youth e-cigarette users, dual users were more likely to use marijuana and alcohol (Maglia et al., 2018). In another study included in the review that was conducted in the US, a lack of accessing smoking cessation programs was associated with a higher likelihood of becoming a dual user among adolescents (Maglia et al., 2018). Finally, a study conducted in Korea identified that most youth who used e-cigarettes were dual users, and they assumed that e-cigarettes were a healthier alternative to traditional cigarettes (Maglia et al., 2018).

Chapter 2. Literature review

In response to the increasing rate of vaping among Canadian youth, the federal government enacted the TVPA (Parliament of Canada, 2018). According to the TVPA, selling vaping products to youth under 18 years old and youth-targeted advertising are prohibited (Parliament of Canada, 2018). In response to the continued rise of youth e-cigarette use in Canada, federal and provincial governments have proposed and implemented additional restrictions such as increasing e-cigarette taxes to reduce the accessibility of e-cigarette devices among youth (Health Canada, 2020). Existing evidence for the impact of e-cigarette tax policies is limited and described in this section.

2.1 The impact of e-cigarette tax policies on youth e-cigarette use

As taxation policies on vaping devices recently came into effect across Canada and the US, there is not much evidence about the association between implementing taxes on e-cigarette products and changes in e-cigarette use among youth.

A few studies have found that increasing the price of e-cigarette products can act as a protective factor and lead to reduced e-cigarette use among youth. One study evaluated the influence of price on e-cigarette use among middle and high school students in the US (Pesko et al., 2018). Results of the study have shown that increasing the price of e-cigarette products by 10% is associated with a 10% e-cigarette reduction among adolescent who were current e-cigarette users and a 17.9% reduction in the number of days of e-cigarette use among students in grades 8 to 12 (Pesko et al., 2018).

Another study investigated the influence of price-related and tax-related policies on the demand for using e-cigarettes (Huang et al., 2014). Their results suggested that a 10% increase in the price of vaping devices led to an approximate 12% decline in their sale (Huang et al., 2014). Therefore, implementing taxation policies might reduce the use of e-cigarettes (Huang et al.,

2014). Another study examined the impact of e-cigarette taxes on youth 18 to 25 years old (Dave et al., 2021). The authors suggested that youth exposed to nicotine by using e-cigarettes have a potential risk of shifting to smoking cigarettes in the future (Dave et al., 2021). The authors found that taxing e-cigarette products can act as a protective factor and delay initiating cigarette use among youth in grades 8, 9 and 12 (Dave et al., 2021). Hence, it appears that studies which evaluated the association between e-cigarette price and e-cigarette use agree that taxation could be an effective policy to control and reduce e-cigarette demand among youth. Yet, more studies over longer periods of time are needed to capture the impact of e-cigarettes tax policies among youth.

2.2 Taxes on e-cigarette products in Canada

Taxing e-cigarette products aims to discourage youth from using e-cigarettes, discourage never-e-cigarette users from initiating use, and reduce the accessibility of e-cigarette devices among adolescents (Risom, 2021). As of October 1, 2022 in Canada, a federal tax of \$1 per 2 mL of e-cigarette liquid was applied (Physicians for a Smoke-Free Canada, 2021). At the time of this thesis, British Columbia (BC), Saskatchewan, Newfoundland and Labrador, and Nova Scotia added taxes to e-cigarette products at the provincial level (Physicians for a Smoke-Free Canada, 2021).

Table 1 provides a summary of provinces in Canada that have added taxes to e-cigarette products. In BC, the provincial sales tax (7%) is applied to taxable services or goods (British Columbia, 2019). As shown in Table 1, On January 1, 2020, BC added an additional 13% tax on e-cigarette products such as vaping devices, cartridges, and accessories (Saminathan et al., 2019; British Columbia, 2019). Hence, the total tax rate on e-cigarettes has increased to 20% which makes e-cigarettes more expensive than other products (Saminathan et al., 2019; British Columbia, 2019). As of September 15, 2020, Nova Scotia enacted a tax of \$0.50 per mL on all e-liquids, even

those that do not contain nicotine (Nova Scotia, 2020). E-cigarette devices and their components have also been taxed at a rate of 20% (Nova Scotia, 2020). On September 1, 2021, Saskatchewan and Newfoundland and Labrador applied a 20% tax on vaping products such as e-liquids and devices (Saskatchewan, 2021; Physicians for a Smoke-Free Canada, 2020a). Alberta is also planning to increase the tax on vaping products to 20%, however it has not yet come into effect (Physicians for a Smoke-Free Canada, 2021).

Table 1. Overview of e-cigarette taxes across provinces in Canada

Province	E-cigarette tax description	Date tax in effect
Saskatchewan	20% applied to e-liquids and e-cigarette devices	2021/09/01
Newfoundland and Labrador	20% applied to e-liquids and e-cigarette devices	2021/09/01
British Columbia	13% applied to e-cigarette devices, cartridges, and accessories	2020/01/01
Nova Scotia	\$0.50 per millilitre applied to all e-liquids	2020/09/15

2.3 Taxes on e-cigarette products in the United States

The US has not implemented a tax on e-cigarettes at a federal level. However, as shown in Table 2, 26 US states have applied a tax on e-cigarette products such as e-liquids (per mL) and refillable cartridges (Centers for Disease Control and Prevention, 2022). The tax rate on e-cigarettes varies by state and has been applied as a percentage of wholesale price, manufacturer’s sales, rate per cartridge, and rate per mL.

Table 2. Overview of e-cigarette taxes across US states

State	E-cigarette tax description	Date tax in effect
California	63.49% of wholesale cost	2022/01/07
Minnesota	95% of wholesale price	2022/01/08
Georgia	7% of wholesale price	2021/01/01
Oregon	65% of wholesale price	2021/01/01
Maryland	12% of taxable price	2021/14/03
North Carolina	\$0.05 per mL	2021/01/06
Louisiana	\$0.05 per liquid mL	2021/15/12
Maine	43% of wholesale price (device and e-liquid)	2020/02/01
Nevada	30% wholesale price	2020/01/01
New Hampshire	\$0.30 per mL	2020/01/01
Massachusetts	75% of wholesale price	2020/01/06
Wyoming	15% of wholesale purchase	2020/01/07
Utah	56% manufacturer's sales (those who are importing or prefilled e-cigarettes)	2020/01/07
Virginia	\$0.06 per mL	2020/01/07
Connecticut	\$0.40 per mL	2019/10/01
New York	20% retail sales of vaping products (including all business that sell vaping products)	2019/12/01
Vermont	92% of wholesale price	2019/01/07
New Mexico	\$0.50 per closed system	2019/01/07
Illinois	15% of wholesale price (device, e-liquid, and cartridges or pods)	2019/01/07
Wisconsin	\$0.05 per mL	2019/05/07
Washington DC	\$0.27 per mL	2019/01/10
Ohio	\$0.01 per vapor volume	2019/17/10
Delaware	\$0.05 per mL	2018/01/01
New Jersey	\$0.10 per mL	2018/30/09
Kansas	\$0.05 per mL	2017/07/01
Pennsylvania	40% purchase price	2016/13/07

Note: all values are in USD

2.4 Taxes on e-cigarette products around the world

Most countries have not implemented tax restrictions on e-cigarette devices and e-liquids (Physicians for a Smoke-Free Canada, 2020b). However, a few countries such as South Korea, Malaysia, Indonesia, and Albania have enacted tax restrictions on e-liquids containing nicotine. On January 1, 2011, South Korea was the first country that implemented a tax policy on e-

cigarettes and the initial tax rate was 370 won (\$0.27 USD) per mL (National Treasury, 2021). Recently, on January 1, 2021, the government of South Korea announced that the tax on e-liquid containing nicotine should be doubled (National Treasury, 2021). The tax rate increased from 525 won per mL to 1,050 won per mL (\$0.90 USD) (Jeehyun, 2020). On January 1, 2021, the government of Malaysia also enacted a 10% tax on the retail price and RM 0.40 (\$0.10 USD) per mL of e-liquid (SEATCA, 2021). On October 1, 2018, the government of Indonesia implemented a 57% tax on the retail cost of e-cigarette products such as e-liquids (Institute for Global Tobacco Control, 2018), while on January 1, 2019, Albania implemented a tax on cigarettes as well as heat-not-burn tobacco products and e-liquids containing nicotine (10 leke or \$0.091 USD per mL of e-liquid) (Vapor Products Tax, 2019).

2.5 The impact of cigarette tax policies on youth cigarette smoking

In 1991, the Canadian federal government increased the taxes on cigarettes (Canadian Public Health Association, 2021). Since then, taxation has been an effective strategy to control and reduce tobacco consumption among youth. (Canadian Public Health Association, 2021).

In 2019, the CTNS reported that the prevalence of smoking cigarettes dropped by 1% among youth aged 15 to 17 years (Health Canada, 2020). Compared to 2013 and 2015, in 2019, the prevalence of occasional smokers remained at 3% (Health Canada, 2020). A study examined the affordability of cigarettes across Canada from 2009 to 2019 (Worrell & Hagen, 2021). In Canada, in 2019, cigarettes were 26% less affordable than in 2009 (Worrell & Hagen, 2021). Decreasing the affordability of cigarettes is positively related to reduced cigarette consumption (Worrell & Hagen, 2021).

A systematic review analyzed the impact of tobacco control policies such as taxation and smoke-free policies on smoking initiation among youth (Bafunno et al., 2020). The authors

assessed 842 articles; only 21 papers met the inclusion criteria (Bafunno et al., 2020). Among the 21 papers, five articles were focused on tobacco taxes and price, and six evaluated the impact of tobacco control policies on adolescents (Bafunno et al., 2020). The results of studies across the US, United Kingdom, Europe, Australia, and Argentina indicate that there is an association between increasing the price of tobacco products through taxes and reduced tobacco consumption among youth (Bafunno et al., 2020). Consistent with these findings, recent European evidence has suggested that increasing tobacco taxes are strongly associated with reducing smoking among youth, older adults with lower education, and low-income populations (Bafunno et al., 2020). When the government increases taxes, tobacco companies also increase the price of their products; therefore, the products are less affordable to youth and low-income individuals, leading to tobacco use reduction (Bafunno et al., 2020). Based on the literature, increasing taxes on tobacco products reduces the risk of cigarette initiation (Bafunno et al., 2020). Other studies suggest that the rising price of cigarettes through taxes has a greater impact on cigarette smoking initiation than cigarette smoking cessation (Gonzalez-Rozada & Montamat, 2019). In fact, increasing the price of tobacco products by 10% decreases tobacco use by 5% among those who have not had a long nicotine addiction history and 1.9% among those with a history of nicotine addiction (Gonzalez-Rozada & Montamat, 2019). Furthermore, increasing the price of cigarettes by 10% can delay smoking onset by two and half years among those who are 15 years old (Gonzalez-Rozada & Montamat, 2019). The authors also suggest that nicotine tax regulations have a larger impact on those who initiate cigarette smoking compared to those who currently smoke cigarettes (Gonzalez-Rozada & Montamat, 2019). Increasing the price of cigarettes might be one of the most effective tobacco control policies to protect youth from cigarette smoking initiation.

