ATHABASCA UNIVERSITY

# CIGARETTE SMOKING IN CANADIAN ADOLESCENTS: A CROSS-SECTIONAL EXAMINATION OF PSYCHOSOCIAL DETERMINANTS

BY

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**Abstract**

Smoking cigarettes is often initiated during adolescence. This study used nested hierarchical modelling to examine the psychosocial risk and protective factors associated with cigarette smoking among Canadian adolescents. Data from the 2022/2023 HBSC survey was utilized and both bivariate analysis and sequential hierarchical models were developed to assess adolescents' odds of having ever smoked in relation to a variety of predictor variables. The bivariate analysis showed significant associations with all the theorized predictor variables, and the fully adjusted hierarchical model showed significant associations between cigarette smoking and other substance use (vaping and alcohol) and higher friend support as significant risk factors, and higher relative family affluence, gender (cis-girls), and family and teacher support as significant protective factors. Using hierarchical modelling, a cross-sectional profile of the psychosocial determinants of Canadian adolescent cigarette smokers was created. Future research should focus on continued monitoring of smoking trends in Canadian adolescents who are trying cigarette smoking, gender differences, and predictors and protective factors in the context of the school environment.

*Keywords:* cigarette smoking, adolescence, cross-sectional, survey, public health, psychosocial determinants

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# Chapter 1. Introduction

## Adolescent Cigarette Smoking

Cigarette smoking is a highly prevalent modifiable risk factor that leads to disease and death in Canada, with more than 45,000 deaths caused by smoking cigarettes each year (Lee, 2023). Smoking cigarettes is started and becomes established mainly during adolescence (CDCTobaccoFree, 2023). The World Health Organization defines "adolescence" as the stage of life that falls between childhood and adulthood and classifies adolescents as those who are 10-19 years of age (World Health Organization, n.d.). This is a time when significant physical, psychological and social growth and development takes place, and when individuals start to gain more advanced thinking and reasoning skills (Singh et al., 2019).

The Canadian Paediatric Society (CPS) position statement on smoking prevention in children and adolescents, which was written in 2016 and reaffirmed in 2022, states the need for continued attention and efforts towards preventing cigarette smoking in adolescents (Canadian Paediatric Society, 2022), and expresses concern that thousands of Canadian youths begin smoking every year despite a variety of targeted prevention campaigns. Even with regulations around age of access to cigarettes and smoking in public places, many Canadian adolescents still start smoking annually and seem resistant to these policy changes and public health measures.

## Cigarette Smoking in Canada

Canada has adopted some of the most comprehensive regulations and mandates around reducing smoking in adolescents, some of which include restricted marketing, strategic labeling, smoke-free spaces and higher taxation rates (Canadian Paediatric

Society, 2022). Rates of adolescent cigarette smoking have dropped to around 10% overall in 2020 (Reid et al., 2022), and this activity is seen as less socially acceptable than it once was (Lim et al., 2022). There are decades of research demonstrating that the behaviour of adolescents is influenced by the behaviours of their peers (Giletta et al., 2021). If adolescent smoking was more culturally accepted, we may expect to see adolescents following their peers in taking up smoking; but the opposite should also be true. If adolescents are generally refraining from cigarette smoking, then so should similar peer groups. Another consideration is the impact that COVID-19 may have had on the development of this group of adolescents. Many pre-existing risk factors for adolescent substance use (including early life stress, boredom and social isolation) have been exacerbated by the pandemic, which could mean that some adolescents who might not otherwise have been at risk could now be experimenting with some of these substances (Sarvey & Welsh, 2021). This could include adolescents who try cigarette smoking and could have an impact on future trends within this population. It is challenging to create prevention strategies for these adolescents who continue to smoke cigarettes without first understanding who they are and what makes them resistant to Canada's efforts to date.

**Statement of the Problem**

With increases in the adolescent usage rates of other modes of nicotine delivery (such as vaping) and decreased smoking rates, the research focus has shifted away from cigarette smoking in recent years. However, this population of young smokers in Canada exists and little is known about them in the contemporary context of increased restrictions, reduced rates, and in the presence of alternative forms of nicotine delivery.

Understanding the risk factors of cigarette smoking is critical to develop targeted prevention programs to continue to move the needle on adolescent cigarette smoking.

# Chapter 2. Background

## Impact of Cigarette Smoking

Cigarette smoking during adolescence poses significant risks to heath and development. Adolescents who smoke are at risk of reduced lung growth and function, early cardiovascular damage, decreased physical fitness, and an increase in the number and severity of respiratory illnesses (American Lung Association, 2024). Those who start smoking at an earlier age are also more likely to develop a severe nicotine addiction compared to those who start smoking at a later age. In animal studies, exposure to nicotine had lasting effects on adolescent brain development (U.S. Department of Health and Human Services, 2024). Nicotine caused harm to the parts of the brain that controlled attention, learning, mood and impulse control (CDC, 2024).

Smoking can significantly increase the risk for other potentially fatal conditions including heart disease, heart attacks and stroke (Heart and Stroke Foundation of Canada, n.d.). People who smoke are twice as likely to suffer a heart attack or stroke, and smokers are also twice as likely to die from these serious health events (Heart and Stroke Foundation of Canada, n.d.). The biological mechanism for this is that smoking cigarettes can cause or worsen the buildup of plaque in the arteries, which then increases the risk of blood clots, while also reducing the oxygen in the bloodstream. This leads to the heart having to work harder, putting more stress on the entire cardiovascular system (Heart and Stroke Foundation of Canada, n.d.)

Aside from the impact that smoking can have on individuals, the impact to the Canadian economy and healthcare system is substantial. In 2020, tobacco use accounted for $5.4 billion in Canadian healthcare costs, which made up about 40% of the total

healthcare costs associated with any substance use (CSUCH, 2023). These included costs associated with hospital visits and hospitalizations, surgeries, specialized treatments, physician time and prescription medications. Additionally, a systematic review showed that smokers missed an average of 2.74 more days of work than non-smokers, and were likely to show decreased productivity as a result of things like smoking breaks, especially with increased restrictions requiring them to travel further off of the workplace property to smoke (Weng et al., 2013).

Lung cancer is the leading type of cancer death, with 1 in 4 Canadians who die from cancer having had lung cancer (Canadian Cancer Statistics Advisory Committee, 2023), and 42.9% of substance-use related hospitalizations being caused by tobacco use (CSUCH, 2023). The Global Burden Disease study in 2017 showed that 1.19 million lung cancer deaths (63.17%) were attributable to smoking globally (Yang et al., 2021). In 2023, lung cancer was the most commonly diagnosed cancer with an estimated 31,000 (13%) new cases diagnosed out of a total 239,100 new cancer cases across Canada (Canadian Cancer Statistics Advisory Committee, 2023).

**Trends in Canadian Adolescent Cigarette Smoking**

To better understand cigarette smoking in Canadian adolescents, it is necessary to observe the patterns and trends over the last several decades as well as in more recent years. In Canada, adolescent cigarette smoking rates have been trending downwards, though the decline has slowed. In 1999, the rate of Canadian adolescents who ever smoked was over 50% (almost 65% for 19-year-olds) but had decreased to 10.5% of adolescents aged 15-19 years in 2020 (*Tobacco Use in Canada*, n.d.). There was a consistent increase in cigarette smoking with age, which became even more pronounced

in more recent years. Other reports put estimates a bit higher; the Canadian Student Tobacco, Alcohol and Drugs Survey (CSTADS), which collects data from Canadian students in grades 6-12 (Health Canada, 2016) showed that the rate of adolescents who had "ever tried smoking" in Canada had declined from 24% in 2012-2013, to 18% in 2014-2015 and 2016-2017, and similarly an average of 19% in 2018-2019 (9% of students in grades 7-9, and 29% of students in grades 10-12) (Health Canada, 2022). The most recent CSTADS study in 2023-24 reported an ever-smoked rate of 17% (Health Canada, 2025). The average age of first trying a cigarette was 13.7 years in 2016. So, although there are some variations in estimates, the evidence shows that over the last decade, adolescent smoking rates in Canada have declined from 20% to 17% (Health Canada, 2025), with some studies reporting rates as low as 10% (*Tobacco Use in Canada*, n.d.).

Today's adolescents have access to nicotine (the addictive component of a tobacco cigarette) products in a wide variety of forms and modes of administration (Fataar & Hammond, 2019). In addition to traditional forms of consumption (i.e., cigarette smoking), nicotine is now also being consumed through vaping and pouches. Many of these non-combustible (sometimes called "smokeless") products have been marketed as smoking cessation or nicotine replacement products, but generally as a newer product, have not been as well researched to date, and lack the same regulation as traditional tobacco products (Patwardhan & Fagerström, 2022). The Health Behaviour in School-Aged Children (HBSC) Survey is another nationally representative, cross-sectional study, which collects self-reported data from students in grades 6-10. Recent iterations of the survey have found a higher proportion of adolescents now use of vapes

(or e-cigarettes) compared to cigarette smoking (Freeman, 2016). One study which observed trends in tobacco and other nicotine product use in Canadian adolescents found that overall usage of any nicotine products had increased in this group from 2017 (17.1%) to 2019 (23.2%) (East et al., 2021). Specifically, the use of smokeless products (e.g., nicotine-replacement therapies such as pouches) and vaping products had all increased. As well, adolescents who smoked or vaped were also more likely to use other tobacco products. While cigarette smoking rates in Canadian adolescents seem to be declining (though more slowly now), tobacco consumption in other forms, such as vaping, are on the rise.

# Chapter 3. Theoretical Framework

## Introduction

A theoretical framework is a previously developed structure that supports a given theory and helps to explain how this idea will be applied in research to investigate a problem, idea or concept (Labaree, 2024). Essentially, it refers to assumptions that are likely to be true based on existing evidence, and which can be tested to confirm if there is evidence in favor of the framework. Use of theoretical frameworks is important because it connects the research to current knowledge and evidence, and provides a basis for the hypothesis (Labaree, 2024). In this case, understanding the theory behind adolescents' interactions with varying levels of psychosocial influence is critical when trying to then understand the relationship to cigarette smoking within each context.