2.6 Challenges and Gaps

Many studies have identified the risk factors of using e-cigarettes among youth (U.S. Department of Health and Human Services, 2016). However, the significant challenge for policymakers is that there are not enough studies that evaluate the influence of e-cigarette regulations on youth e-cigarette use.

E-cigarette use among youth is a concern for public health researchers and policymakers. Many historical studies show that increasing the price of cigarettes decreases the likelihood of cigarette smoking among youth. As preliminary studies have shown, increasing the price of e-cigarettes may also decrease the likelihood of e-cigarette use among youth. However, more evidence is needed to evaluate the impact of taxation policies on e-cigarette use outcomes among adolescents. Notably, there is lack of evidence that evaluates the real-world impact of newly implemented tax policies and e-cigarette use among youth.

2.7 Research Questions

Developing programs and policies to protect youth from the harmful impacts of e-cigarette initiation and nicotine addiction is essential. This study aimed to evaluate the impact of an e-cigarette tax on the prevalence of e-cigarette use and the likelihood of e-cigarette initiation among high school students in Canada. The study answered the following research questions:

Research Question (RQ) 1: Does the prevalence of ever e-cigarette use among youth change after implementing an e-cigarette tax policy in British Columbia relative to the prevalence of ever e-cigarette use in Ontario, Alberta, and Quebec?

RQ2: Does the prevalence of current (past 30-day) e-cigarette use among youth change after implementing an e-cigarette tax policy in British Columbia relative to the prevalence of current e-cigarette use in Ontario, Alberta, and Quebec?

RQ3: What is the individual likelihood of e-cigarette initiation among youth in British Columbia after implementing an e-cigarette tax policy relative to the likelihood of e-cigarette initiation among youth in Ontario, Alberta, and Quebec?

2.8 Hypotheses

Overall, I expected to observe a lower prevalence of e-cigarette use among youth in British Columbia (the intervention group) because the government of British Columbia increased the tax on e-cigarette products. A tax on e-cigarette products did not occur in Ontario, Alberta, and Quebec (the control group). There are a lack of studies that evaluate the impact of e-cigarette taxes on e-cigarette use among youth. However, evidence from studies evaluating the effect of cigarette taxes on cigarette smoking suggests that when there is an increase on the taxes of cigarettes, fewer youth smoke cigarettes (Worrell & Hagen, 2021).

RQ1: I hypothesized that the prevalence of ever e-cigarette use would reduce in British Columbia after implementing the tax policy compared to the other provinces.

RQ2: I hypothesized that the prevalence of current e-cigarette use would reduce in British Columbia after implementing the tax policy compared to the other provinces.

RQ3: I hypothesized that youth in British Columbia would have a lower likelihood of e-cigarette initiation than youth in the other provinces after implementing the tax policy.

Chapter 3: Methodology

3.1 Host study

The COMPASS study is a 15-year prospective cohort study (2012-2027) funded by the Canadian Institutes of Health Research (Leatherdale et al., 2014). It collects hierarchical longitudinal data from a purposive sample of secondary schools (Leatherdale et al., 2014). It is designed to evaluate and develop strategies to improve youth health in various aspects, such as healthy eating, obesity, physical activity, bullying, academic achievement, tobacco use, alcohol, and marijuana use (Leatherdale et al., 2014). The main purpose of the COMPASS study is to guide and advance youth prevention research and practice (Leatherdale et al., 2014). The COMPASS study uses several measurement tools, such as the COMPASS student questionnaire (Cq), the school policies and practices (SPP) questionnaire, and the COMPASS School Environment Application (Co-SEA). For this study, I used the Cq to analyze student-level behavioural (e.g., e-cigarette use) and sociodemographic (e.g., grade, ethnicity) data (Leatherdale et al., 2014). The COMPASS study collected data annually from 95+ secondary schools and 70,000+ students in grades 9 to 12 attending schools across Alberta, Ontario, Quebec, and British Columbia (BC). For this quasi-experimental study, I selected data from two waves of the COMPASS study: Wave 7 (2018-19, baseline), representing the e-cigarette tax pre-implementation period (in BC), and Wave 9 (2020-21, follow-up), representing the e-cigarette tax post-implementation period (in BC).

3.1.1 School board and school recruitment

All secondary school boards with grades 9 to 12 with 100 or more students in each grade, and that agreed to use active-information passive-consent parental permission protocols were eligible to participate in the COMPASS study (Leatherdale et al., 2014). After school board approval, eligible schools were contacted by the COMPASS recruitment coordinator via phone or email to

set up the data collection date (Thompson-Haile & Leatherdale, 2013). All participating schools were contacted via email or phone between September 2018 and March 2019 to collect data for Wave 7 (2018-19) (Reel et al., 2021). In Wave 9 (2020-21), all participating schools were contacted via email or phone between October 2020 and March 2021 (Rezvani et al., 2023).

3.1.2 Participant selection and recruitment

A letter about the COMPASS study was emailed to parents of eligible students (Leatherdale et al., 2014). Based on active-information passive-consent parental permission protocols, parents needed to contact the research team if they did not want their child/ren to participate in the study. The use of passive consent procedures maximized the participation rate and limited some types of bias. For studies that measure substance use behaviours, it is important to use passive consent procedures to be able to produce robust results while maintaining student confidentiality (Rojas et al., 2008, White et al., 2004). All students in participating schools were eligible to participate. Students also had the option to withdraw from the study anytime should they so desire (Leatherdale et al., 2014).

3.1.3 Survey protocols

The Cq gathered student-level behavioural and demographic data from Canadian students. Student-level data included demographic characteristics, eating habits, physical activity, substance use (such as e-cigarette use, cannabis use, and alcohol use), bullying, sleep quantity, and academic performance (Leatherdale et al., 2014). In this study I used two waves of the sample and data collection occurred in 2018-19 and 2020-21.

Wave 7 data collection occurred between September 2018 and June 2019. During Wave 7, students completed a paper-based survey during class time. The Cq took approximately 30 minutes to complete.

Wave 9 data collection occurred between October 2020 and March 2021 using an online survey. In response to the COVID-19 pandemic, some in-person classes were suspended and the COMPASS team created an online version of Cq for students to complete during virtual classes or at home in their own time. The average participation rate for schools that completed the survey during class time was 72%, and it was 26% for schools that had students complete the survey on their own time. Only 2% of schools did not confirm whether they completed the survey during class time (Rezvani et al., 2023).

3.1.4 Data linkage procedures

As the COMPASS study is a longitudinal study, tracking and maintaining participants can be challenging in the follow-up year (Bredin & Leatherdale, 2013). At the beginning of the Cq, there are five questions which create a unique code for students. The unique code is used to link student data over time and helps ensure that the information provided by students remains anonymous (Leatherdale et al., 2014).

The Cq asked five questions from each student to create a self-generated code (Bredin & Leatherdale, 2013). These questions and the responses do not change in the follow-up year, and students can be identified via this code over time (Bredin & Leatherdale, 2013). The questions include:

1. What is the first letter of your middle name? (if you have more than one middle name, use your first middle name; if you do not have a middle name, select the letter "Z")
2. In which month were you born?
3. What is the last letter of your full last name?
4. What is the second letter of your full first name?

5. What is the first initial of your mother's first name? (Think about the mother you see the most.)

At the school level, to address the issue of students entering and exiting the study, the Cq asked students, "Did you attend this school last year?" with responses 'Yes, I attended the same school last year' and 'No, I was at another school last year'. If the response was 'No', there are no matching data from previous years for that student within that school (Bredin & Leatherdale, 2013).

3.2 Sample Selection

This quasi-experimental study used data from both repeat cross-sectional and longitudinal samples. This study used data from Wave7 (2018-19; baseline/pre-implementation period), and Wave 9 (2020-21; follow-up/post-implementation period) of the COMPASS study. This study received ethics approval from the Ontario Tech University Research Ethics Board (Certificate number 16943; Appendix A).

3.2.1 Repeat cross-sectional sample

Overall, 48 schools from Quebec, 61 schools from Ontario, 8 schools from Alberta, and 15 schools from BC participated at baseline. At follow-up, 59 schools from Quebec, 51 schools from Ontario, 5 schools from Alberta, and 14 schools from BC participated in the repeat cross sectional sample. Students in grades 9, 10, 11, and 12 were included in the repeat-cross sectional sample.

At baseline, n=1,135 students were removed because they did not state whether they had tried e-cigarettes or not and n=1,035 students were removed because they did not report how many days they had used an e-cigarette in the past 30 days. Additionally, n=13,891 students were excluded because they were in Secondary I and II in Quebec (equivalent to grades 7 and 8) or enrolled in a class with no official grade (such as newcomer classes). Finally, n=1,647 students were removed

because they were missing demographic characteristics and n=2,674 students were removed because they did not report their other substance use during the past 30 days. After the exclusions, a total of n=57,786 students made up the baseline repeat cross-sectional sample.

At follow-up, n=4,207 students were removed because they did not state whether they had tried e-cigarettes or not and n=64 students were removed because they did not report how many days they had used an e-cigarette in the past 30 days. Additionally, n=14,792 students were excluded because they were in Secondary I and II or enrolled in a class with no official grade in Quebec. Finally, n=2,417 students were removed because they were missing demographic characteristics and n=4,832 students were removed because they did not report their other substance use during the past 30 days. After the exclusions, a total of n=34,391 students made up the follow-up repeat cross-sectional sample.

3.2.2 Longitudinal sample

Overall, students from 49 schools in Quebec, 46 schools in Ontario, 3 schools in Alberta, and 9 schools in BC made up the longitudinal sample. In total, n=4,311 students in Secondary I and II or enrolled in a class with no official grade were excluded from the longitudinal sample. In addition, students in grades 11 (n=96) and 12 (n=7) were removed from the longitudinal sample because they graduated high school during the study period and follow-up data were not available. Therefore, only students in grades 9 and 10 at baseline were included in the longitudinal sample.

At baseline, n=209 students were removed because they did not report how many days they used an e-cigarette in the last month. At follow-up, n=751 students were removed because they did not state how many days they used an e-cigarette in the last month. To identify the students who initiated e-cigarette use between baseline and follow-up, n=1,941 ever and n=1,356 current e-cigarette use were excluded from the longitudinal sample at baseline.

Due to missing demographic data, n=252 students were removed, and n=213 students were removed because they did not report their other substance use during the past 30 days. After I removed the missing data, n=23,506 students were included in the longitudinal sample.

3.3 Measures

The following section describes the measure that were used for this research. They are divided into outcome, independent, demographic, and substance use variables. A copy of the 2018-19 COMPASS student questionnaire is available in Appendix B.

3.3.1 Outcome variables

Ever e-cigarette use: To measure ever e-cigarette use among students, the Cq asked: “Have you ever tried an electronic cigarette, also known as an e-cigarette?” (Response options 1=‘Yes’, 2=‘No’). In the follow-up year, the Cq changed the term ‘e-cigarette’ to ‘vape’. However, there was no change to the response options for this question. If students responded ‘Yes’ to this question, they were coded as ever e-cigarette users. If students reported ‘No’ to this question, they were coded as never e-cigarette users. As the Cq is anonymous, we expect that students are less likely to skip the question. However, students who did not respond to this question were removed from the sample.