## Bronfenbrenner's Bio-Ecological Model

Bronfenbrenner's Bio-Ecological Model outlines the many different systems that influence an individuals' development and acknowledges the complex interactions between these systems (Bronfenbrenner, 1977). For adolescents, development is influenced by not only their immediate environment (family and peers), but also their larger environment and the social and cultural values that exist within them. The five ecological systems (in order of magnitude) include the microsystem, mesosystem, exosystem, macrosystem and chronosystem (Figure 1). Not only does this model suggest that each system directly influences the development of an individual, but also the interactions between the levels impact development as well. In the context of adolescent cigarette smoking, the risk that the individual will start smoking cigarettes is influenced by each of these systems as they exist in the lives of adolescents; not just individually,

but as they interact with each other they will influence the individual as well. For example, the gender or ethnicity of someone may impact their risk of starting cigarette smoking, but where they live, or where they go to school could also compound their risk of starting smoking.

**Sallis, Owen, and Fisher's Extension to the Bio-Ecological Model**

Sallis, Owen, and Fisher built on this concept by proposing that the development and behaviours of adolescents are influenced by the contexts in which they are raised (Sallis et al., 2008). That is, if the environment or context is created in such a way that it becomes easier (convenient, economical, attractive) to make healthy choices, then this will be more likely to happen. Conversely, if individuals have the motivations and skills to make healthy choices, but environments or policies make it challenging to prioritize health, then it will be less likely that adolescents will do so. In the context of adolescent cigarette smoking, this theory hypothesizes that if cigarettes were less expensive, more easily accessible, and more culturally accepted, then there would likely be a rise in adolescent cigarette smoking. However, even with the restrictions that we have in place and awareness about the risks of cigarette smoking, if there are significant challenges to making healthy choices (for example, lack of affordable access to recreational physical activity spaces or lack of smoking prevention and cessation education and resources) then it may still be possible that adolescents would not make these healthier lifestyle choices.

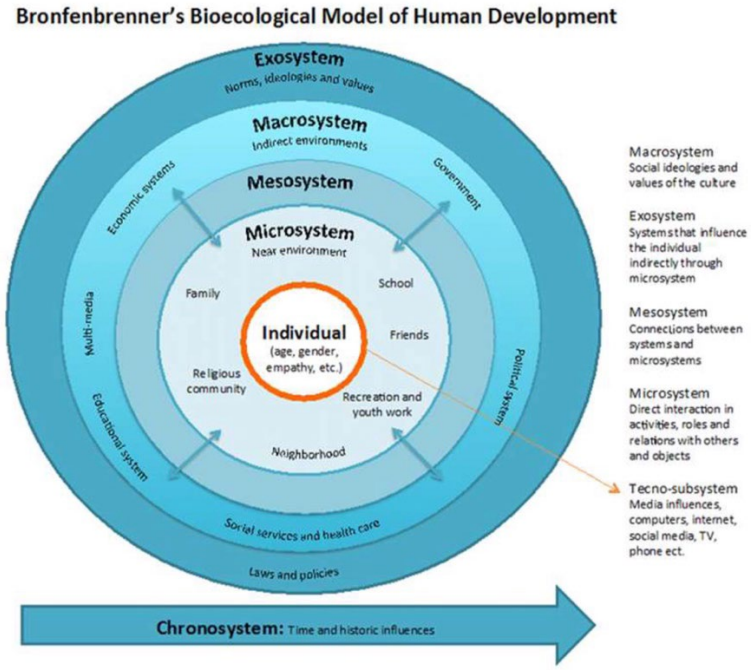
**Digital Environments**

In recent years, it has become important to consider digital environments in the context of adolescent development. The digital environment has become much more

prevalent in the lives of adolescents, who have increasing access and are seeking independence and autonomy as part of their development (Hammond et al., 2023). As technological and digital environments continue to become more dominant in society, and their influence on the other bio-ecological systems increases, consideration of these environments and their influence on adolescent development is essential (Caperon et al., 2022). In response to this, Currie and Morgan (2020) present an update to Bronfenbenner's Bioecological model that includes a techno-subsystem that surrounds the individual. The digital environment is a critical consideration in the context of adolescent cigarette smoking to ensure our understanding incorporates all environments that are influential in the lives of adolescents.

**Figure 1.**

*The five systems (in order of magnitude) in Bronfenbrenner's Bioecological Model as they relate to the individual adolescent, and their interactions between each other.*




*Note*. Figure retrieved from (Currie & Morgan, 2020)

# Chapter 4. Psychosocial Factors Related to Adolescent Cigarette Smoking: A Narrative Review

## Introduction

This chapter will explore the literature on psychosocial predictors of adolescent smoking, which was then used to inform the empirical approach used in this study.

## Sociodemographic Factors

Demographic and socioeconomic factors including age, gender, ethnicity and family affluence, and are known to be strongly associated with cigarette smoking. In the Youth Risk Behaviour Survey (Mejia et al., 2023), which examined students in grades 9 through 12 in the United States, students in grade 12 consistently reported the highest rates of trying cigarettes than all other grades. Another Canadian study which surveyed students in grades 9-12 in four Canadian provinces (British Columbia, Alberta, Ontario and Quebec) between 2013 and 2019 (Cole et al., 2021) found that cigarette smoking was highest among grade 12 students, and lower among grade 9 students. In addition to age, cigarette smoking has also been found to be associated with gender and ethnicity (East et al., 2021; Strong et al., 2015; Trinidad et al., 2017). Rates of cigarette smoking are higher among boy adolescents than girls in Canada (Cole et al., 2021). However, findings from the USA Youth Risk Behaviour survey also noted that, while variations by gender have existed in the past, this was not the case in 2021 (Mejia et al., 2023) as this study reported the gender gap had narrowed. In terms of ethnicity, a Canadian study looking at students in grades 9-12 in four provinces between 2013 and 2019 (Cole et al., 2021) reported that Asian students had lower rates of cigarette smoking. Another study using the 2017 Youth Risk Behaviour survey in the US found that White adolescents were the

most likely to be cigarette users when compared to other ethnicities, and Black and Asian students had a significantly lower relative risk (Seo & Huang, 2012)

In terms of socioeconomic status, higher family affluence has been shown to be associated with lower smoking rates (Kim & Chun, 2018). International survey data from 2005/2006 from several European countries, as well as Israel and Canada showed an association between family affluence and rates of smoking among youth; higher family affluence was associated with lower rates of smoking (Pförtner et al., 2015). As well, this relationship between smoking and family affluence was stronger in wealthier countries. This is relevant for Canada, which was near the top of the gross domestic product for the countries studied. Further, studies have looked at what might make someone susceptible to starting smoking or becoming a smoker and have found similar inverse socioeconomic associations (Strong et al., 2015; Trinidad et al., 2017). In contrast to family affluence, these models found that susceptibility to smoking was higher with increased parental education (Trinidad et al., 2017). Another study of youth from the United States found that adolescents who had parents with higher levels of education were found to be more susceptible to starting smoking (Dai et al., 2023). This is somewhat counterintuitive, as family affluence has been shown to be inversely proportional to rates of cigarette smoking; therefore, the measure used to report family affluence may be of importance when examining adolescent smoking.

## Individual-Level Factors

### *Other Substance Use*

A positive association between smoking and vaping has been well documented (Azagba et al., 2019; Farsalinos et al., 2018; Warner, 2016). A large Canadian survey of

over 51,000 students in grades 7-12 found that students who vaped more frequently, were also more likely to have smoked cigarettes in the last month, and students who had not used e-cigarettes were less likely to have smoked cigarettes. A longitudinal study of early adolescents (before age 15) in the USA and the UK, found that early vaping led to higher odds of cigarette smoking later in adolescence (Kelly et al., 2024). Noteworthy in this study is that these two countries have stark differences in national marketing and regulation around vaping (USA policy tends to be significantly more variable due to implementation at the state as opposed to national level), yet the pattern is similar. One further study looked at vaping and smoking trends in Canada, the United States and England among 16- to 19-year-olds (Hammond et al., 2019). They did note an increase in the rates of vaping within this group, but the rates of cigarette smoking remained relatively consistent, therefore implying that the increase in vaping did not have the expected impact on rates of increased cigarette smoking, nor did vaping begin to "replace" cigarette smoking. These studies highlight that contemporary work that examines cigarette smoking should consider vaping as a potential risk factor.

A relationship between cigarette smoking and use of other substances has also been found in multiple studies (Dai et al., 2023; East et al., 2023; Lowry & Corsi, 2020; Mehra et al., 2019). Cannabis use has been shown to be strongly associated with cigarette smoking, with cigarette smokers being 5 times more likely to also report using cannabis in individuals aged 15 years and older (Lowry & Corsi, 2020). Cigarette smoking is also associated with alcohol consumption. A systematic review of cigarette smoking trajectories among adolescents found that all the studies that observed alcohol and cigarette smoking trajectories reported a significant association between the two (Ahun et

al., 2020). One study found that early smokers and chronic smokers are at higher risk for other drug use and substance abuse problems, including alcohol (Nelson et al., 2015).

### *Physical Activity*

Physical activity has been found to be negatively associated with cigarette smoking. Cigarette smoking was associated with physical inactivity, no participation or dropping out of sports, as well as more screen time in a longitudinal study of over 5000 Canadian students in grades 9-12 (Irvine et al., 2022). The same study found that smoking cessation also correlated with *increased* physical activity and decreased screen time. Current and former smokers are less likely to be involved in organized sports (intramural, competitive and team sports) as compared to non-smokers (Milicic et al., 2019). Survey data from 38 977 Canadian students in grades 9-12 showed that current and former smokers were about half as likely to participate in these types of activities (Milicic et al., 2019). A different study of grade 12 students in the United States also showed that respondents who participated in a competitive sport were less likely to engage in cigarette smoking (Veliz et al., 2017). This study found that students who participated in three or more competitive sports had statistically significantly lower rates of cigarette smoking.

### *Mental Health and Wellbeing*

Many studies have shown an increased risk of smoking for those with mental health problems, and that the rates of smoking also increase with the severity level of the mental health problems. One systematic review observed that there was a link between cigarette smoking and depression, anxiety, or both, in the general population (Fluharty et al., 2017). This systematic review was not specific to adolescents, but still sheds some

light on relationships that could exist across age groups. Although smoking rates in the general public have been declining, smoking rates among adults with mental health problems have remained essentially unchanged (Royal College of Physicians of London & Royal College of Psychiatrists, 2013). Individuals with mental illnesses tend to start smoking earlier, smoke more heavily, and are more addicted or have a harder time quitting smoking than the general population (Fluharty et al., 2017), which could apply to the adolescent population being observed in our study.

Looking specifically at adolescents, a study of American 9- and 10-year-olds, found that internalizing problems, symptoms of mental health problems, anxiety, depression and withdrawal behaviours were positively associated with susceptibility to tobacco use (Dai et al., 2023). They hypothesized that youth with poor mental health may be more susceptible to intensive marketing around cigarette smoking, and may be looking for stress reduction or social popularity, though the systematic review of adults by Fluharty et al. (2017) highlights that further research is needed to confirm such hypotheses.

## Interpersonal-Level Factors

In addition to individual-level determinants, interpersonal determinants are important to consider as a factor in adolescents who are vulnerable to becoming smokers. For adolescents, interpersonal determinants could include factors such as relationships with family, friends and classmates. It could also involve how the individual sees or feels about themselves and their connectedness to different social groups, any of which might potentially influence their smoking behaviour.

### *Interpersonal Relationships: Family*

Adolescence is a time of growth and significant development, as well as a time when young people are trying to understand their identity as individuals – family relationships play a critical role in development to this point, and as adolescents grow into young adults, they may be influenced by their relationships with family as well as social behaviours in their home environment. Living with both parents has been shown to be associated with lower smoking rates (Kim & Chun, 2018). The results of a study out of Greenland reported that the number of adults living at home was significantly associated with adolescent smoking (Hansen et al., 2020). Individuals with two adults in their home smoked less than individuals with one adult or those living in foster care. Increased parental monitoring has also been shown to be associated with decreasing rates of susceptibility to tobacco use, but the relationship with parental influence became less significant as children got older, with the focus shifting towards more peer- and environment-influenced factors (Dai et al., 2023). It has also been demonstrated that adolescents with parents who were smokers were more vulnerable to also start smoking (Strong et al., 2015). It is likely that early exposure to these behaviours could influence the likelihood of adolescents trying cigarettes or becoming cigarettes smokers themselves.

### *Interpersonal Relationships: Peers*

A systematic review looking at social networks of adolescents found that low levels of social relations could lead to adolescent smoking (Seo & Huang, 2012). While having less peer support and a weaker social network can lead to increased risk of cigarette smoking, there also seems to be some level of social structure and cohesion in peer groups of those who do smoke (Hansen et al., 2020). For example, a study from

Greenland examined associations between adolescents' "structural" (a quantitative measure of the relationships) and "functional" (qualitative) relationships and demonstrated that adolescents with high levels of social support had lower rates of cigarette smoking (Hansen et al., 2020). Social support and social anchorage tended to be "low" or "medium" in those who smoked cigarettes (though it was not a significant association). This study found that that the number of friends that an adolescent had was not significantly related to cigarette smoking (Hansen et al., 2020). Another study using hierarchical modelling to analyze social networks found that having *delinquent friends* (who smoke, drink, use other substances and/or carry a weapon) is positively associated with cigarette smoking (Kim & Chun, 2018).

## Context-Level Factors

One final consideration is the contextual factors that contribute to adolescent smoking. Context-level determinants are the environment in which the individual is raised and lives or spends time, such as one's home, community, school or work.

### *School Environment*

A significant portion of adolescents' time is spent in and around their school environment, so it is not surprising that this can be a very influential place for a lot of individuals. There were several school environmental factors that were significantly associated with lower rates of smoking among US adolescents, including policies prohibiting teachers and staff from smoking, antismoking academic curriculum, better classroom relations among peers, positive school attachment and higher perceived teacher evaluation of performance (Kim & Chun, 2018). Favorable school environments were associated with lower susceptibility to tobacco use in a population of adolescents

living in the United States (Dai et al., 2023). Negative school climate, as well as weaker implementation of anti-smoking policies have both been associated with higher prevalence of adolescent cigarette smoking in schools (Kim & Chun, 2018). Findings on school environments show that, while schools can be a high-risk environment for starting smoking there could also be protective factors in within a school's culture.

### *Neighbourhood Environment*

Several studies have explored the relationship between smoking and aspects of the neighbourhood, specifically, perceived neighbourhood safety (Dai et al., 2023; Kim & Chun, 2018; Strong et al., 2015). The findings report a negative relationship between perceived neighbourhood safety and cigarette smoking. For example, results from a study looking at HBSC data that surveyed students from 173 neighbourhoods across Canada found that neighbourhood risk factors were associated with an increased likelihood of frequent substance use (although not tobacco specific) (Lambe & Craig, 2017). Neighbourhood risk factors were defined as area-level socioeconomic status, crime, neighbourhood physical disorder and residential instability. Another study that combined survey data with context-level administrative data related to crime and area-level socioeconomic status showed that there was an association between increased levels of crime in a neighbourhood and increased cannabis use (although not tobacco use) (de Looze et al., 2015). These findings highlight that further tobacco-specific studies are warranted as these focused on general substance use and cannabis use rather than cigarettes, though the relationships could be similar.

### *Digital Environments: Social Media Use*

The pervasive nature of social media in the lives of today's adolescents is apparent. A large meta-analysis including 27 cross-sectional studies found a positive association between social media use and substance use, with a small-medium effect size (Vannucci et al., 2020). A large study of 190,089 adolescents across 42 countries (including Canada), observed positive relationships between intense (high frequency and inability to control) social media use and problematic social media use, and various wellbeing outcomes including cigarette smoking (Boniel-Nissim et al., 2022). Those classified as problematic social media users had more than three times higher odds of having smoked cigarettes in the past 30 days compared to active social media users. This study offers the explanation that problematic social media users may have more frequent exposure to marketing and substance use-related content than those who use social media less frequently and may also be influenced by seeing more substance use behaviours by their peers or friends being shared, impacting their perception of peer norms, especially if they are using social media to escape from negative feelings or emotions. It has been hypothesized that adolescents who use social media and see online content around risky behaviours may engage in more similar behaviours both online and offline, to receive social reinforcement and conform to what they believe to be social norms in-person and online (Nesi et al., 2018; Vannucci et al., 2020). Considering the relationship between digital environments and social media use is therefore critical in understanding how they may influence contemporary adolescent cigarette smoking.

# Chapter 5. Methodology

## Introduction

Applying Bronfennbenner's theoretical framework, this study used hierarchical modelling to create a cross-sectional overview of factors related to adolescent cigarette smoking in Canada. In essence, it revealed who is at risk for cigarette smoking, from which it may be possible to understand how to reach or target adolescents more effectively.

## Study Aim

The primary aim of this study was to explore the potential psychosocial risk and protective factors of cigarette smoking amongst adolescents in Canada.

## Research Design

The HBSC survey is an international, repeated cross-sectional study done every four years in more than 50 different countries including Canada (in collaboration with the World Health Organization) (Craig, 2020). Our study utilized secondary data from the Canadian arm of this survey. In Canada, the HBSC survey is representative of the Canadian population from grades 6-10. It is distributed in schools across multiple provinces and territories. Cluster sampling is used to collect a sample of respondents to mirror the larger population (students are clustered in schools) (HBSC, n.d.). This sampling method is used in large, dispersed geographic regions (like in Canada) because it is more feasible to obtain samples from clusters (Frost, 2024). Complex sampling was also used, which means that the sample being included and used for analysis is not completely random; the sample is selected to ensure that it is an adequate representation (a *sample*) of the larger population (Caplan et al., 1999).

This thesis utilized data from the 2022-2023 HBSC survey, which collected information from 9 provinces and 2 territories through either electronic or paper-based anonymous surveys. No survey data was collected for New Brunswick or Nunavut; therefore, these two areas were not included in the study. A total of 26,571 students (ages 11-17 years) were included in the 2022/23 survey. An extended survey period was required for this data collection year given the substantial challenges posed by COVID-19 such as variable attendance and elevated levels of illness in schools (HBSC, n.d.). The survey collected data on a wide variety of health and behavioral factors, including information around substance use such as smoking cigarettes and psychosocial factors. The exclusion criteria for HBSC studies included children in Canada who attended private schools, who were home-schooled, youth in schools on First Nation or Inuit reserves, youth who were incarcerated, or children who were not attending school at the time of the survey. In 2018, this exclusion criteria eliminated less than 7% of the population of Canadian adolescents within this age group (Gazendam et al., 2020).

Variables included in the analyses were based on the narrative review of the determinants of adolescent cigarette smoking and informed by the theoretical framework, outlined in Chapters 3 and 4.

### *Ethical considerations*

HBSC surveys for 2022/23 were completed by the students individually and in an anonymous format. Consent was obtained from schools and administrators, passive consent was obtained from parents and assent was obtained from the students (Exner-Cortens et al., 2021). Ethics approval for the HBSC survey was obtained through Queen's University and the Public Health Agency of Canada. For this specific study, full

research ethics board review was waived by Athabasca University, as this was a secondary use of deidentified data only (Appendix A).

## Measures

### *Cigarette Smoking*

The outcome variable for this study was cigarette smoking in the adolescents' lifetime (ever smoked). The self-reported history of ever having smoked cigarettes was determined by the question "*On how many days (if any) have you smoked cigarettes in your lifetime"*, with the response options being *Never, 1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days* or *30 days or more*. Responses were treated as categorical and re-coded as *Never Smoked* (those who responded *Never*) or *Ever Smoked* (those who responded 1 or more days).

### *Sociodemographic Variables*

Age of respondents was determined by which grade they were in at the time of the survey, ranging from grades 6-10, which was treated as a continuous variable in multivariable models. The participants' gender came from two survey questions asking participants' sex at birth and gender identity: "*Identities of people are varied: some people identify themselves as girls, others as boys, and there are people who don't feel represented in this system. Please, choose the option that you feel more identified with?"* The response options were *I identify myself as a girl, I identify myself as a boy, I identify myself neither boy nor girl* or *Other/s (please specify).* These two variables were then combined to create a final "gender" variable. This classified the participants' gender as *boy* (cis-boy), *girl* (cis-girl), and *other* (gender-diverse).