Current e-cigarette use: To assess current e-cigarette use among students, the Cq asked: “On how many of the last 30 days did you use an e-cigarette?” (Response options: 1=‘None’, 2=‘1 day’, 3=‘2 to 3 days’, 4=‘4 to 5 days’, 5=‘6 to 10 days’, 6=‘11 to 20 days’, 7=‘21 to 29 days’, and 8=‘30 days (every day)’). In the follow-up year, the Cq changed the term ‘e-cigarette’ to ‘vape’. However, there was no change to the response options for this question. Consistent with another study (Aleyan, Hitchman, Ferro & Leatherdale, 2021), if students reported using e-cigarettes on

any days in the past 30 days, they were coded as current e-cigarette users. All other students were coded as non-current e-cigarette users.

E-cigarette initiation: E-cigarette initiation was assessed using the same question for ever e-cigarette use. If students reported never e-cigarette use at baseline but they reported ever and/or current e-cigarette use at follow-up, they were categorized as initiating e-cigarette use. If students reported never e-cigarette use at baseline and follow-up, they were categorized as never e-cigarette users.

3.3.2 Independent variables

To evaluate the impact of the tax policy, participating schools were categorized into two groups: 1) Intervention group, which included schools in BC where the e-cigarette tax was implemented, and 2) Control group, which included schools in Alberta, Ontario, and Quebec where no e-cigarette tax was implemented. Students that attended schools in BC formed the intervention group, while students that attended schools in Alberta, Ontario, and Quebec formed the control group.

3.3.3 Demographic Variables

The Cq gathered demographic information, including student **grade** (1='grade 9', 2='grade 10', 3='grade 11', and 4='grade 12'), **ethnicity** ('White', 'Black', 'Asian', 'Latin-American/Hispanic', 'Aboriginal (First Nations, Metis, Inuit)', and 'Other'), and **amount of spending money** ("About how much money do you usually get each week to spend on yourself or to save? (Remember to include all money from allowances and jobs like babysitting, delivering papers, etc.)". (Response options: 1='Zero', 2='\$1 to \$5', 3='\$6 to \$10', 4='\$11 to \$20', 5='\$21 to \$40', 6='\$41 to \$100', 7='More than \$100', 8='I do not know how much money I get each week'). Consist with other studies (Cole et al., 2022; Milicic & Leatherdale, 2017), responses for

ethnicity were grouped as ‘White’ and ‘Other’, and responses for spending money were grouped as ‘<\$20’, ‘\$21-100’, ‘>\$100’, and ‘I don’t know’.

To identify the **gender** of students, at baseline the Cq asked “Are you female or male?” (Response options: 1=‘female’, 2=‘male’). At follow-up the response options to the gender question changed (Response options: 1=‘female’, 2=‘male’, 3=‘I describe my gender in a different way’, 4=‘I prefer not to say’). Due to a lower number of responses, students who identified their gender in a different way and preferred not to answer were grouped together in analyses.

3.3.4 Substance use variables

Evidence suggests that youth who use e-cigarettes are more likely to engage in other risky behaviours (Milicic & Leatherdale, 2017), and it is important to account for these behaviours during the analysis. The Cq collected information about other substance use, including cigarette smoking, binge drinking, and cannabis use.

Cigarette smoking: Two questions assessed cigarette smoking. The first asked about ever cigarette smoking: “Have you ever tried cigarette smoking, even just a few puffs?” (Response options: 1=‘Yes’, 2=‘No’). If students reported they had never smoked, they were coded as never cigarette smokers. If students reported they have ever smoked, they were coded as ever cigarette smokers.

The second question asked about cigarette smoking in the past 30 days: “On how many of the last 30 days did you smoke one or more cigarettes?” (Response options: 1=‘None’, 2=‘1 day’, 3=‘2 to 3 days’, 4=‘4 to 5 days’, 5=‘6 to 10 days’, 6=‘11 to 20 days’, 7=‘21 to 29 days’, 8=‘30 days (every day)’). If students reported smoking cigarettes every day in the last 30 days, they were coded as current cigarette smokers.

Binge drinking: One question assessed the frequency of binge drinking in the past year: “In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?” (Response options 1=‘I have never done this’, 2=‘I did not have 5 or more drinks on one occasion in the last 12 months’, 3=‘Less than once a month’, 4=‘Once a month’, 5=‘2 to 3 times a month’, 6=‘Once a week’, 7=‘2 to 5 times a week’, 8=‘Daily or almost daily’, 96=‘Valid skip’ (did not drink alcohol in the last 12 months), 99=‘Not Stated’). Consistent with another study (Milicic & Leatherdale, 2017), participants were categorized as never alcohol drinkers if they reported ‘Valid Skip’ or ‘Not Stated’, never binge drinkers if they have never drunk alcohol or never engaged in binge drinking, infrequent binge drinkers if they reported binge drinking less than once a month, or frequent binge drinkers if they reported binge drinking once a month or more frequently.

Cannabis use: One question assessed the frequency of cannabis use in the past year: “In the last 12 months, how often did you use marijuana or cannabis? (a joint, pot, weed, hash)” (Response options: 1=‘I have never used marijuana’, 2=‘I have used cannabis but not in the last 12 months’, 3=‘Less than once a month’, 4=‘Once a month’, 5=‘2 or 3 times a month’, 6=‘Once a week’, 7=‘2 or 3 times a week’, 8=‘4 to 6 times a week’, 9=‘Every day’). Consistent with another study (Milicic & Leatherdale, 2017), participants were categorized as never cannabis users if they never used cannabis, non-current cannabis users if they used cannabis but less than once a month, and current cannabis users if they used cannabis once a month or more frequently.

3.4 Analysis

This natural experimental study used a quasi-experimental design to evaluate the impact of a tax policy on the prevalence of using e-cigarettes and e-cigarette initiation among students in the intervention and control groups (Leatherdale, 2019). Natural experiments are a type of observational study that can be used when the researcher cannot manipulate and control when or

where the intervention, event, or policy arose, like when evaluating changes in policies or developing a new program (Leatherdale, 2019). Natural experimental studies are applicable when there is a limitation to evaluating the impact of the intervention and policy for ethical or practical reasons (Leatherdale, 2019).

R Studio software was used for the statistical analysis of this study. The analyses of the study were conducted in two parts. The first part evaluated changes in the overall prevalence of ever e-cigarette and current e-cigarette use over time among students in the intervention group relative to students in the control group. The second part focused on student-level changes in the likelihood of e-cigarette initiation among students.

3.4.1 Part 1: Repeat cross-sectional analysis

The first research question evaluated the population-level changes in the prevalence of ever e-cigarette use among youth in the intervention and control groups over time. The difference-in-differences (DID) approach was used in this study. The DID approach is a quasi-experimental approach that compares the changes in the outcome variable over time between intervention and control groups (Schwerdt & Woessmann, 2020). Hence, the results of the DID approach can indicate two differences between group means in a unique way (Schwerdt & Woessmann, 2020). The first difference is the difference in the means of outcome variable over two periods of time for each group (Schwerdt & Woessmann, 2020). The second difference measures how changes in the outcome are different between the intervention and control groups (Schwerdt & Woessmann, 2020).

Before conducting the DID analysis, I used Chi-square tests to identify differences in the demographic characteristics of the control and intervention groups at baseline and follow-up. In this study, the DID approach evaluated how the e-cigarette tax may have led to changes in the

prevalence of ever e-cigarette use among youth in the intervention group compared to the changes in the prevalence of ever e-cigarette use in the control group over time.

To address the second research question, which evaluated the population-level change in the prevalence of current e-cigarette use among youth in the intervention and control groups over time, the DID approach was also used. This approach evaluated how the e-cigarette tax may have led to changes in the prevalence of current e-cigarette use among youth in the intervention group compared to the changes in the prevalence of current e-cigarette use in the control group over time.

3.4.2 Part 2: Longitudinal analysis

To answer the third research question, which evaluated the likelihood of e-cigarette initiation in the intervention versus the control group, students were placed into two groups based on exposure to the e-cigarette tax: 1) Intervention group (which included students attending schools in BC), and 2) Control group (which included students attending schools in Alberta, Ontario, and Quebec).

Chi-square tests identified differences in the demographic characteristics of the control and intervention groups at baseline. Multi-level regression modelling is a statistical approach that is used to provide a comprehensive picture to identify similarities or differences in population-level and individual-level factors on health outcomes (Diez-roux, 2000). One of the key research areas that multi-level methods can be used is when the researcher is investigating the effect of the social environment on health outcomes (Diez-roux, 2000). Students in the COMPASS study are clustered into schools. The behaviours of students attending the same school are expected to be more correlated to one another than to the behaviours of students attending different schools. A multi-level regression model was used to examine the association between the outcome (e-cigarette initiation) and the independent variable (e-cigarette tax policy) while accounting for student-level

clustering within schools. Two multi-level regression models were conducted. The first model evaluated the effect of the intervention alone on e-cigarette initiation (while accounting for student-level clustering within schools), and the second model evaluated the impact of the intervention on e-cigarette initiation while controlling for other student-level demographic and behavioural characteristics and accounting for student-level clustering within schools.

Chapter 4: Results

4.1 Part 1: Repeat cross-sectional analysis

4.1.1 *Demographic characteristics of the repeat cross-sectional sample*

Table 3 presents the demographic characteristics of students in the intervention and control groups in the repeat cross-sectional sample at baseline (2018-19). It also provides an overview of the demographic variables among students in the intervention and control groups in the repeat cross-sectional sample at follow-up (2020-21). The following paragraphs will outline the differences between the demographic characteristics of the intervention and the control groups.

As shown in Table 3, at baseline and follow-up, there were more students in the control group than in the intervention group. There was a significant difference in the grade distribution between the control and intervention group at baseline (Chi-square = 550.94, $df = 3$, $p < 0.001$) and at follow-up (Chi-square = 771.93, $df = 3$, $p < 0.001$). The proportion of the students who were in grade 9 was higher in the control group than the intervention group at baseline and follow-up, while the proportion of grade 12 students was higher in the intervention group than the control group at baseline and follow-up. There was also a significant difference in the grade distribution of the control group between baseline and follow-up (Chi-square = 288.72, $df = 3$, $p\text{-value} < 0.01$), but not of the intervention group between baseline and follow-up (Chi-square = 6.6901, $df = 3$, $p\text{-value} < 0.08$).

Similarly, there was a significant difference in the ethnic distribution between the control and intervention group at baseline (Chi-square = 6112.8, $df = 1$, $p < 0.001$) and at follow-up (Chi-square = 3709.6, $df=1$, $p < 0.001$). While the majority of students in the control and intervention groups identified themselves as White, the control group had a higher percentage of students that identified themselves as another ethnicity at both baseline and follow-up. There was also a

significant different in the ethnic distribution of the control group between baseline and follow-up (Chi-square = 185.71, df = 1, $p < 0.001$), but not of the intervention group between baseline and follow-up (Chi-square = 3.1144, df = 1, $p < 0.07$).