The question about ethnicity was phrased "*People living in Canada come from many different racial backgrounds. How would you describe yourself? (Mark all that apply)"*. As was done by Seo and Huang (Seo & Huang, 2012), the response categories were re-grouped into *White, Black, Latin American, Asian, Other (or mixed race)* and an additional category was included for *Indigenous*. During the analysis, it was determined that the Latin American category had too few participants (total n=277; never smoked=259, smokers=18) and this was grouped with the *Other* category. Due to requirements of the HBSC study ethics, the results of the ethnicity analyses were not reported in the tables; although this variable was included as a covariate in the multiple logistic regressions.

As was done by Gazendam et al. (2020), relative family affluence was assessed using the survey question "*How well off do you think your family is?"* The response options for this question were *Very well off, Quite well off, Average, Not very well off* or *Not at all well off,* which was then re-categorized into *below average, average* and *above average.* This question was treated as categorical.

***Other Individual Variables***

**Other Substance Use.** Other substance use was measured with two variables (1) vaping and (2) alcohol use. Vaping was captured using the question "*On how many days (if any) have you used a vape, also known as an e-cigarette? (e.g. JUUL, Vype, Suorin, Smok) in your lifetime?"*. Response categories were *Never, 1-2 days, 3-5 days, 6-9 days, 10-19 days, 20-29 days or 30 days or more*. To assess alcohol use, data was collected for the following question: *"On how many days (if any) have you drunk alcohol in your lifetime?"* with the following categories, *Never, 1-2 days, 3-5 days, 6-9 days, 10-19 days,*

*20-29 days, 30 days or more.* Respondents who selected "never" were coded as non-users, and respondents who selected any of the other options were coded as ever used for both of these substances use variables.

**Physical Activity.** The HBSC survey defines physical activity in the survey as "*Any activity that increases your heart rate and makes you get out of breath some of the time. Physical activity can be done in sports, school activities, playing with friends, or walking to school".* The survey question was then asked, "*Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?"* The responses were numerical from 0-7 days, and this variable was treated as a continuous variable.

**Mental Wellbeing** For this study, mental wellbeing was measured using Cantril's ladder analog scale (Cantril, 1965), as an indicator of life satisfaction (cognitive wellbeing) which asks respondents to mark on a "ladder" (scale of 1-10) how satisfied they feel with their life currently. Previous studies have used satisfaction with life as an indicator of mental health and wellbeing (Ottendahl et al., 2024). The question explains that 0 indicates the *"worst possible life"* and 10 indicates the *"best possible life"*. The responses for analysis were grouped in the same way as was done by Gazendam et al. (2020), with scores of 0-5 being labelled *Low*, scores of 6-7 as *Moderate*, scores of 8-9 as *High* and 10 as *Highest.* Later, the *High* and *Highest* categories were combined due to a relatively small number in the *Highest* group (total n=2149, 8.1%). This was treated as a categorical variable.

***Interpersonal-Level Variables***

**Family & Peer Support.** Two composite measures, which have been compiled to assess interpersonal relationships within the HBSC survey were included in the analysis: (1) The Family Support Scale and (2) The Friend Support Scale (Freeman, 2016). Each of these scales are comprised of four questions from the survey (Appendix B), and the responses range from a scale of 1 (low) to 7 (high). The mean value across all questions was used, and person mean imputation was applied to compute the scores, so respondents had to have answered at least 3 of the 4 questions to be included in the analysis. These were treated as continuous variables.

### *Context-Level Variables*

**School Environment.** Two composite measures, which have been compiled to assess perceived school support within the HBSC survey are included in the analysis: (1) The Teacher Support Scale and, (2) The Classmate Support Scale. Each of these scales are comprised of three questions from the survey (Appendix B), and the responses range from a scale of 1 (low) to 5 (high). These were treated as continuous variables. Both of these scales have been previously validated using the HBSC data (Torsheim et al., 2012). The mean value across all questions was used, and person mean imputation was applied to compute the scores, so respondents had to have answered at least 2 of the 3 questions to be included in the analysis.

**Perceived Neighbourhood Social Capital.** Perceived neighbourhood social capital was calculated into a composite measure from a compilation of HBSC survey questions (Freeman, 2016) which has been previously validated (Martin et al., 2017). The questions ask respondents five items that get at how they feel about their neighbourhood and the perceived level of safety where they live (Appendix B). The composite results

were treated as continuous on a scale from 1 (lower social capital) to 5 (higher social capital). The mean value across all questions was used, and person mean imputation was applied to compute the scores, so respondents had to have answered at least 4 of the 5 questions to be included in the analysis.

**Social Media Use**. To measure respondents' social media use, a previously validated, 9-item composite scale, called the Social Media Disorder Scale (van den Eijnden et al., 2016), was used (Appendix B). Respondents who answer "yes" to 5 or more of the 9 questions, are classified as a "disordered social media user" (van den Eijnden et al., 2016). This variable was treated as categorical with respondents being categorized as either *Disordered* or *Non-disordered* social media users.

**Statistical Analysis**

Descriptive statistics were calculated (frequency for categorical variables, mean and standard deviation for continuous variables). Data were reported based on never-smoked versus ever-smoked. Bivariate logistic regression analysis was completed to obtain unadjusted odds ratios (Szumilas, 2010). Observing the unadjusted odds ratios for the predictor variables provides some insight into how strongly-associated the variables are and indicates the odds that someone would have ever smoked a cigarette.

Multiple logistic regression was conducted with multiple variables in the same model, as logistic regression facilitates the ability to adjust for multiple predictors (adjusted odds ratios) (LaValley, 2008). Nested hierarchical logistic models were conducted that first examined and adjusted for (1) sociodemographic variables (i.e., demographics, relative family affluence), (2) sociodemographic + other individual variables (other substance use, physical activity, mental wellbeing), (3)

sociodemographic + other individual + interpersonal (family support and friend support), and (4) sociodemographic + other individual + interpersonal + other contextual (i.e., classmate and teacher support, neighbourhood social capital, and social media use) to see which variables were better predictors of adolescent cigarette smoking (Dai et al., 2023). Relative Family Affluence (although this could be considered at the family level) was included in Model 1 (sociodemographic factors) because it is a known to be a strong predictor of health behaviours of adolescents (World Health Organization, 2020). Also, it was important to include this variable from the beginning, to ensure that all subsequent models would also be adjusted for age, gender and socioeconomic status, as core predictors of adolescent health (Craig, 2020).

The results from each model were presented with the odds ratio, confidence interval and p-value. Logistic regression gives some information about the effect size of the increase in the odds ratio for each unit of increase in the exposure (Szumilas, 2010). An odds ratio of less than one implies that the outcome (smoking) is negatively associated with the predictor (protective), and an odds ratio of higher than one indicates a greater association (Tenny & Hoffman, 2021). A p-value $<0.05$ was considered statistically significant in all analyses.

The Variance Inflation Factor (VIF) was calculated to assess for multicollinearity. If any predictor variables were found to be correlated, they were examined and either excluded from the logistic regression analysis, or, if conceptually similar, combined into one index variable for analysis (Senaviratna & Cooray, 2019).

***Model Goodness of Fit***

Measuring goodness of fit is an important part of any statistical analysis and helps to quantify whether the model that has been used is an appropriate fit for the dataset. It compares the "observed" data to the "expected" data that you would normally see using the chosen model and calculates the discrepancy between the two (Kery & Royle, 2016). The Nagelkerke's pseudo R-squared value is one example of a goodness of fit measure that is calculated for models with nominal or ordinal outcome variables (Hemmert et al., 2018). Nagelkerke's pseudo R-squared ranges from 0-1, with values closer to 1 being indicative of a better model fit. The Nagelkerke's model goodness of fit was calculated for each of the four adjusted hierarchical models in this study.

***Missing Data***

As this study uses secondary data, some responses were incomplete or were missing data points. To address missing points within a composite scale, person mean imputation was utilized, which is an approach that has been previously outlined to address these types of gaps in survey data analyses (Lee et al., 2015). Additionally, a *missing* category for the race/ethnicity survey question was created. This was done because there were 2,533 respondents (>10%) who did not indicate any selection for the survey question related to race (Table 1). Had I not included this group, there would have been a large number of data points removed from the adjusted analysis, which could have significantly impacted the final results. Instead, the data was left in and designated as *missing* data for the race question. For bivariate models all complete cases on the variables of interest were maintained. Beyond this, as has been done by similar studies using the HBSC data set, for adjusted models any responses where data points on a

variable of interest were missing were removed and excluded from the analysis (Borraccino et al., 2020).

### *Sampling Design*

To account for the potential clustering of cigarette smoking within schools and to account for weighting, a complex sampling file for this study was created by members of the research team which was applied by using IBM SPSS Statistics (Version 27) Complex Samples for analysis (IBM, 2023). This accounted for school clustering and weighting. This is important since when participants are sampled with unequal probability (as in complex sampling) it can be helpful to weight the data in statistical analysis and account for clustering (Hahs-Vaughn, 2005). This helps to ensure that, even though some data are intentionally sampled at a higher rate, they do not carry more weight in the analysis than they would in the general population. This is a commonly used technique in population surveys and was used in this study for all analyses.

# Chapter 6. Results

## Introduction

The 2022/23 HBSC survey included a total of 26,571 survey responses from Canadian adolescents. There were 2839 respondents (10.7%) who did not answer the question about having ever tried cigarette smoking in their lifetime, and who were therefore excluded from the analysis. This left a total of 23,732 adolescents (weighted total = 23, 506) for the final analysis. The sample included students in all grades surveyed (grade 6-10) with a mean grade of 7.9. In total, 48.1% (weighted n= 11,164.4) were cis-girls, 46.2% (weighted n= 10,724.1) were cis-boys and 5.7% (weighted n= 1,331.0) were gender-diverse.

## Bivariate Analysis

The results of a bivariate analysis (using complex sampling design to account for weighting and clustering in schools) performed for participants reported to have *ever-smoked* versus *never-smoked* on each of the dependent variables of interest are shown in Table 1.

**Table 1**

*Table showing the bivariate analyses between those who had ever-smoked or never-smoked for all independent variables used in the hierarchical model.*

| *Variable* | *Cigarette Smoking Status* | | | | |
|---|---|---|---|---|---|
| | Sample | Ever Smoked | Never Smoked | Odds ratio (CI) | p-value |
| ***Unweighted N*** | 23,732 | 2,023 (8.5) | 21, 709 (91.5) | | |
| ***Weighted N (%)*** | 23,506 | 1,760 (7.5) | 21,746 (92.5) | | |
| ***Grade, Mean (SD)*** | | | | | |
| *Grade 6-10* | 7.8 (1.4) | 8.7 (1.3) | 7.8 (1.4) | 1.6 (1.6-1.7) | <0.001 |
| ***Gender, N (%)*** | | | | | |
| *Cis-boys* | 10,724.1 (46.2) | 701 (40.6) | 10,023 (46.6) | Ref | |
| *Gender-diverse* | 1,331.0 (5.7) | 178 (10.3) | 1,153 (5.4) | 2.2(1.7-2.9) | <0.001 |
| *Cis-girls* | 11,164.4 (48.1) | 849 (49.1) | 10,315 (48.0) | 1.2 (1.0-1.4) | 0.051 |
| ***Relative Family Affluence, N (%)*** | | | | | |
| *Below Average* | 2,047.5 (9.3) | 301 (18.0) | 1,746 (8.5) | Ref | |
| *Average* | 8,403.8 (38.0) | 761 (45.6) | 7,643 (37.4) | 0.6 (0.5-0.7) | <0.001 |
| *Above Average* | 11,676.3 (52.8) | 607 (36.4) | 11,069 (54.1) | 0.3 (0.3-0.4) | <0.001 |
| ***Vaping Status, Mean (SD)*** | | | | | |
| *Never Vaped* | 19,893.6 (85.2) | 212 (12.3) | 19,681 (91.0) | Ref | |
| *Ever Vaped* | 3,460.0 (14.8) | 1,516 (87.7) | 1,944 (9.0) | 72.2 (56.5-92.3) | <0.001 |
| ***Alcohol Status, Mean (SD)*** | | | | | |
| *Never drank alcohol* | 15,878.9 (68.6) | 192 (11.2) | 15,687 (73.3) | Ref | |
| *Ever drank alcohol* | 7,255.2 (31.4) | 1,527 (88.8) | 5,728 (26.7) | 21.8 (17.0-27.9) | <0.001 |
| ***Physical Activity, Mean (SD)*** | 4.7 (2.0) | 4.3 (2.0) | 4.7 (2.1) | 0.9 (0.8-0.9) | <0.001 |
| ***Mental Wellbeing (Life Satisfaction), N(%)*** | | | | | |
| *High* | 10,203.7 (44.6) | 7,343 (84.2) | 9,867 (46.6) | Ref | |
| *Moderate* | 7,961.2 (34.8) | 618 (7.1) | 7,343 (34.7) | 2.5 (2.0-3.1) | <0.001 |
| *Low* | 4,738.1 (20.7) | 763 (8.7) | 3,975 (18.8) | 5.6 (4.6-7.0) | <0.001 |
| ***Family Support (1-7), Mean(SD)*** | 4.8 (1.8) | 3.9 (1.7) | 4.9 (1.8) | 0.7 (0.7-0.8) | <0.001 |
| ***Friend Support (1-7), Mean(SD)*** | 4.6 (1.8) | 4.5 (1.8) | 4.7 (1.8) | 0.9 (0.9-1.0)* | <0.001 |
| ***Teacher Support Scale (1-5), Mean(SD)*** | 3.7 (0.9) | 3.1 (1.0) | 3.8 (0.9) | 0.5 (0.47-0.52) | <0.001 |
| ***Classmate Support Scale (1-5), Mean(SD)*** | 3.4 (0.9) | 3.0 (1.0) | 3.5 (0.9) | 0.6 (0.5-0.6) | <0.001 |
| ***Neighbourhood Social Capital (1-5)*** | 3.5 (0.7) | 3.3 (0.7) | 3.5 (0.6) | 0.6 (0.6-0.7) | <0.001 |
| ***Social Media Use, N(%)*** | | | | | |
| *Non-disordered* | 20, 695.3 (88.0) | 1,336 (75.9) | 19,359 (89.0) | Ref | |
| *Disordered* | 2,811.1 (12.0) | 424 (24.1) | 2,387 (11.0) | 2.6 (2.1-3.1) | <0.001 |

*Note. *95% confidence interval= 1.0 due to rounding (upper limit =0.967)*

Table 1 shows 92.5% (weighted n= 21,746, 95% CI= 91.6% - 93.4%) of adolescents reported to have never smoked cigarettes, while 7.5% (weighted n=1,760,

95% CI= 7.2% - 7.8%) reported to have ever smoked. The bivariate analysis also shows that most variables included were significantly associated with having ever smoked in the unadjusted models. Increasing grade (OR=1.6; CI=1.6-1.7; p<.001) and being gender-diverse (OR=2.2; CI=1.7-2.9; p<.001) compared to cis-boys, were both associated with higher odds of ever having tried cigarette smoking. Additionally, having ever vaped (OR=72.2; CI=56.5-92.3; p<.001) or ever drank alcohol (OR=21.8; CI=17.0-27.9; p<.001) was also associated with increased odds of ever smoking. Disordered social media use (OR=2.6; CI=2.1-3.1; p<.001) was associated with a higher likelihood of ever having tried cigarette smoking. Some significant protective factors were also found in unadjusted models. Higher relative family affluence (above average: OR=0.3; CI-0.3-0.4; p<.001, average: OR=0.6; CI=0.5-0.7; p>.001 compared to below average) was significantly associated with a lower risk of cigarette smoking. Also, increasing physical activity (OR=0.9; CI=0.8-0.9); p<.001, family support (OR=0.7; CI-0.7-0.8; p<.001), friend support (OR=0.9; CI=0.9-1.0; p<.001) and school (teacher: OR=0.5; CI=0.47-0.52; p<.001, and classmate: OR=0.6; CI=0.5-0.6; p<.001) support were all found to be significant protective factors. Higher neighbourhood social capital (OR=0.6; CI=0.6-0.7; p<.001) was significantly associated with a decreased likelihood of ever having tried cigarette smoking**.** In sum, all dependent variables were found to be statistically significant (p<0.05) predictors of having ever tried cigarette smoking, except for cis-girls compared to cis-boys (which was just above the threshold for statistical significance at p=.051, OR=1.2, CI=1.0-1.4).

**Check for Multicollinearity**

Based on the VIF calculations, none of the variables were found to be collinear to a degree of concern for multivariable models (Table 2). VIF ranged from 1.070 – 1.480. A VIF of 5 or greater indicates multicollinearity (Kim, 2019). Therefore, it was not necessary to combine or exclude any variables from the multivariable analyses.

**Table 2**

*Table showing the variance inflation factor of each independent variable.*

| *Variable* | VIF |
|---|---|
| ***Grade*** | 1.162 |
| ***Gender*** | 1.090 |
| ***Race/Ethnicity*** | 1.044 |
| ***Relative Family Affluence*** | 1.103 |
| ***Vaping Status*** | 1.333 |
| ***Alcohol Status*** | 1.397 |
| ***Physical Activity, mean (SD)*** | 1.130 |
| ***Mental Wellness (Life Satisfaction)*** | 1.461 |
| ***Family Support (1-7)*** | 1.442 |
| ***Friend Support (1-7)*** | 1.267 |
| ***Teacher Support Scale (1-5)*** | 1.460 |
| ***Classmate Support Scale (1-5)*** | 1.480 |
| ***Neighbourhood Social Capital (1-5)*** | 1.166 |
| ***Social Media Use*** | 1.070 |

## Hierarchical Adjusted Models

Table 3 shows the results from the multivariable logistic regression analysis which included several nested hierarchical models that each progressively adjust for different predictors of cigarette smoking in adolescents. The first baseline model included only sociodemographic variables (grade, gender, race/ethnicity, and relative

family affluence). Next, other individual-level factors were added (Model 2), followed by interpersonal factors (Model 3) and, finally, contextual-level factors in the final model (Model 4). The total number of survey respondents which had complete data across all variables and were therefore included for analysis was 19, 636.

Once the 19,636 complete responses included in the final hierarchical models were isolated, this left 3,870 responses which were removed from the analyses. A look at these 3,870 responses showed that 3,572 (92.3%) had never smoked cigarettes, while 298 (7.7%) had ever smoked cigarettes. There were 1,632 (46.5%) cis-girls, 1,636 (46.6%) cis-boys and 193 (5.5%) gender diverse responses removed (359 students did not complete the question). In total, 920 (23.8%) were in grade 6, 812 (21.0%) were in grade 7, 808 (20.9%) were in grade 8, 750 (19.4%) were in grade 9, and 576 (14.9%) were in grade 10 (2 students did not complete the question). Finally, of the survey responses that were not included in the hierarchical models, 143 (7.8%) reported a below average RAF, 1,038 (31.9%) reported an average RAF and 1,455 (44.4%) reported an above average RAF (615 students did not complete the survey question).