There was a significant difference in the gender distribution between the control and intervention groups at baseline (Chi-square = 4.0197, df = 1, $p < 0.04$) and at follow-up (Chi-square = 99.233, df = 2, $p < 0.001$). While approximately half of the sample described themselves as female at both baseline and follow-up in the control and intervention groups, the proportion of students who reported describing their gender in a different way or who preferred not to say was higher in the intervention group than the control group at follow-up.

Finally, there was a significant difference in the amount of spending money reported by students in the control and intervention groups at baseline (Chi-square = 349.04, df = 3, $p < 0.001$) and at follow-up (Chi-square = 363.47, df = 1, $p < 0.001$), and by students between baseline and follow-up in the control group (Chi-square = 679.39, df = 3, $p < 0.001$) and the intervention group (Chi-square = 145.45, df = 3, $p < 0.001$). At both baseline and follow-up, the proportion of students who had more than \$100 per week in spending money was higher in the control group than the intervention group, and the proportion of students who had less than \$20 per week in spending money was higher in the intervention group than the control group.

Table 3. Demographic characteristics of students from baseline to follow-up in the repeat cross-sectional sample (n=92,177), by intervention and control groups, COMPASS study, 2018-21

Demographic Characteristics	Baseline (n=57,786)		Follow-up (n=34,391)		Chi-square test result			
	Intervention Group % (n)	Control Group % (n)	Intervention Group % (n)	Control Group % (n)	Intervention vs Control Group		Baseline vs Follow-up	
					Baseline	Follow-up	Intervention Group	Control Group
Grade								
9	23.89 (2343)	29.87 (14,332)	22.08 (993)	31.87 (9,526)	550.94 (3) p < 0.001	771.93 (3) p < 0.001	6.6901 (3) p < 0.08	288.72 (3) p < 0.001
10	26.11 (2561)	29.35 (14,079)	27.12 (1,220)	31.92 (9,541)				
11	26.94 (2643)	26.69 (12,807)	26.81 (1,206)	26.02 (7,778)				
12	23.06 (2262)	14.09 (6,759)	23.99 (1,079)	10.20 (3,048)				
Ethnicity								
White	67.69 (6640)	79.72 (38,247)	66.18 (2,977)	84.25 (24,931)	6112.8 (1) p < 0.001	3709.6 (1) p < 0.001	3.1144 (1) p < 0.07	185.71 (1) p < 0.001
Other	32.31 (3169)	20.28 (9,730)	33.82 (1,521)	15.75 (4,962)				
Gender								
Female	49.24 (4830)	50.36 (24,160)	52.20 (2,348)	52.79 (15,782)	4.0197 (1) p < 0.04	99.233(2) p < 0.001	N/A	N/A
Male	50.76 (4979)	49.64 (23,817)	41.51 (1,867)	43.53 (13,012)				
I describe my gender in a different way/I prefer not to say	N/A	N/A	6.29 (283)	3.68 (1,099)				
Amount of weekly spending money								
<\$20	42.79 (4197)	36.51 (17,515)	47.64 (2,143)	35.36 (10,569)	349.04 (3) p < 0.001	363.47 (3) p < 0.001	145.45 (3) p < 0.001	679.39 (3) p < 0.001
\$21-100	25.83 (2534)	24.13 (11,578)	17.14 (771)	17.55 (5,247)				
>\$100	15.28 (1499)	23.59 (11,317)	15.14 (681)	26.54 (7,935)				
I don't know	16.10 (1579)	15.77 (7,567)	20.08 (903)	20.55 (6,142)				

4.1.2 Evaluating changes in the prevalence of ever e-cigarette use among students in the intervention and control groups

As shown in Figure 2, the prevalence of never and ever e-cigarette use increased among students in the intervention and control groups at follow-up. However, the prevalence of current e-cigarette use was lower among the intervention group compared to the control group at baseline and follow-up. As Figure 2 shows, there were differences between the control and intervention groups. Unlike the control group, the intervention group started with a lower prevalence of e-cigarette use among students. At follow-up, the prevalence of never e-cigarette use was higher among students in the intervention group compared to the control group. Additionally, the prevalence of never e-cigarette use increased by approximately 5.88% (absolute change) in the intervention group at follow-up. The prevalence of never e-cigarette use increased by approximately 5.01% (absolute change) in the control group at follow-up. At follow-up, the prevalence of ever e-cigarette use increased by 4.1% (absolute change) in the intervention group, while the prevalence of ever e-cigarette use increased by 5.8% (absolute change) in the control group. Moreover, at follow-up, the prevalence of current e-cigarette use decreased by 9.98% (absolute change) in the intervention group, and by 10.81% (absolute change) in the control group.

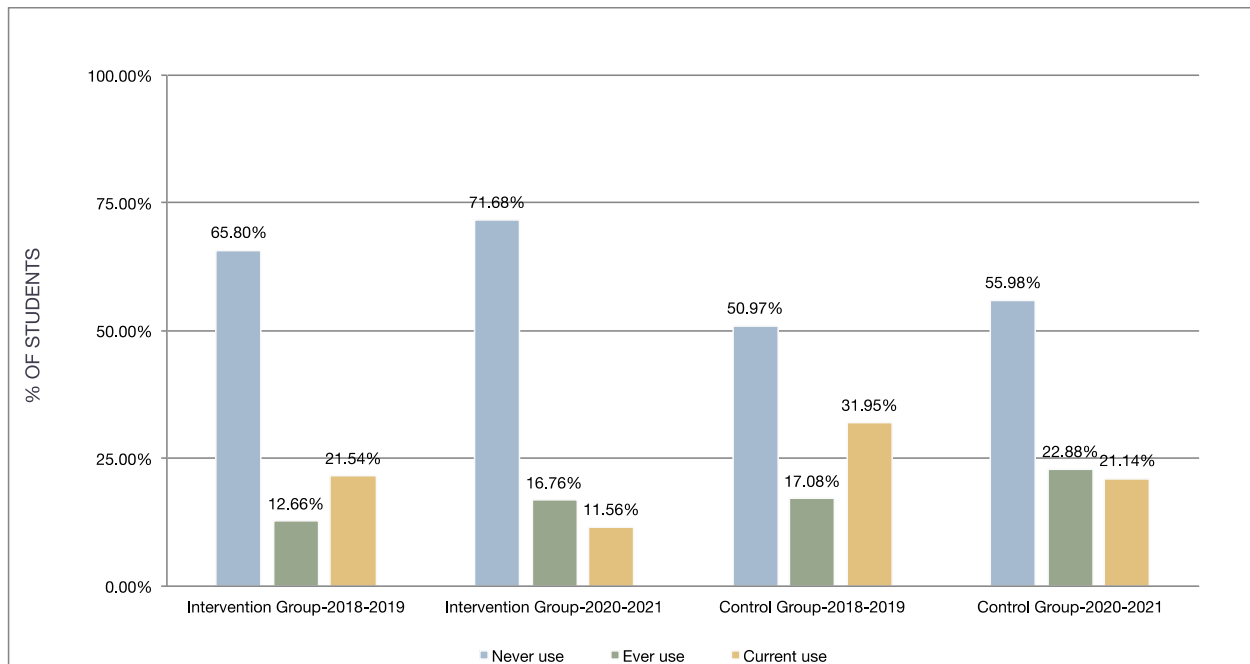


Figure 2. Prevalence of e-cigarette use among students in the intervention and control groups at baseline and follow-up within a cross-sectional sample of students, COMPASS study 2018-2021

The first part of the difference-in-difference (DID) analysis identified changes in the prevalence of ever e-cigarette use (including past 30-day use) between baseline and follow-up in the control and intervention groups. Figure 3 shows that the prevalence of ever e-cigarette use was lower among students in the intervention group than in the control group at both baseline and follow-up. Also, the prevalence of ever e-cigarette use dropped by the same amount over time between both groups. Table 4 shows the variable time was significant and negative which means there was an overall change (reduction) in the prevalence of ever e-cigarette use from baseline to follow-up. The variable group was also significant and negative, meaning that the prevalence of ever e-cigarette use was lower in the intervention group compared to the control group. Lastly, the non-significant interaction between time and group indicates that there was no significant difference in the change in prevalence of ever e-cigarette use that occurred from baseline to follow-up in the control and intervention groups.

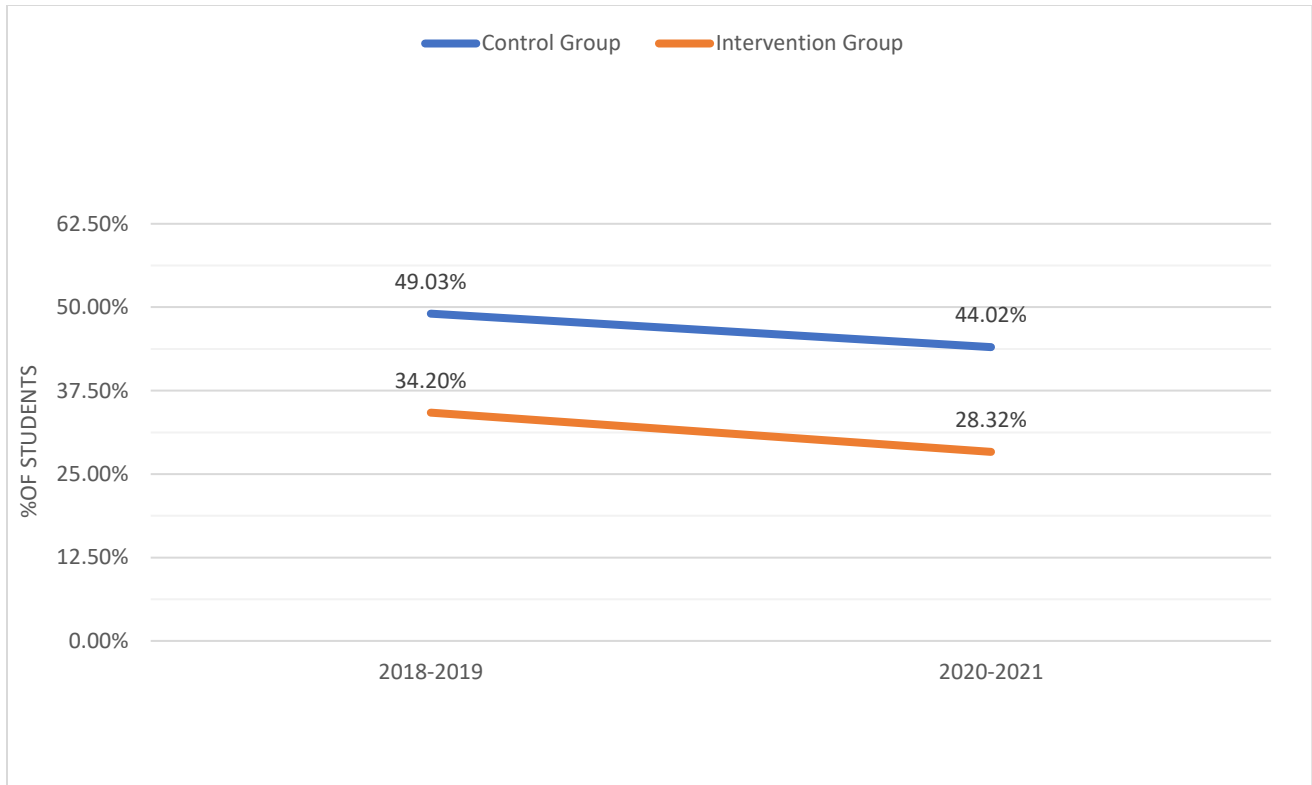


Figure 3. Changes in the prevalence of ever e-cigarette use in intervention and control groups from baseline to follow-up within the repeat cross-sectional sample of students, COMPASS study 2018-21

Table 4. Difference-in-difference estimates of ever e-cigarette use between intervention and control groups over time within the repeat cross-sectional samples students, COMPASS study, 2018-2021.