**Table 3**

*Table showing results from the nested hierarchical modeling using the different levels of predictors of adolescent cigarette smoking and the goodness of fit of each model (unweighted n =19,636).*

| *Variable* | *Hierarchical Model* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Model 1 (socio-demographics) OR (95%CI) | p-value | Model 2 (Model 1 + Other Individual Factors) OR (95%CI) | p-value | Model 3 (Model 2 + Interpersonal Factors OR (95%CI) | p-value | Model 4 (Model 3 + Other Contextual Factors) OR (95%CI) | p-value |
| ***Grade**6-10* | 1.7 (1.6-1.8) | <0.001 | 1.1 (1.0-1.2) | 0.210 | 1.1 (1.0-1.2) | 0.195 | 1.1 (1.0-1.2) | 0.155 |
| ***Gender*** | | | | | | | | |
| *Cis-boys* | Ref | | Ref | | Ref | | Ref | |
| *Gender-diverse* | 1.6 (1.2-2.3) | 0.005 | 1.1 (0.7-1.7) | 0.781 | 0.9 (0.6-1.5) | 0.753 | 0.9 (0.5-1.4) | 0.528 |
| *Cis-girls* | 1.2 (0.9-1.4) | 0.108 | 0.6 (0.5-0.7) | <0.001 | 0.5 (0.4-0.7) | <0.001 | 0.5 (0.4-0.6) | <0.001 |
| ***Relative Family Affluence*** | | | | | | | | |
| *Below Average* | Ref | | Ref | | Ref | | Ref | |
| *Average* | 0.5 (0.4-0.7) | <0.001 | 0.6 (0.5-0.9) | 0.011 | 0.6 (0.5-0.9) | 0.011 | 0.6 (0.5-0.9) | 0.012 |
| *Above Average* | 0.3 (0.2-0.4) | <0.001 | 0.5 (0.4-0.7) | <0.001 | 0.5 (0.4-0.8) | <0.001 | 0.6 (0.4-0.8) | 0.001 |
| ***Vaping Status*** | | | | | | | | |
| *Never Vaped* | | | Ref | | Ref | | Ref | |
| *Ever Vaped* | | | 28.2 (21.1-37.7) | <0.001 | 27.5 (20.6-36.8) | <0.001 | 26.3 (19.7-35.1) | <0.001 |
| ***Alcohol Status*** | | | | | | | | |
| *Never drank alcohol* | | | Ref | | Ref | | Ref | |
| *Ever drank alcohol* | | | 4.9 (3.5-6.7) | <0.001 | 4.8 (3.5-6.7) | <0.001 | 4.7 (3.4-6.5) | <0.001 |
| ***Physical Activity*** | | | 0.9 (0.9-1.0) | 0.024 | 0.9 (0.9-1.0) | 0.020 | 0.9 (0.9-1.0) | 0.053 |
| ***Mental Wellbeing (Life Satisfaction)*** | | | | | | | | |
| *High* | | | Ref | | Ref | | Ref | |
| *Moderate* | | | 1.4 (1.0-1.9) | 0.019 | 1.4 (1.0-1.8) | 0.042 | 1.2 (0.9-1.6) | 0.210 |
| *Low* | | | 1.9 (1.4-2.6) | <0.001 | 1.7 (1.2-2.4) | 0.001 | 1.3 (0.9-1.8) | 0.138 |
| ***Family Support (1-7)*** | | | | | 0.9 (0.8-0.9) | <0.001 | 0.9 (0.8-1.0) | 0.002 |
| ***Friend Support (1-7)*** | | | | | 1.1 (1.0-1.2) | 0.009 | 1.1 (1.0-1.2) | 0.002 |
| ***Teacher Support Scale (1-5)*** | | | | | | | 0.8 (0.7-0.9) | <0.001 |
| ***Classmate Support Scale (1-5)*** | | | | | | | 0.9 (0.7-1.0) | 0.056 |
| ***Neighbourhood Social Capital (1-5)*** | | | | | | | 0.9 (0.8-1.1) | 0.216 |
| ***Social Media Use*** | | | | | | | | |
| *Non-disordered* | | | | | | | Ref | |
| *Disordered* | | | | | | | 1.2 (0.9-1.6) | 0.139 |
| ***Nagelkerke (model goodness of fit)*** | 0.128 | | 0.529 | | 0.534 | | 0.542 | |

*Note*. OR=odds ratio, CI=confidence interval. All models are adjusted for race/ethnicity.

In Model 1 (sociodemographic model), grade (OR=1.7; CI=1.6-1.8, p<.001) was a significant predictor of cigarette smoking (p<0.05). Being gender-diverse (OR=1.6;

CI=1.2-2.3, p=0.005) compared to cis-boys, was also a significant predictor. Having higher relative family affluence (above average: OR=0.3; CI=0.2-0.4, p<0.001, average: OR=0.5; CI=0.4-0.7, p<0.001, compared to below average) was associated with significantly lower risk of cigarette smoking. The Negelkerke's R-squared was 0.128 for this model.

In Model 2, other individual factors (other substance use, physical activity and overall life satisfaction) were added into the hierarchical model. When adjusting for the sociodemographic factors, all the newly added individual-level factors had significant associations with cigarette smoking. Adolescents who do (or had) vaped (OR=28.2, CI=21.1-37.7, p<0.001), who drank alcohol (OR=4.9; CI=3.5-6.7, p<0.001) and who had *low* (OR=1.9; CI=1.4-2.6, p<0.001) or *moderate* (OR=1.4; CI=1.0-1.9, p=0.019) compared to *high* mental wellness, were significantly more likely to try cigarette smoking. Both physical activity (OR= 0.9; CI=0.9-1.0, p=0.024) and *average* (OR=0.6; CI=0.5-0.9, p=0.011) or *above average* (OR=0.5; CI=0.4-0.7, p<0.001) relative family affluence were protective and were significantly associated with lower odds of starting cigarette smoking. From Model 1, there were no longer any significant associations between grade (although the direction stayed the same) and cigarette smoking and ethnicity were no longer significantly related either; all became non-significant (p >0.05) in the adjusted models. Being a cis-girl compared to cis-boy was now a significant predictor of lower likelihood of cigarette smoking (OR=0.6; CI=0.5-0.7, p<0.001), but being gender-diverse became insignificant as a predictor. The Nagelkerke's R-squared value for goodness of fit increased substantially from 0.128 to 0.529 for this model.

In Model 3, interpersonal factors (family support and friend support) were added into the hierarchical model, adjusting for sociodemographic and other individual factors. Both family and friend support were significantly related to cigarette smoking in this model. Family support was a predictor of lower odds of trying cigarette smoking (OR=0.9; CI=0.8-0.9, p<0.001), while friend support was a risk factor (OR=1.1; CI=1.0-1.2, p=0.009) in the adjusted model. All other predictors which were significant in Model 2 remained significant predictors in Model 3. The Nagelkerke's R-squared values only increased from 0.529 to 0.534, indicating that although the model improved this was not to the same magnitude as between Models 1 and 2.

In the fully adjusted model (Model 4), contextual factors (teacher support, classmate support, neighbourhood social capital, and social media use) were added. When adjusting for all factors, only teacher support was a significant predictor of lower risk of cigarette use (OR=0.8; CI=0.7-0.9, p<0.001). While classmate support did not turn out to be a significant factor in cigarette smoking, the p-value of p=0.056 was just above the threshold for being a significant protective factor. In the fully adjusted model, vaping (OR=26.3; CI=19.7-35.1, p<0.001) and alcohol use (OR=4.7; CI=3.4-6.5, p<0.001) remained significant predictors of cigarette smoking. Friend support (OR= 1.1; CI=1.0-1.2, p=0.002) also remained a significant risk factor, as per Model 3. As well, being a cis-girl (OR=0.5; CI=0.4-0.6, p<0.001) compared to cis-boy and having *average* (OR=0.6; CI=0.5-0.9, p=0.012) or *above average* (OR=0.6; CI=0.4-0.8, p=0.001) relative family affluence were significant predictors of lower risk of cigarette smoking in the fully adjusted model. Family support (OR=0.9; CI= 0.8-1.0, p=0.002) was also still a significant protective factor. Having *low* or *moderate* mental wellbeing was no longer

significant in this final model. Physical activity level was still protective but no longer significant, though it was also just above the threshold for significance with a p-value of p=0.053. The Nagelkerke's R-squared value showed only a slight increase from 0.534 to 0.542. This indicates that the fit did improve in the final fully adjusted model.

## Chapter 7. Discussion & Conclusion

Decades of research has documented the harmful health effects of cigarette smoking. Surveys conducted on Canadian adolescents reveal that the rates of those who are trying cigarette smoking have declined from 20% to 16-17% (Health Canada, 2025) over the last decade, with studies reporting rates as low as 10% (*Tobacco Use in Canada*, n.d.). This study looked at a large national sample of adolescents who were included in the HBSC survey in the years 2022-2023 and used hierarchical modelling to explore some of the predictors and protective factors for having ever tried cigarette smoking which are discussed below. Findings from this analysis show that for adolescents in grades 6-10 the 2022/23 rate of having ever smoked is 7.5% with 95% confidence intervals at 7.2% to 7.8%, indicating that leveling off of cigarette smoking rates is continuing among Canadian adolescents and that a slight decline may even be present. Trend studies are needed to examine this in more detail.

With research showing the pervasive nature of alternative nicotine delivery systems in today's society, and still little known about the long-term effects, much attention has shifted away from exploring contemporary predictors of cigarette smoking. However, it is important to remain focused on this group of Canadian adolescents who are smoking cigarettes, despite the decreased prevalence. Further, this is a unique group of adolescents who have grown up through COVID-19 which included extensive school closures, online schooling and significant physical distancing and social isolation. Post-COVID data may differ from the risk and protective factors from past studies. Despite the increased popularity of alternative nicotine products and the experience of COVID-

19, we see little movement in terms of cigarette smoking rates compared to previous estimates.

## Risk and Protective Factors for Cigarette Smoking

### *Sociodemographic Variables*

Sociodemographic factors including age, gender, ethnicity and relative family affluence have all been shown to be associated with adolescent smoking (East et al., 2021; Kim & Chun, 2018; Seo & Chang, 2022; Strong et al., 2015). The World Health Organization has defined the social determinants of health – the conditions under which people are born, grow, work, live and age – and the inequalities that are associated with these (WHO, n.d.). Many sociodemographic factors, including gender, socioeconomic status and ethnicity would be included in these determinants, and can positively or negatively influence an individual's health equity. The results of bivariate analyses showed that being a cis-girl or gender-diverse (compared to cis-boy) was associated with higher odds of cigarette smoking. Some adolescent smoking studies which reported on sex (as opposed to gender) have reported slightly different findings where males are more likely to be cigarette smokers than females (Cole et al., 2021; Dai et al., 2023), though some report no difference by sex (Mejia et al., 2023). This indicates that previously identified gender gaps in substance use (where boys tended to be at greater risk of substance use than girls) is closing. This has been found in other substances, such as alcohol use (Charrier et al., 2024). However, in the hierarchical modelling, the results from this study were more complex; specifically, being a girl was protective when other individual factors were added in (Model 2). The odds ratio for gender-diverse adolescents also started out higher than for cis-boys (Model 1) and was significant but

later became non-significant when adding interpersonal and contextual factors. This could mean that looking at gender in isolation is not necessarily capturing the bigger picture when talking about risk of becoming a cigarette smoking. It's an important piece of the larger puzzle, but other factors (such as social and familial relationships or other substance use) could also be at play when talking about gender differences.