	Estimate (Std. Error)	P-value
Intercept	0.490 (0.002)	<0.001
Time (Follow-up vs Baseline)	-0.050 (0.003)	<0.001
Group (Intervention vs Control)	-0.148 (0.004)	<0.001
Interaction of Time X Group	-0.008 (0.009)	0.367

4.1.3 Evaluating changes in the prevalence of current e-cigarette use among students in the intervention and control groups

The second part of the DID analysis identified changes in the prevalence of current e-cigarette use between baseline and follow-up in the control and intervention groups. Figure 4 illustrates that the prevalence of current e-cigarette use decreased in both the intervention and control groups. As shown in Table 5, the variable time was significant and negative which means that over time, the prevalence of current e-cigarette use dropped. Additionally, the variable group was significant and negative, which means the prevalence of current e-cigarette use was lower among students in the intervention group compared to the control group. Lastly, the non-significant interaction between time and group indicates that there was no difference in the change in prevalence of current e-cigarette use that occurred from baseline to follow-up in the control and intervention groups.

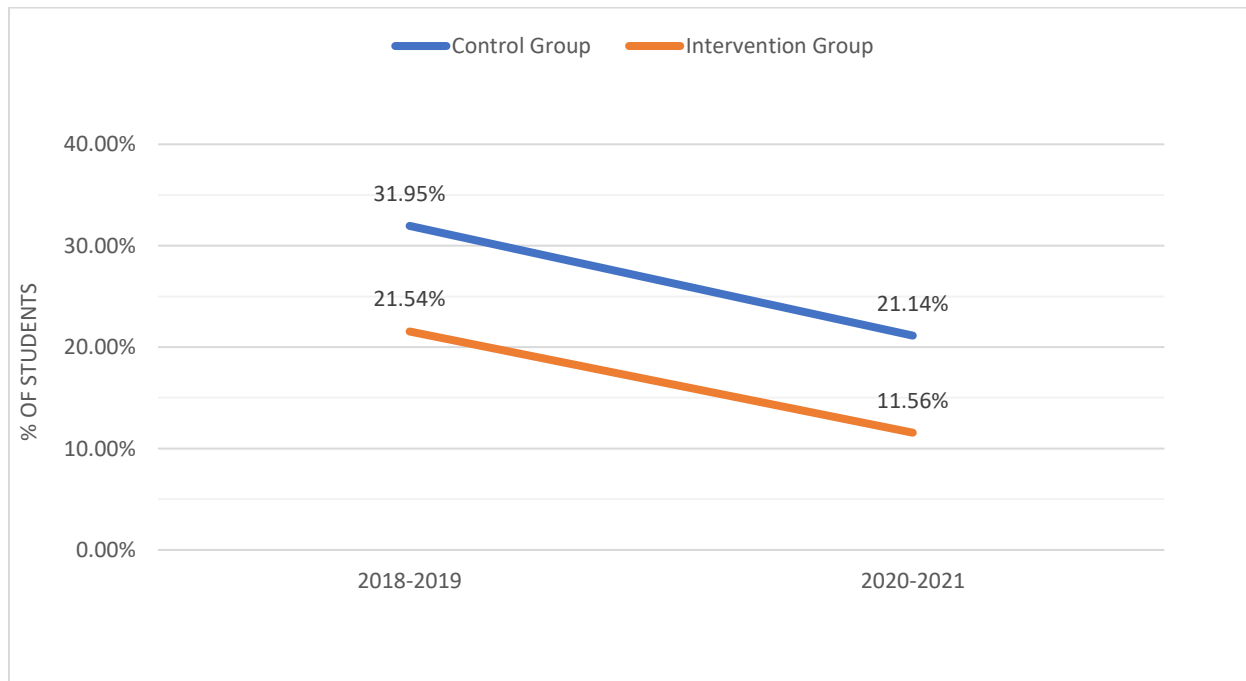


Figure 4. Changes in the prevalence of current e-cigarette use in intervention and control groups from baseline to follow-up within the repeat cross-sectional sample of students, COMPASS study 2018-21

Table 5. Difference-in-difference (DID) estimates of current e-cigarette use between intervention and control groups over time within the repeat cross-sectional samples of students, COMPASS study, 2018-2021.

	Estimate (Std. Error)	P-value
Intercept	0.319 (0.001)	<0.001
Time (Follow-up vs Baseline)	-0.108 (0.003)	<0.001
Group (Intervention vs Control)	-0.104 (0.004)	<0.001
Interaction of Time X Group	0.008 (0.008)	0.323

4.2 Part 2: Longitudinal analysis

4.2.1 Demographic and behavioural characteristics of the longitudinal sample

In the longitudinal sample, 5.90% of students were in the intervention group and 94.10% of students were in the control group. Table 6 presents the characteristics of never e-cigarette use students in the control and intervention groups at baseline in the longitudinal sample. There was a significant difference in the distribution of grade in the intervention and control groups (Chi-square = 75.958, df = 1, p-value < 0.01). The proportion of grade 9 students was higher in the control group than the intervention group. In contrast, there were no significant difference in the gender distribution of students in the control and intervention groups (Chi-square = 0.60278, df = 1, p-value < 0.43). The majority of students in the intervention and the control groups identified themselves as female. There was a significant difference in the ethnic distribution of students in the intervention and control groups (Chi-square = 489.48, df = 1, p-value < 0.001). The proportion of students who identified as White ethnicity was higher in the control group than the intervention group. There was also a significant difference in the distribution of the amount of spending money in the control and the intervention group (Chi-square = 24.258, df = 3, p-value < 0.001). The proportion of students with less than \$20 of spending money each week was higher in the intervention group than in the control group.

Table 6. Demographic and behavioural characteristics of never e-cigarette use students at baseline in the longitudinal sample (n=4,145), by intervention and control group, COMPASS study, 2018-19

Demographic characteristic	Intervention Group % (n)	Control Group % (n)	Chi-square test result
Overall	5.90 (549)	94.10 (3,596)	
Grade			
9	53.19 (292)	71.72 (2,579)	75.958 (1) p < 0.001
10	46.81 (257)	28.28 (1,017)	
Ethnicity			
White	67.21 (369)	78.28 (2,815)	489.48 (1) p < 0.001
Other	32.79 (180)	21.72 (781)	
Gender			
Female	58.11 (319)	59.96 (2,156)	0.60278 (1) p < 0.43
Male	41.89 (230)	40.04 (1,440)	
Amount of weekly spending money			
<\$20	60.66 (333)	52.11 (1,874)	24.258 (3) p < 0.001
\$21-100	16.94 (93)	18.49 (665)	
>\$100	3.10 (17)	8.15 (293)	
I don't know	19.31 (106)	21.25 (764)	

4.2.2 Evaluating the likelihood of e-cigarette initiation among students in the control and intervention groups

Table 7 presents the rate of e-cigarette initiation in both the control and intervention groups. The prevalence of never e-cigarette use was lower among students in the intervention group compared to students in the control group. Additionally, e-cigarette use initiation was significantly lower among students in the intervention group. In the control group, 33.76% of students initiated e-cigarette use, while 16.94% of students initiated e-cigarette use in the intervention group.

Table 7. Percentage of never e-cigarette users at baseline who initiated e-cigarette use at follow-up by intervention and control group, COMPASS study 2018-2021

E-cigarette use status at follow-up	Intervention Group % (n)	Control Group % (n)	Chi-square test result
Never used e-cigarettes	83.06 (456)	66.24 (2,382)	61.636 (1) p< 0.001
Initiated e-cigarette use	16.94 (93)	33.76 (1,214)	

Table 8 presents, the impact of the e-cigarette tax on e-cigarette initiation among students in the intervention and control groups at follow-up. Two models were created to evaluate the impact of the tax policy on e-cigarette initiation among youth. Model 1 evaluated the effect of the intervention alone on e-cigarette initiation while controlling for students-level clustering within schools. Model 2 evaluated the impact of the intervention on e-cigarette initiation while controlling for other student-level demographic and behavioural characteristics. As Table 11 shows, students in the intervention group had a lower likelihood of e-cigarette initiation compared to students in the control group even after controlling for student-level demographic and behavioural characteristics.

Table 8. Association between the e-cigarette tax and e-cigarette initiation in the longitudinal sample of grade 9 and 10 students, COMPASS study, 2018- 2021

	Odds of e-cigarette initiation among students at follow-up (95% CI)
Model 1	
Control group	1.00
Intervention group	0.41 (0.28- 0.59)
Model 2	
Control group	1.00
Intervention group	0.66 (0.53-0.83)

Model 1: Controlled for students-level clustering within schools.

Model 2: Controlled for demographic (grade, ethnicity, gender, amount of spending money) and behavioural (cigarette smoking, binge drinking, cannabis use) factors and students-level clustering within schools.

Chapter 5: Discussion

To my knowledge, this study is the first Canadian study that evaluated the impact of an e-cigarette tax policy on ever and current e-cigarette use. This study used both repeat cross-sectional and longitudinal data from a large sample of Canadian youth across Ontario, Alberta, Quebec, and British Columbia, to evaluate the impact of an e-cigarette tax in British Columbia on youth e-cigarette use compared to other provinces that did not implement an e-cigarette tax across two waves of the COMPASS study. Overall, the results of the cross-sectional sample indicate that the prevalence of e-cigarette use was lower among students in the intervention group compared to students in the control group; however, there was no significant change observed in the prevalence of ever and current e-cigarette use after implementing the tax policy. The results of the longitudinal sample indicate that the likelihood of e-cigarette initiation was lower among students in the intervention group compared to the control group. Hence, a tax policy might be an important strategy to prevent youth from e-cigarette initiation.

5.1 Repeat cross-sectional findings

The results of the difference-in-difference (DID) analysis identified that compared to the control group, the prevalence of ever e-cigarette use was lower among youth in the intervention group at both baseline and follow-up, and the prevalence of ever e-cigarette use decreased at the same rate in both the intervention and control groups. These findings suggest that the e-cigarette tax may not have impacted the prevalence of ever e-cigarette use among youth in the intervention group compared to the control group over time. Similarly, the prevalence of current e-cigarette use decreased at the same rate both in the intervention and control groups. In other words, there was no significant difference in the change in prevalence of current e-cigarette use observed in the

control and intervention groups. Based on the results of both DID models, it does not appear that the e-cigarette tax policy contributed to changes in e-cigarette use among youth over time.

Even though the results of both DID models in this study have not provided sufficient evidence that increasing e-cigarettes taxes influences the prevalence of ever and current e-cigarette use among youth in the control and intervention groups, we cannot conclude that e-cigarette taxes are ineffective in reducing e-cigarette use among youth. A recent study reviewed the trend in cigarette affordability among Canadian provinces over 10 years (Worrell & Hagen, 2021). Their results indicate that cigarette tax increases have contributed to a reduced prevalence of smoking and reduced cigarette consumption (Worrell & Hagen, 2021). Consistent with this evidence, other studies suggest that taxation and other tobacco control policies have been effective at increasing smoking cessation and reducing the prevalence of cigarette smoking among youth and young adults in the United States (Chaloupka et al., 2012). Because of this, several factors should be considered in interpreting the repeat cross-sectional findings.

First, at baseline and follow-up of the repeat cross-sectional sample, the proportion of students that identified themselves as White was higher in the control group compared to the intervention group. Findings from a Canadian longitudinal study suggest that non-White students are more likely to stop using e-cigarette compared to White students (Cole et al., 2022). This might explain why the prevalence of never e-cigarette use was lower in the control group compared to the intervention group in the repeat cross-sectional sample.

Secondly, there are differences in schools that participated in the baseline and follow-up periods that could affect the study results. From baseline to the follow-up year, the number of schools participating in this study decreased. At baseline only 6 schools withdrew from the COMPASS study (3 Ontario schools, 2 British Columbia schools, and 1 Quebec school) (Reel et

al., 2021). In total, 61 Ontario schools, 8 Alberta schools, 15 British Columbia schools, and 52 Quebec schools participated in this study. At follow-up, 3 Ontario schools, 4 Alberta schools, 3 British Columbia schools, and 1 Quebec school withdrew from the COMPASS study (Rezvani et al., 2023). In total, 51 schools from Ontario, 5 schools from Alberta, 59 schools from Quebec, and 14 schools from British Columbia participated at follow-up. Notably, after schools withdrew from the host study, there was a decrease in the total sample size of students across all provinces. For this reason, it is difficult to generalize the results to all students in these provinces. Given the fact that the COVID-19 pandemic impacted the data collection in the second wave of this study, some schools refused to complete the survey because they were dealing with the transition from in-person to online classes and they did not have enough time or capacity to distribute the COMPASS survey to students (Rezvani et al., 2023). Additionally, previous evidence suggests the lower participation rate might bias the results because students who did not participate in the online survey might be more likely to use e-cigarettes (Leatherdale et al., 2021).

Thirdly, evidence has shown that the prevalence of e-cigarette use dropped during the COVID-19 pandemic. According to the 2020 Canadian Tobacco and Nicotine Survey (CTNS), the prevalence of ever e-cigarette use among youth aged 15 to 19 years was 35% (Statistics Canada, 2021). However, in 2021, ever e-cigarette use decreased to 29% among youth (Statistics Canada, 2022). Similarly, another study suggests that changes in e-cigarette use among youth and young adults started at the beginning of the COVID-19 pandemic (Gaiha et al., 2020). Their findings indicate that 67.7% of youth and young adults reported reducing or quitting e-cigarette use during the COVID-19 pandemic (Gaiha et al., 2020). These findings are consistent with evidence from Canada (Leatherdale et al., 2021). A longitudinal study used three waves of data to explore changes in e-cigarette use between the pre-COVID and initial COVID-lockdown periods among Canadian

adolescents (Leatherdale et al., 2021). This study identified that from 2019-2020 the prevalence of e-cigarette use decreased among those who used e-cigarettes weekly and monthly (Leatherdale et al., 2021). During the early stages of the COVID-19 pandemic, there was a significant reduction in e-cigarette use among males who were daily e-cigarette users compared to females (Leatherdale et al., 2021). Given the fact that the COVID-19 pandemic occurred at the same time as the e-cigarette tax increase in British Columbia, it is possible that an unintended impact of the COVID-19 pandemic was a reduction in e-cigarette use among students in both the intervention and control groups. In other words, the e-cigarette tax may not have had as large an impact because students already decreased their e-cigarette use the year before.

Finally, in British Columbia in 2020, only e-cigarette products such as devices, cartridges, accessories, and vaping substances were subject to a 20% tax (British Columbia, 2019). Notably, vaporizers that could be used with dry cannabis were only subject to a 7% tax (British Columbia, 2019). One year before the e-cigarette tax, in October 2019, under the *Cannabis Act*, e-cigarette products containing cannabis became legal for sale in Canada (Health Canada, 2019a). Previously, e-cigarette products containing cannabis were available through an illegal market, and there could be health risks associated with using those products purchased through an illegal market (Health Canada, 2019). A key purpose of the *Cannabis Act* was to ensure public safety and to protect youth from accessing cannabis through the illegal market (Health Canada, 2019a). Earlier evidence suggests that youth who use e-cigarettes are at risk of using multiple substances, such as cigarettes, cannabis, and alcohol (Milicic & Latherdale, 2017). More recent studies have identified that vaping cannabis is becoming increasingly popular among adolescents across the United States, Canada, and England (Fataar & Hammond, 2019). While there is a lack of evidence about the uptake of cannabis vaping among Canadian youth, the results of a longitudinal study identified

that after cannabis was legalized, consuming cannabis in multiple ways such as vaping, eating and smoking increased among Canadian youth (Leatherdale et al., 2021). The results of these studies might help to explain why the e-cigarette tax was not effective among ever and current e-cigarette users. Cannabis-containing vaporizers were taxed at a lower rate in British Columbia, so students may have switched from vaping nicotine to vaping cannabis instead (Leatherdale et al., 2021).

5.2 Longitudinal findings

It is well-known in the literature that cigarette tax policies contribute to a reduction in cigarette initiation among youth and young adults (Hasselt et al., 2016, Pesko et al., 2018). A systematic review identified that increasing the tax on tobacco products is one of the most effective policies for controlling tobacco consumption among youth (Bafunno et al., 2020). When the government implements higher tobacco taxes, tobacco companies also frequently increase the price of their products; therefore, tobacco products are less accessible to youth and low-income individuals, which leads to reduced tobacco use (Bafunno et al., 2020). Taxes on e-cigarette devices only recently came into effect in Canada and other countries such as the United States, South Korea, Malaysia, Indonesia, and Albania. As a result, there are not many studies evaluating e-cigarette taxation policies on e-cigarette use among youth. Previous studies have shown that by increasing the price of e-cigarettes, youth reduced e-cigarette use (Pesko et al., 2018, Huang et al., 2014).

The COMPASS questionnaire provided anonymous linked data for students over time that allowed me to observe changes in the likelihood of e-cigarette initiation within individuals over time. Results from the longitudinal sample identified that students in the intervention group were less likely to initiate e-cigarettes compared to students in the control group. In other words, the tax policy might be a protective factor in reducing e-cigarette initiation among youth. Consistent with these findings, two other studies examined the impact of an e-cigarette tax on youth, and they

identified that taxing e-cigarette products could delay initiating e-cigarettes and reduce e-cigarette demand among youth because youth are more sensitive to price changes (Dave et al., 2021, Huang et al., 2014). In addition, another longitudinal study identified that students with more spending money were more likely to initiate e-cigarettes (Williams et al., 2021). As a result, taxation policies that reduce the affordability of e-cigarettes may play an important role in reducing the risk of e-cigarette initiation among youth (Williams et al., 2021).

5.3 Strengths and limitations

5.3.1 Overall strengths

This study has several strengths. This study provided unique findings that contribute to a gap in knowledge of the impact of e-cigarette tax policies on youth e-cigarette use. This is the first study that used a large, school-based sample to examine the impact of an e-cigarette tax on e-cigarette use among youth across four provinces in Canada. Hence, this study provides practice-based evidence which presents the impact of an e-cigarette tax in the real world and extends our knowledge of the effect of an e-cigarette tax on e-cigarette use and initiation among youth in Canada.

Secondly, this study used passive consent procedures to maximize the participation rate and limit some types of bias. For studies that measure substance use behaviours, it is important to use passive consent procedures to be able to produce robust results while maintaining student confidentiality (Rojas et al., 2008, White et al., 2004). There are several reasons that the use of passive consent was important in this study. First, passive consent increases the participation rate, and a low participation rate might bias the results (Bredin & Leatherdale, 2013). This means that the results might not be generalizable to the whole population. Second, male students and older students may be less likely to participate in longitudinal studies because of challenges obtaining

consent (Bredin & Leatherdale, 2013). The use of passive consent helps to reduce the bias that is related to demographic characteristics such as gender and age (Bredin & Leatherdale, 2013). Passive consent protocols are also confidential and do not require any personal information from participants (Bredin & Leatherdale, 2013). This can make youth more likely to participate in the study (Bredin & Leatherdale, 2013).

Third, the use of a quasi-experimental design to evaluate the impact of a natural experiment is a strength of the study. Since the impact of policies and interventions in public health is a significant concern for decision makers, the results of experimental studies help to draw stronger conclusions about the impact of the intervention (Craig et al., 2011). However, randomly assigning individuals to control or intervention groups is not always ethically acceptable or feasible. In these circumstances, quasi-experiment studies are useful for evaluating the impact of policies on health in the real world (Leatherdale, 2019). Evaluating these policies can provide additional support for policy makers to make better decisions (Leatherdale, 2019). This study evaluated the impact of an e-cigarette tax policy in the real world, and the results of this study can provide important evidence for policy makers who are considering implementing a tax policy on e-cigarette products in other Canadian provinces and other countries.

Finally, this study used two waves of data from a longitudinal sample of youth from four Canadian provinces. The key strength of a longitudinal sample is the ability to link student data over time. In the current study, a significant number of students could be linked from baseline to follow-up, which allowed me to observe and measure changes in e-cigarette use over time among students in the intervention and control groups.

5.3.2 *Overall limitations*

This study is not without limitations. A common limitation of longitudinal studies is linking students over time. When a study is measuring changes in substance use behaviours over time, it is possible that a significant number of students who report using substances cannot be linked over time. In this study, the substance use behaviours of students in grades 11 and 12 at baseline could not be measured at follow-up because these students graduated from high school. Additionally, it is not possible to identify changes in the behaviours of students who dropout and do not complete the survey at follow-up. Students who dropout are more likely to engage in risky behaviours such as smoking cigarettes, drinking alcohol, and cannabis use (Qian et al., 2015). Student dropout in longitudinal studies can bias the results because it is not possible to investigate the characteristics of these students and to observe how an e-cigarette tax might impact their e-cigarette use.