Increasing grade was also a predictor of cigarette smoking in both the bivariate and hierarchical modeling analyses, though only significant in the bivariate analysis and Model 1. This is consistent with findings from two other large surveys looking at adolescent cigarette smoking in grades 9-12 (Cole et al., 2021; Mejia et al., 2023). Both of these studies also found that smoking was less common among grade 9 students, and most common among grade 12 students. Where our study included even younger students (Grade 6), this supports the idea that the risk of starting cigarette smoking increases with age in a continuous manner and is less common in adolescents younger than Grade 9. The CSTAD surveys have shown significant increases in ever-smoked adolescents with age – from 9% of students in grades 7-9 up to 29% of students in grades 10-12 in 2018/2019 (Health Canada, 2022). Since our survey data only captured adolescents up and including grade 10, it's possible that we are still only seeing the early stages of adolescents who will ever try cigarette smoking. This may also be why their contemporary ever-smoked rates (17% in 2023/24) are slightly higher than the rates from this study (Health Canada, 2025). Extending the survey age to capture students in grades 11 and 12 might shed some more light on this trend of increasing risk for trying cigarette smoking with age.

Findings showed that both average and above average family affluence were associated with significantly lower odds of cigarette smoking in both the bivariate and hierarchical modelling. This variable remained a significant protective factor in all models, even when adjusting for all other variables. In a similar study to this one, hierarchical modelling was applied to HBSC data from the United States, which demonstrated that relative family affluence was associated with lower risk of adolescent cigarette smoking (Kim & Chun, 2018). Indicating that those that self-perceived their family affluence as low are at increased risk and may therefore warrant further study for what type of prevention approaches work best with this group.

***Other Individual-Level Variables***

After adjusting for sociodemographic factors, other individual-level factors generally known to be associated with cigarette smoking were observed. Vaping and alcohol use were found to be significant predictors of cigarette smoking in adolescents. The link between having tried cigarette smoking and vaping has been well-documented among adolescents (Azagba et al., 2019; Farsalinos et al., 2018; Warner, 2016). Although vaping rates are on the rise, a study involving repeated cross-sectional surveys in Canada, England and the US of adolescents aged 16-19 found that rates of both vaping and smoking had increased in Canada between 2017 and 2018 (Hammond et al., 2019). They identify that vaping cannot be replacing cigarette smoking if the rates are continuing to increase, but if the two increases were directly related, they would have expected to see the same increases in cigarette smoking in England and the US, which was not the case.

In our study, vaping was the factor with the highest odds ratio of all the predictor variables. The relationship between cigarette smoking and vaping in Canadian

adolescents is complex and requires further investigation. Rather than completely shifting the focus from cigarette smoking to vaping and alternative methods of nicotine delivery, there should be a combined effort to create prevention strategies that can address both cigarette smoking and vaping in adolescents. In terms of alcohol consumption, a systematic review that looked at cigarette smoking in adolescents revealed a consistent association between alcohol consumption and cigarette smoking (Ahun et al., 2020). Our study also indicates that those who ever consumed alcohol were at a significantly higher risk of cigarette smoking. Our findings are in line with past research that finds a link between cigarette smoking and other substance use, indicating that substance use behaviors in adolescents can cluster. This puts adolescents who use cigarettes as well as other substances at an increased risk of harms. Overall, a key finding was that vaping and alcohol use greatly increased the odds of cigarette use. This could be due to common factors associated with multiple substance use types such as risk taking, coping mechanisms, peer pressure and stress (Alhammad et al., 2022).

The study findings related to physical activity were consistent with findings in the literature. In both our bivariate and hierarchical modelling analyses, physical activity was protective with respect to cigarette smoking and was significant in all models except for the fully adjusted model (though even then, it was just above the significance threshold). This is consistent with findings from a longitudinal study that looked at cigarette smoking and physical activity in Canadian adolescents in grades 9-12 and found that cigarette smoking was associated with low participation in sport, and that smoking cessation was associated with increased physical activity (Irvine et al., 2022). This could suggest that that cultural views within competitive sports and the perceived status of

athletes may play a role in cigarette smoking being seen as less acceptable, particularly in some sports more so than others (Veliz et al., 2017). For example, individuals involved in non-contact sports have been shown to engage in cigarette smoking less frequently than those in contact sports (Veliz et al., 2015). This might relate to the perceived risk associated with contact sports, and individuals who are involved may be more likely to engage in other *risky* behaviours as well.

Low and moderate wellbeing (compared to high wellbeing) was also a risk factor for cigarette smoking, and was significant until the final, fully adjusted model that included the addition of contextual factors. This is consistent with findings from another hierarchical study looking at cigarette smoking in 9- and 10-years old in the US (Dai et al., 2023). The authors suggest that some interactions between some of the emotional (mental wellness, friends, family support) and environmental (school, neighbourhood) factors could explain why this variable is not significant after the addition of environmental variables. For example, it is possible that school (teacher and classmate) support, and positive influences from the surrounding environment (neighbourhood and/or digital environments) could mediate some of the influences from low self-reported wellbeing. Adolescent wellbeing has been shown to be heavily influenced by relationships, including personal, societal and environmental (Ross et al., 2020) so it is not surprising to see these so closely linked. It is unclear whether there is a causal relationship, and whether the relationship is directional (i.e., smoking leads to mental illness or vice versa) or bidirectional. It may be possible that associations could potentially be a result of other shared genetic and environmental factors as well (Boden et al., 2010). Considering this, these relationships warrant further investigation.

### *Interpersonal-Level Variables*

In this study family support was a significant protective factor for cigarette smoking. These findings add to the evidence on family and friend support as predictors for adolescent smoking. Previous studies looking at psychosocial predictors in US adolescents found parental monitoring has a protective relationship with cigarette smoking in 9- and 10-year-olds (Dai et al., 2023). This same study also found that family support may have even moderated some of the risk to adolescents associated with poor neighbourhood safety. Taken together it seems that family environment can be protective for cigarette smoking among adolescents and may even outweigh some other risk factors when looked at in combination.

Friend support was found to be a significant risk factor for cigarette smoking in this study. However, a study from Greenland found that adolescents with higher levels of social support had lower rates of smoking (Hansen et al., 2020), which contradicts our results. One explanation could be that adolescents in our study who had friends that had tried cigarette smoking might have also been more at risk of trying cigarette smoking, which has been reported in the literature previously (Kim & Chun, 2018). Adolescence is a time of significant development, and a time when individuals may be heavily influenced by external relationships (Ross et al., 2020). Though this could be a contributing risk factor in our findings, this could potentially also be leveraged in targeting peer groups for smoking prevention. Peer interventions are more impactful than individual interventions, including increased awareness and greater reported intent to quit cigarette smoking (Mejia et al., 2023).

### *Context-Level Variables*

Higher perceived classmate and teacher support were protective factors in the bivariate and fully adjusted models, although only teacher support was significant in fully adjusted model. Classmate support was just above the significance threshold. These findings are consistent with two other hierarchical studies which reported similar results with favorable school environments, as measured by the 6-item School Environment subscale, being associated with lower susceptibility to smoking (Dai et al., 2023) and negative school climate, as measured by poor peer relationships, low school attachment and perceived emphasis on academic performance from the teacher being associated with a higher prevalence of adolescents trying cigarettes (Kim & Chun, 2018). This highlights the important role that the school environment and specifically a positive teacher influence may have on adolescents with respect to cigarette smoking. This could be leveraged when looking at supporting teachers in how to engage with their students and build meaningful relationships. For example, the Icelandic Prevention Model, which has been successful in dramatically reducing rates of adolescent substance use in Iceland, involves (in part) investing in and strengthening protective factors in schools and communities including local-level school meetings and poster campaigns (Sigfusdottir et al., 2011). This campaign aims to build up positive aspects in the whole school and community, rather than specifically targeting “negative” behaviours. Since a significant portion of adolescents’ time is spent in school, it could play a critical role in influencing behaviours such a cigarette smoking.

Neighbourhood social capital was protective in the bivariate aspect of this study but not in the fully adjusted models, which is inconsistent with a hierarchical modelling study looking at cigarette smoking among adolescents in the US (Dai et al., 2023), which

found that perceived neighbourhood safety (measured by parents) was significantly associated with lower rates of smoking susceptibility among males, though not significant for females. Further, this study found that disordered social media use was a risk factor for cigarette smoking in bivariate analysis, which was also supported by the findings of a large meta-analysis of cross-sectional studies which reported that increased social media use was a risk factor for substance use (Vannucci et al., 2020). Although both contextual factors were significant in the bivariate models, neither of them was significant in adjusted hierarchical models. This likely means that, individually, they may have a stronger relationship to cigarette smoking, but when adjusting for other variables, the influence they have on the larger model lessens. From this, it could be inferred that efforts to address cigarette smoking in adolescents would be more effective elsewhere for the time being. It could also be that the interpersonal and modifiable individual factors explain some of the association between social media and neighbourhood social capital, therefore future models that look at mechanisms underlying these potential mediators are warranted.

**Limitations**

There are some limitations in this study that should be noted. Knowing that substance use is a strong predictor of cigarette smoking, we had hoped to include cannabis use as a predictor, especially since its relatively recent legalization in Canada and becoming more socially acceptable among adults and adolescents. Unfortunately, the survey question relating to marijuana use was only included in the survey for Grades 9 and 10 (not Grades 6, 7 and 8) so there was a significant amount of missing data, and therefore it was not possible to include it in the present analysis which included all

grades. In addition to missing data related to cannabis use, the survey did not collect or include any data from New Brunswick or Nunavut either. As a result, it is not possible to infer that the results are representative of these two areas of Canada. This study also used data from the HBSC survey, and there are limitations associated with use of secondary data and cross-sectional study design. For one, the researcher using the secondary data cannot go back and change survey questions to collect more or different data, and it is common for responses to be missing or incomplete (Cheng & Phillips, 2014). Since cross-sectional data represents just one moment in time, it is not possible to make any causal inferences based on the results (Wang & Cheng, 2020). These types of surveys rely on self-reported behaviour data, which is susceptible to social-desirability biases, particularly in younger respondents (Dai et al., 2023). However, the impact of this was likely low due to the anonymous nature of the survey, which would minimize this risk. Further, test and retest reliability related to self-reported tobacco use is high indicating good validity for self-reported cigarette smoking (Brener et al., 2003).