The COMPASS study is designed to evaluate policy changes using a natural experimental methodology and it gathers data from a significant number of Canadian students. However, it is only representative of some Canadian students in each province. Additionally, part of the data collection occurred during the COVID-19 pandemic when it was challenging for schools to participate in the study due to the transition from in-person to online classes. As a result, some schools were not interested in participating in the COMPASS study, and the number of schools that participated decreased from baseline to follow-up. The average rate of participation for the in-person paper-based survey was about 80%, while the average rate of participation for the online survey was 29% (Reel et al., 2020). The provincial participation rate for the online survey was 22% in Ontario, 37% in Quebec, and 19% in British Columbia (Reel et al., 2020). Given the reduction in the participation rate across all provinces, and in particular the province of British Columbia, the results of this study might not be generalized to all of students in the participating

provinces or all students in Canada. Furthermore, the lower online response rate might have biased the results because students who did not complete the online survey might be more likely to use e-cigarettes (Leatherdale et al., 2021). Nevertheless, there is a lack of Canadian longitudinal data evaluating e-cigarette tax policies among youth, and this study provides important implications for research and policy.

Students were only exposed to the tax policy only for one year. This means that this study only captured a lower level of exposure to this policy. Future studies should continue and extend this work when additional years of data become available.

Lastly, in 2018-19, the question related to gender identity in the COMPASS questionnaire had two response options ‘female’ and ‘male’. However, in 2020-21 the COMPASS questionnaire added ‘I describe my gender in different way’ and ‘I prefer not to say’ as response options to this question. For this reason, it was not possible to identify differences in the impact of the e-cigarette tax among non-binary and gender diverse youth in either the DID analysis or the regression models. Future studies should investigate the association of e-cigarette taxes on e-cigarette use and initiation among gender diverse youth.

5.4 Implications for policy

Implementing e-cigarette policies is a critical step to protect youth from nicotine exposure. Given the new nature of e-cigarette use among youth, additional studies are needed to evaluate the impact of policies on e-cigarette use among youth. It is a significant challenge for policy makers to enact policies when there is little known about the potential impact of policies on the prevalence of e-cigarette use among adolescents.

The cross-sectional findings of the current study identified no significant difference in the prevalence of current and ever e-cigarette use that occurred from baseline to follow-up in the

control and intervention groups. However, the results of the longitudinal analysis identified that students in the intervention group were less likely to initiate e-cigarettes compared to students in the control group. Given that other studies indicate that students with more spending money are more likely to initiate e-cigarette use (Williams et al., 2021) and that taxation helps to increase smoking cessation and reduce the prevalence of cigarette smoking among youth and young adults (Worrell & Hagen, 2021; Chaloupka et al., 2012), e-cigarette tax policies appear to be an important strategy to minimize e-cigarette initiation among youth. In the absence of price regulation, manufacturers may lower their prices and promote their products to target new users, such as youth and price-sensitive users (Physicians for a Smoke-Free Canada, 2023). Therefore, other provinces should add or increase the tax on e-cigarette products and devices to reduce the affordability of e-cigarettes among youth and young adults.

Existing literature has shown that the affordability of e-cigarette devices and the accessibility of flavoured e-cigarettes are associated with e-cigarette initiation among youth (Zare et al., 2018, Kong, 2015, Williams et al., 2021). Therefore, a combination of prevention strategies, such as price-related policies and e-cigarette flavour regulations, might be beneficial to reduce e-cigarette initiation among youth. Evidence suggests that some e-cigarette flavours might cause serious health issues such as lung disease and bronchiolitis obliterans (Barrington-Trimis et al., 2014). Yet, flavours are one of the most common reasons that youth initiate and use e-cigarettes (Bold et al., 2016; Kong et al., 2015; Pepper et al., 2014), and a recent systematic review suggested that flavoured e-cigarettes increase the risk of e-cigarette initiation among youth (Zare et al., 2018). It is expected that implementing a policy that restricts e-cigarette flavours would make these products less attractive, decrease the likelihood of e-cigarette initiation among youth (Zare et al., 2018), and could contribute to a decrease in e-cigarette sales among youth (Ali et al., 2022). Some Canadian

provinces, such as Nova Scotia, Ontario, Nunavut, Prince Edward Island, Saskatchewan, and British Columbia, have already banned the sale of flavoured e-cigarette products and other provinces should follow.

5.5 Directions for future research

Implementing the most effective tobacco control policies to protect youth from initiating e-cigarettes is a significant concern for policy makers. Given that British Columbia recently increased the tax on e-cigarette devices, additional longitudinal studies are needed to evaluate the impact of the e-cigarette tax on youth e-cigarette use, particularly when additional years of data become available.

Adolescents who use e-cigarettes might be at risk of initiating cigarette smoking because they have been exposed to nicotine at an early stage in their lives. However, increasing the tax on e-cigarettes might have an unintended impact on cigarette smoking among youth (Friedman & Pesko, 2022). While investigating the association between increasing the tax on e-cigarettes and changes to cigarette smoking among youth was outside the scope of this study, future studies could investigate whether there are unintended impacts of this policy on youth cigarette smoking.

Chapter 6: Conclusions

E-cigarette use among youth is a concern for public health researchers and policy makers. To my knowledge, this is the first study that evaluated the impact of increasing the tax on e-cigarettes on youth e-cigarette use in Canada. The results of the repeat cross-sectional analysis indicate that there was no significant change observed in the prevalence of ever e-cigarette use from baseline to follow-up between the intervention and control groups. Similarly, there was no significant change in the prevalence of current e-cigarette use from baseline to follow-up between the intervention and control groups. In contrast, the results of the longitudinal analysis indicate that at follow-up, students in the intervention group were less likely to initiate e-cigarette use compared to students in the control group. It appears that an e-cigarette tax policy might prevent youth from e-cigarette initiation.

It is clear that additional longitudinal studies are needed to evaluate whether an e-cigarette tax policy influences e-cigarette use among Canadian youth over time. Such evidence is needed to provide a comprehensive picture to policy makers to help them make informed decisions.

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<https://doi.org/10.1371/journal.pone.0194145>

APPENDICES

Appendix A: REB APPROVAL

Date: August 10, 2022
To: Adam Cole
From: Ruth Milman, REB Chair
File # & Title: 16943 - Is implementing a provincial e-cigarette tax associated with e-cigarette initiation and use among high school students? Evaluating the experience in British Columbia: data from the COMPASS study, 2018-2021
Status: APPROVED

Review Type: Administrative Review
REB Expiry August 01, 2023
Date:

Documents Approved:

Document Type	Document Description	Version Date
External Permission/Approval Letter	COMPASS Data Use Approval Letter	2022/08/05
External Permission/Approval Letter	COMPASS Data Use Application Form	2022/08/05
Data Collection Materials		
Recruitment Materials		

Notwithstanding this approval, you are required to obtain/submit, to Ontario Tech Research Ethics Board, any relevant approvals/permissions required, prior to commencement of this project.

The Ontario Tech Research Ethics Board (REB) has reviewed and approved the research study named above to ensure compliance with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2 2018), the Ontario Tech Research Ethics Policy and Procedures and associated regulations. As the Principal Investigator (PI), you are required to adhere to the research protocol described in the REB application as last reviewed and approved by the REB. In addition, you are responsible for obtaining any further approvals that might be required to complete your project.

Under the TCPS2 2018, the PI is responsible for complying with the continuing research ethics reviews requirements listed below:

Renewal Request Form: All approved projects are subject to an annual renewal process. Projects must be renewed or closed by the expiry date indicated above (“Current Expiry”). Projects not renewed 30 days post expiry date will be automatically suspended by the REB; projects not renewed 60 days post expiry date will be automatically closed by the REB. Once your file has been formally closed, a new submission will be required to open a new file.

Change Request Form: If the research plan, methods, and/or recruitment methods should change, please submit a change request application to the REB for review and approval prior to

implementing the changes.

Adverse or Unexpected Events Form: Events must be reported to the REB within 72 hours after the event occurred with an indication of how these events affect (in the view of the Principal Investigator) the safety of the participants and the continuation of the protocol (i.e. un-anticipated or un-mitigated physical, social or psychological harm to a participant).

Research Project Completion Form: This form must be completed when the research study is concluded.

Always quote your REB file number (16943) on future correspondence. We wish you success with your study.

Sincerely,

Ruth Milman, PhD Fabiola Limon Bravo, MA
REB Chair Research Ethics Coordinator
Ruth.Milman@ontariotechu.ca researchethics@ontariotechu.ca

NOTE: If you are a student researcher, your supervisor has been copied on this message.

Appendix B: 2018-29 COMPASS QUESTIONNAIRE



- **This is NOT a test.** All of your answers will be kept **confidential**. No one, not even your parents or teachers, will ever know what you answered. So, please be honest when you answer the questions.
- Mark only **one option per question** unless the instructions tell you to do something else.
- Choose the option that is the **closest** to what you think/feel is true for you.



Please, use a pencil to complete this questionnaire



Please mark all your answers with full, dark marks like this:



START HERE



Please read each sentence below carefully. Write the correct letter, number, or word on the line and then fill in the corresponding circle.

Note: These five questions are only used to link data from one year to the next. They cannot be used to identify participants. Only University of Waterloo researchers have access to the responses, and they never have access to student names or other information. All responses are strictly confidential.

The first letter of your middle name (If you have more than one middle name use your first middle name; if you don't have a middle name use "Z"): _____	The name of the month in which you were born: _____	The last letter of your full last name: _____	The second letter of your full first name: _____	The first initial of your mother's first name (think about the mother you see the most): _____
(A) (J) (S) (B) (K) (T) (C) (L) (U) (D) (M) (V) (E) (N) (W) (F) (O) (X) (G) (P) (Y) (H) (Q) (Z)	(1) January (2) February (3) March (4) April (5) May (6) June (7) July (8) August (9) September (10) October (11) November (12) December	(A) (J) (S) (B) (K) (T) (C) (L) (U) (D) (M) (V) (E) (N) (W) (F) (O) (X) (G) (P) (Y) (H) (Q) (Z)	(A) (J) (S) (B) (K) (T) (C) (L) (U) (D) (M) (V) (E) (N) (W) (F) (O) (X) (G) (P) (Y) (H) (Q) (Z)	(A) (J) (S) (B) (K) (T) (C) (L) (U) (D) (M) (V) (E) (N) (W) (F) (O) (X) (G) (P) (Y) (H) (Q) (Z)

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About You

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1. What grade are you in?

- Grade 9
- Grade 10
- Grade 11
- Grade 12

<i>Quebec students only</i>
<input type="radio"/> Secondary I
<input type="radio"/> Secondary II
<input type="radio"/> Secondary III
<input type="radio"/> Secondary IV
<input type="radio"/> Secondary V
<input type="radio"/> Other

2. How old are you today?

- 12 years or younger
- 13 years
- 14 years
- 15 years
- 16 years
- 17 years
- 18 years
- 19 years or older

3. Are you female or male?

- Female
- Male

4. How would you describe yourself? (Mark all that apply)

- White
- Black
- Asian
- Aboriginal (First Nations, Métis, Inuit)
- Latin American/Hispanic
- Other

5. About how much money do you usually get each week to spend on yourself or to save?
(Remember to include all money from allowances and jobs like baby-sitting, delivering papers, etc.)

- Zero
- \$1 to \$5
- \$6 to \$10
- \$11 to \$20
- \$21 to \$40
- \$41 to \$100
- More than \$100
- I do not know how much money I get each week

6. How do you usually travel to and from school? (If you use two or more modes of travel, choose the one that you spend most time doing)

To school

- By car (as a passenger)
- By car (as a driver)
- By school bus
- By public bus, subway, or streetcar
- By walking
- By bicycling
- Other

From school

- By car (as a passenger)
- By car (as a driver)
- By school bus
- By public bus, subway, or streetcar
- By walking
- By bicycling
- Other

7. Did you attend this school last year?

- Yes, I attended the same school last year
- No, I was at another school last year

8. How tall are you without your shoes on? (Please write your height in feet and inches OR in centimetres, and then fill in the appropriate numbers for your height.)

- I do not know how tall I am

"My height is _____ feet, _____ inches"

OR

"My height is _____ centimetres"



Height	
Feet	Inches
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

OR

Height	
Centimetres	
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	

Example:
My height is 5 ft 7 in

Height	
Feet	Inches
5	7
6	0
7	1
8	2
9	3
0	4
1	5
2	6
3	7
4	8
5	9

9. How much do you weigh without your shoes on? (Please write your weight in pounds OR in kilograms, and then fill in the appropriate numbers for your weight.)

- I do not know how much I weigh

"My weight is _____ pounds"

OR

"My weight is _____ kilograms"



Weight	
Pounds	
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	

OR

Weight	
Kilograms	
0	
1	
2	
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Example:
My weight is 127 lbs

Weight	
Pounds	
1	
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10. How do you describe your weight?

- Very underweight
- Slightly underweight
- About the right weight
- Slightly overweight
- Very overweight

11. Which of the following are you trying to do about your weight?

- Lose weight
- Gain weight
- Stay the same weight
- I am not trying to do anything about my weight

12. How much time per day do you *usually* spend doing the following activities?

For example: If you spend about 3 hours watching TV each day, you will need to fill in the 3 hour circle, and the 0 minute circle as shown below:

	Hours										Minutes			
a) Watching/streaming TV shows or movies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
a) Watching/streaming TV shows or movies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Playing video/computer games	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) Doing homework	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) Talking on the phone	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) Surfing the internet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) Texting, messaging, emailing (note: 50 texts = 30 minutes)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g) Sleeping	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

13. In the last 30 days, did you gamble online for money?

- Yes
- No

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17. Your closest friends are the friends you like to spend the most time with. How many of your closest friends are physically active?

- None
- 1 friend
- 2 friends
- 3 friends
- 4 friends
- 5 or more friends

18. Are you taking a physical education class at school this year?

- Yes, I am taking one this term
- Yes, I will be taking one or have taken one this school year, but not this term.
- No, I am not taking a physical education class at school this year

19. Do you participate in before-school, noon hour, or after-school physical activities organized by your school? (e.g., intramurals, non-competitive clubs)

- Yes
- No
- None offered at my school

20. Do you participate in competitive school sports teams that compete against other schools? (e.g., junior varsity or varsity sports)

- Yes
- No
- None offered at my school

21. Do you participate in league or team sports outside of school?

- Yes
- No
- There are none available where I live

22. On how many days in the last 7 days did you do exercises to strengthen or tone your muscles? (e.g., push-ups, sit-ups, or weight-training)

- 0 days
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

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26. YESTERDAY, from the time you woke up until the time you went to bed, how many servings of meats and alternatives did you have? One 'Food Guide' serving of meat and alternatives includes cooked fish, chicken, beef, pork, or game meat, eggs, nuts or seeds, peanut butter or nut butters, legumes (beans), and tofu.

- None
- 1 serving
- 2 servings
- 3 servings
- 4 servings
- 5 or more servings

Canada's Food Guide Serving Size of Meats and Alternatives



27. YESTERDAY, from the time you woke up until the time you went to bed, how many servings of vegetables and fruits did you have? One 'Food Guide' serving of vegetables and fruit includes pieces of fresh vegetable or fruit, salad or raw leafy greens, cooked leafy green vegetables, dried or canned or frozen fruit, and 100% fruit or vegetable juice.

- None
- 1 serving
- 2 servings
- 3 servings
- 4 servings
- 5 servings
- 6 servings
- 7 servings
- 8 servings
- 9 or more servings

Canada's Food Guide Serving Sizes of Vegetables and Fruits



28. YESTERDAY, from the time you woke up until the time you went to bed, how many servings of milk and alternatives did you have? One 'Food Guide' serving of milk or milk alternatives includes milk, fortified soy beverage, reconstituted powdered milk, canned (evaporated) milk, yogurt or kefir (another type of cultured milk product), and cheese.

- None
- 1 serving
- 2 servings
- 3 servings
- 4 servings
- 5 servings
- 6 or more servings

Canada's Food Guide Serving Size of Milk and Alternatives



29. YESTERDAY, from the time you woke up until the time you went to bed, how many servings of grain products did you have? One 'Food Guide' serving of grain products includes bread, bagels, flatbread such as tortilla, pita, cooked rice or pasta, and cold cereal.

- None
- 1 serving
- 2 servings
- 3 servings
- 4 servings
- 5 servings
- 6 servings
- 7 servings
- 8 servings
- 9 or more servings

Canada's Food Guide Serving Sizes of Grain Products



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Your Experience with Smoking

30. Have you ever tried cigarette smoking, even just a few puffs?

- Yes
- No

31. Do you think in the future you might try smoking cigarettes?

- Definitely yes
- Probably yes
- Probably not
- Definitely not

32. If one of your best friends were to offer you a cigarette, would you smoke it?

- Definitely yes
- Probably yes
- Probably not
- Definitely not

33. At any time during the next year do you think you will smoke a cigarette?

- Definitely yes
- Probably yes
- Probably not
- Definitely not

34. Have you ever smoked 100 or more whole cigarettes in your life?

- Yes
- No

35. On how many of the last 30 days did you smoke one or more cigarettes?

- None
- 1 day
- 2 to 3 days
- 4 to 5 days
- 6 to 10 days
- 11 to 20 days
- 21 to 29 days
- 30 days (every day)

36. Your closest friends are the friends you like to spend the most time with. How many of your closest friends smoke cigarettes?

- None
- 1 friend
- 2 friends
- 3 friends
- 4 friends
- 5 or more friends

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Alcohol and Drug Use

Please remember that we will keep your answers **completely confidential**.

A **DRINK** means: 1 regular sized bottle, can, or draft of beer; 1 glass of wine; 1 bottle of cooler; 1 shot of liquor (rum, whisky, etc); or 1 mixed drink (1 shot of liquor with pop, juice, energy drink).

42. In the last 12 months, how often did you have a drink of alcohol that was more than just a sip?

- I have never drunk alcohol
- I did not drink alcohol in the last 12 months
- I have only had a sip of alcohol
- Less than once a month
- Once a month
- 2 or 3 times a month
- Once a week
- 2 or 3 times a week
- 4 to 6 times a week
- Every day

43. How old were you when you first had a drink of alcohol that was more than just a sip?

- I have never drunk alcohol
- I have only had a sip of alcohol
- I do not know

- 8 years or younger
- 9 years
- 10 years
- 11 years
- 12 years
- 13 years
- 14 years
- 15 years
- 16 years
- 17 years
- 18 years or older

44. In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?

- I have never done this
- I did not have 5 or more drinks on one occasion in the last 12 months
- Less than once a month
- Once a month
- 2 to 3 times a month
- Once a week
- 2 to 5 times a week
- Daily or almost daily

45. In the last 12 months, have you had alcohol mixed or pre-mixed with an energy drink (such as Red Bull, Rock Star, Monster, or another brand)?

- I have never done this
- I did not do this in the last 12 months
- Yes
- I do not know

Mental Health

52. How much do you agree or disagree with the following statements?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
a) I have a happy home life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) My parents/guardians expect too much of me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) I can talk about my problems with my family	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) I can talk about my problems with my friends	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

53. How much do you agree or disagree with the following statements?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
a) I lead a purposeful and meaningful life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) My social relationships are supportive and rewarding	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) I am engaged and interested in my daily activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) I actively contribute to the happiness and well-being of others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) I am competent and capable in the activities that are important to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) I am a good person and live a good life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g) I am optimistic about my future	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h) People respect me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i) I generally recover from setbacks quickly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

54. Choose the answer that best describes how you feel.

	True	Mostly true	Sometimes true, sometimes false	Mostly false	False
a) In general, I like the way I am	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Overall, I have a lot to be proud of	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) A lot of things about me are good	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) When I do something, I do it well	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) I like the way I look	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

55. If you had concerns regarding your mental health, are there any reasons why you would not talk to an adult at school (e.g., a school social worker, child and youth worker, counsellor, psychologist, nurse, teacher, or other staff person)? (Mark all that apply)

- I would have no problem talking to an adult at school about my mental health
- Worried about what others would think of me (e.g., I'd be too embarrassed)
- Lack of trust in these people - word would get out
- Prefer to handle problems myself
- Do not think these people would be able to help
- Would not know who to approach
- There is no one I feel comfortable talking to

Your School and You

60. How strongly do you agree or disagree with each of the following statements?

	Strongly agree	Agree	Disagree	Strongly disagree
a) I feel close to people at my school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) I feel I am part of my school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) I am happy to be at my school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) I feel the teachers at my school treat me fairly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) I feel safe in my school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) Getting good grades is important to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

61. In the last 30 days, in what ways were you bullied by other students? (Mark all that apply)

- I have not been bullied in the last 30 days
- Physical attacks (e.g., getting beaten up, pushed, or kicked)
- Verbal attacks (e.g., getting teased, threatened, or having rumours spread about you)
- Cyber-attacks (e.g., being sent mean text messages or having rumours spread about you on the internet)
- Had someone steal from you or damage your things

62. In the last 30 days, how often have you been bullied by other students?

- I have not been bullied by other students in the last 30 days
- Less than once a week
- About once a week
- 2 or 3 times a week
- Daily or almost daily

63. In the last 30 days, in what ways did you bully other students? (Mark all that apply)

- I did not bully other students in the last 30 days
- Physical attacks (e.g., beat up, pushed, or kicked them)
- Verbal attacks (e.g., teased, threatened, or spread rumours about them)
- Cyber-attacks (e.g., sent mean text messages or spread rumours about them on the internet)
- Stole from them or damaged their things

64. In the last 30 days, how often have you taken part in bullying other students?

- I did not bully other students in the last 30 days
- Less than once a week
- About once a week
- 2 or 3 times a week
- Daily or almost daily

65. How supportive is your school of the following?

	Very supportive	Supportive	Unsupportive	Very unsupportive
a) Making sure there are opportunities for students to be physically active	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Making sure students have access to healthy foods and drinks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) Making sure no one is bullied at school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) Giving students the support they need to resist or quit tobacco	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) Giving students the support they need to resist or quit drugs and/or alcohol	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