**Strengths & Contributions to the Literature**

There is limited contemporary (post-COVID) Canadian research looking at a large group of known predictors of adolescent cigarette smoking in a representative sample. I analyzed secondary data to add to the Canadian body of research looking at post-pandemic trends, risk and protective factors of adolescent cigarette smoking. This study highlights the importance of utilizing secondary data to explore adolescent smoking trends in Canada, especially in the context of post-pandemic changes. By leveraging existing datasets like the HBSC survey, researchers can gain insights without the extensive resources required for primary data collection, making it an efficient

approach for understanding public health issues. As well, for large population studies like the HBSC survey, there are large teams of professionals working on data cleaning, survey weights and design variables, which means that the data are accessible to teams who might not otherwise have access to the funding needed to conduct these surveys (Cheng & Phillips, 2014). The HBSC study is a large, validated and widely recognized dataset which gives a representative sample for Canada, including different provinces, communities, ethnicities and physical and social environments.

This is a contemporary study which created a "profile" of adolescent cigarette smokers in Canada and is novel in that it took a holistic approach, considering a wide range of psychosocial predictors of cigarette smoking, from demographic to interpersonal and contextual. Previous studies have looked at a portion of these, but this study extends the current literature in a more complete way. In another study that used a similar research methodology, Dai et al. (2023) noted that there has been very limited research assessing the incremental effects of different factors influencing the lives of adolescents in the context of vulnerability to starting smoking. Applying Bronfenbrenner's bioecological model to this question to systematically analyze changes in the likelihood of starting cigarette smoking will strengthen the literature on this topic and create a more complete overview of this group of individuals. Hierarchical models have been created for other countries (Dai et al., 2023; Kim & Chun, 2018), but this study helps to strengthen the body of research specific to Canadian adolescents and cigarette smoking. Use of hierarchical modeling allows for a more nuanced understanding of the factors influencing adolescent smoking behavior in Canada, and for a more direct comparison to similar studies from other countries. This systematic and sequential approach revealed

some interesting relationships between predictors which suggests opportunities for further research to explore relationships in more detail. Identifying and understanding the relationships that exist between predictor variables could also be a key to future smoking prevention campaigns and education and may help to increase the efficacy of these efforts.

This study provides a novel snapshot of cigarette use among the cohort of adolescents who were impacted by the COVID-19 pandemic in Canada. This is the first HBSC survey round to take place since the start of the pandemic. These results may provide the first glimpse into shifts and trends that could begin to emerge within this group as a result of the pandemic. The findings of this study provide important information about adolescent behaviors, specifically regarding smoking, in response to the pandemic's social and environmental changes. The findings may also offer a baseline for future research on how COVID-19 has influenced youth health behaviors.

It will be important to continue to monitor adolescent smoking trends in Canada, and to keep the focus on this issue. Smoking is so closely intertwined with other substance use; it is important that it does not fall off the radar in favor of research looking at new or upcoming adolescent substance use issues. The approach should be broad and include a multifactorial approach to prevention in adolescents.

**Implications for Future Research**

This study provides some interesting information which lends itself to further research in a number of different areas. Firstly, it remains important to continue to collect data and monitor trends related to adolescent smoking in Canada. Although we know the rates of cigarette smoking have declined slightly in this population, this study reports an

ever-smoked rate of 7.5%, which is consistent, if slightly lower than the Canadian trend over the last 5-10 years (Health Canada, 2022), indicating a leveling off. Given the known health implications of cigarettes, and that smoking often begins in adolescence (CDCTobaccoFree, 2023), it will be important to continue to monitor this trend as the landscape in which adolescents are developing is changing. For example, there is some indication that the social context of smoking may be shifting again, and that celebrities are glamorising smoking once more (Rufo, Y., 2024). Though smoking has been less culturally accepted than decades ago, a new rise of "cigfluencers" may be contributing to adolescents being influenced to try cigarette smoking. Although it may be too early to know how this will impact rates of cigarette smoking in adolescents, it should be monitored.

Further research should also be focused on gender differences. The switch in directionality for cis-girls from being a risk factor to protective when including other substance use, physical activity, and mental wellbeing is curious, particularly in the context of the gender gap in substance use reducing across various substance use behaviours. Exploring potential interactions of gender with other substance use, health behaviours, and mental wellbeing could provide more insight into this observation.

Finally, future research should delve deeper into the connection between cigarette smoking and other substance use, especially with the emergence of other nicotine delivery products, such as pouches. It will be important to try to understand this relationship and determine whether there is a causal link between other nicotine product use and cigarette smoking in this population. Though vaping has been the center of much recent attention, less is known about some of the newer methods of nicotine delivery, and

limited marketing restrictions is resulting in misinformation being consumed by adolescents, including lack of clear understanding of potential risks and marketing vaping as an effective smoking cessation tool (McAlinden et al., 2020). It would also be useful to repeat this study with the next iteration of the HBSC survey to observe any differences in the predictors.

**Implications for Policy and Practice**

This study could help inform future policy and practice around targeted prevention measures to address cigarette smoking among Canadian adolescents. For example, including smoking prevention or cessation education alongside targeted vaping or alcohol consumption (or other substance use) prevention could be beneficial. Perhaps trying to address substance use using upstream approaches, rather than individual substances could be more effective, as has been done in the Icelandic Prevention Model (Sigfusdottir et al., 2011). As well, teacher support is significantly associated with adolescent cigarette smoking, so perhaps a valuable strategy could be to invest in building positive relationships within schools and fostering a positive school environment (Sigfusdottir et al., 2011). An approach that builds support between classmates could have positive impacts on adolescent cigarette smoking given the associations found in this study. The school environment could be an opportunity to foster positive interactions and relationships which could have wider benefits.

It would be timely to revisit the CPS position statement on smoking prevention in children and adolescents as well, since most of the data upon which the statement is based came from 2013 (Canadian Paediatric Society, 2022). Observing and incorporating some of the post-COVID data and trends may reveal some new insights to help guide

contemporary work. There have been significant changes since it was first written over 10 years ago, especially with respect to the nicotine delivery systems landscape and increased prevalence of social media in society. Additionally, it may be possible to learn from some of the successes and barriers of decades of cigarette smoking prevention strategies to create more impactful campaigns for cigarette smoking *and* vaping prevention in this age group.

Adolescent cigarette smoking remains a public health concern in Canada with 7.5% of survey respondents from the 2022/2023 HBSC survey reporting having ever tried cigarette smoking. This study has helped to develop a clearer picture of the psychosocial risk and protective factors associated with adolescent cigarette smoking.

In the fully adjusted hierarchical model, vaping, drinking alcohol and increased friend support were all significant risk factors for cigarette smoking. Adolescents who were cis girls, reported average or above average family affluence, and reported higher family and teacher support were at significantly lower odds of cigarette smoking. Increased physical activity and higher classmate support were also just on the threshold for being significant protective factors. Future research can build off these findings to examine gender differences and the connection between cigarette smoking and other substance use. Continued monitoring of adolescent cigarette smoking trends in Canada will be critical, especially in the face of another potential shift in the social context and social acceptability of cigarette smoking. There are also implications for policy and practice to address this group of adolescent cigarette smokers and to learn from the successes and challenges of decades of smoking prevention campaigns.

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## Appendix A: Research ethics board waiver

Claire,

As the survey data was originally collected anonymously and you will not be gathering any further primary data/information, then your project would qualify for exemption under Article 2.4 as you are not proposing to link the data in a way that would or could generate identifiable information.

You may read Article 2.4 here: Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans – TCPS 2 (2022) – Chapter 2: Scope and Approach (ethics.gc.ca)

I will proceed to issue a memorandum of exemption to you through the research portal.

Thanks. Best wishes with your project.

Gail

**Gail Leicht** (she/her)
Research Ethics Officer
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Athabasca University respectfully acknowledges that we live and work on the traditional lands of the Indigenous Peoples (Inuit, First Nations, Métis) of Canada. We honour the ancestry, heritage, and gifts of the Indigenous Peoples and give thanks to them

## Appendix B: Composite items from the HBSC survey used for the analysis

### B1. Composite Items: Family Support Scale

1. My family really tries to help me.
2. I get the emotional help and support I need from my family.
3. I can talk about my problems with my family.
4. My family is willing to help me make decisions.

*Available responses to each question: Scale of 1 (Very Strongly disagree) to 7 (Very Strongly Agree)*

### B2. Composite Items: Friend Support Scale

1. My friends really try to help me.
2. I can count on my friends when things go wrong.
3. I can share both my happy feelings and my sad feelings with my friends
4. I can talk about my problems with my friends.

*Available responses to each question: Scale of 1 (Very Strongly disagree) to 7 (Very Strongly Agree)*

### B3. Composite Items: Teacher Support Scale

1. I feel that my teachers accept me as I am.
2. I feel that my teachers care about me as a person.
3. I feel a lot of trust in my teachers.

*Available responses to each question: Scale of 1 (Strongly disagree) to 5 (Strongly Agree)*

**B4. Composite Items: Classmate Support Scale**

1. The students in my class(es) enjoy being together.
2. Most of the students in my class(es) are kind and helpful.
3. Other students accept me as I am.

*Available responses to each question: Scale of 1 (Strongly disagree) to 5 (Strongly Agree)*

**B5. Composite Items: Neighbourhood Social Capital**

In the area where you live…:

1. People say 'hello' and often stop to talk to each other on the street.
2. It is safe for younger children to play outside during the day.
3. You can trust people around here.
4. There are good places to spend your free time (e.g., leisure centres, parks, shops).
5. I could ask for help or a favour from neighbours.

*Available responses to each question: Scale of 1 (Strongly disagree) to 5 (Strongly Agree)*

**B6. Composite Items: Social Media Disorder Scale**

During the past year, have you…:

1. Regularly found that you can't think of anything else but the moment you will be able to use social media again?

2. Regularly felt dissatisfied because you wanted to spend more time on social media?
3. Often felt bad when you could not use social media?
4. Tried to spend less time on social media, but failed?
5. Regularly neglected other activities (e.g. hobbies, sports) because you wanted to use social media?
6. Regularly had arguments with others because of your social media use?
7. Regularly lied to your parents or friends about the amount of time you spend on social media?
8. Often used social media to escape from negative feelings?
9. Had serious conflicts with your parents, brother(s) or sister(s) because of your social media use?