PUBLIC HEALTH ENGAGEMENT IN SECONDARY SCHOOLS

THE ASSOCIATION BETWEEN PUBLIC HEALTH ENGAGEMENT IN SCHOOL-BASED SUBSTANCE USE PREVENTION PROGRAMS AND STUDENT ALCOHOL, CANNABIS, E-CIGARETTE AND CIGARETTE USE

By TRISH BURNETT, RN, BScN

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TITLE:	The association between public health engagement in school-based substance use prevention programs and student alcohol, cannabis, e-cigarette and cigarette use
AUTHOR:	Trish Burnett, RN, BScN (McMaster University)
SUPERVISOR:	Dr. Maureen Dobbins
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Lay Abstract

The purpose of this study is to determine the impact of public health unit (PHU) engagement in school-based substance use prevention programs on student substance use. Data for this study was collected from the Cannabis, Obesity, Mental health, Physical activity, Alcohol use, Smoking and Sedentary behaviour (COMPASS) study. The results show that 70% of schools had PHU engagement in substance use prevention programs. Across all schools, when PHUs and schools solved problems jointly an increase in student binge drinking, alcohol and cannabis use was found. When schools were divided into low and high-use schools, similar results were found when PHUs engaged with low-use schools whereas when PHUs engaged in high-use schools a reduced odds of student cannabis and cigarette use was found in some situations. These findings highlight the importance for PHUs to consider the specific needs and risk-levels of the students and schools they are engaging with.

Abstract

Background: Substance use can have lifelong consequences for adolescents and the rates of substance use in Canadian adolescents are increasing. This is a serious public health issue which needs to be addressed. The purpose of this study is to determine the impact of public health unit (PHU) engagement in school-based substance use prevention programs on student substance use.

Methods: Data was collected from the Cannabis, Obesity, Mental health, Physical activity, Alcohol use, Smoking and Sedentary behaviour (COMPASS) study over the 2018/19 data collection year. A multi-level logistic regression was used to analyze the associations between PHU engagement and student substance use.

Results: The analyses found that 70% of schools had PHU engagement in substance use prevention programs. Overall, PHU engagement made no difference on student substance use. However, when PHU engagement was divided into five levels of engagement (with zero being no engagement and five being the highest level of engagement) it was found that students from schools where PHUs solved problems jointly (level two) had statistically significantly greater odds of binge drinking, alcohol use and cannabis use. Schools were also divided into low and high-use schools for each substance. It was found that students in low-use schools had statistically significantly greater odds of binge drinking, alcohol and cannabis use with some levels of PHU engagement and students from high-use schools had statistically significantly lower odds of cannabis and cigarette use with some levels of PHU engagement compared to a similar student from a school without PHU engagement.

Conclusions: Our findings show that there is opportunity for greater PHU engagement with schools in substance use prevention programming. Furthermore, it is important that PHUs are working with schools to ensure school-based substance use prevention programs are evidence-based and tailored to the specific needs and risk-levels of the students.

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List of Abbreviations

AHS	Alberta Health Services
AOR	Adjusted Odds Ration
BAI	Brief Alcohol Intervention
BC	British Columbia
CASP	Critical Appraisal Skill Programme
CBD	Cannabidiol
COMPASS	Cannabis, Obesity, Mental health, Physical activity, Alcohol use, Smoking and Sedentary behaviour
CSH	Comprehensive School Health
CSTADS	Canadian Student Tobacco Alcohol and Drugs Survey
Cq	COMPASS Questionnaire
GEE	Generalized Estimating Equations
GRADE	Grades of Recommendation, Assessment, Development and Evaluation
HSP	Health School Planner
JCSH	Joint Consortium for School Health
MOHLTC	Ministry of Health and Long-Term Care
NHLBI	National Heart, Lung and Blood Institute
OR	Odds Ratio
PHAC	Public Health Agency of Canada
PHU	Public Health Unit
PPIH	Population, Public and Indigenous Health
SCNs	Strategic Clinical Networks
SES	Socio-economic Status
SFC	Smoke Free Class
SHC	School Health Coordinator
SPP	School Programs and Policies
THC	Tetrahydrocannabinol
TVPA	Tobacco and Vaping Products Act

Declaration of Academic Achievement

I, Trish Burnett, declare this thesis to be my own work. This thesis is an original synthesis of the research presented. No part of this work has been published or submitted for publication or for a higher degree at another institution.

My supervisor, Dr. Maureen Dobbins, and the members of my supervisory committee, Dr. Scott Leatherdale, Dr. Diana Sherifali and Dr. Michelle Butt, have provided guidance and support at all stages of this project.

Chapter 1

Introduction

Problem Statement

Alcohol, cannabis, e-cigarette, and cigarette use can have serious lifelong health consequences for adolescents such as lung disease, cognitive deficits and premature death (Camchong et al., 2017; Leslie, 2020; Lubman et al., 2015 & World Health Organization, 2018b). It is important to have programs in place to prevent the use of alcohol, cannabis, e-cigarettes and cigarettes among adolescents. This study will examine the relationship between public health unit (PHU) engagement in school-based alcohol, cannabis, e-cigarette and cigarette use prevention programs and alcohol, cannabis, e-cigarette and cigarette use among secondary school students in Alberta, British Columbia (BC) and Ontario.

In 2018 the Chief Public Health Officer in Canada, Dr. Theresa Tam, published a report on the state of public health in Canada (Public Health Agency of Canada, 2018). This report highlighted the need for public health to address problematic substance use in adolescents through a comprehensive public health approach. This approach involves having both, broad population-based approaches such as substance use prevention programs in schools along with more individual-focused interventions to address the specific needs of high-risk adolescents (Public Health Agency of Canada, 2018). In Canada, each province/territory is responsible for organizing and implementing public health programs and initiatives (Government of Canada, 2020a). This is accomplished through various provincial agencies which for the purposes of this paper will be referred to as PHUs. PHUs are government agencies in place to protect the health of Canadians through disease prevention and health promotion including substance use prevention (Government of Canada, 2020a).

Worldwide, alcohol contributes to three million deaths each year and alcohol misuse is responsible for over 5% of the global burden of disease (World Health Organization, 2018a). In Canada, over 23% of adolescents in grades 7 to 12 engage in binge drinking and over 44% report consuming an alcoholic beverage in the past year (CSTADS, 2019). Binge drinking in adolescents can have many serious health impacts including injury, memory loss, sexual assault, suicide, alcohol toxicity and motor vehicle accidents (Bonnie et al., 2004; Gohari et al., 2019; Public Health Agency of Canada, 2018; World Health Organization, 2018a). Furthermore, initiation of alcohol use in adolescence has been linked to future alcohol misuse (Pitkanen et al., 2005; Warner & White, 2003; Zakrajsek & Shope, 2006). Therefore, it is important to address this issue at an early age to delay and prevent the use of alcohol in adolescents.

On October 17th, 2018 cannabis was legalized in Canada. This law permits adults, 19 years or older (18 years or older in Quebec and Alberta) to possess and/or share up to 30 grams of legal dried cannabis, buy cannabis from a provincial or territorial retailer and grow up to four plants per residence (Government of Canada, 2018). Research findings on the impact of cannabis legalization on adolescent cannabis use are varied. Research from other jurisdictions have found that in some cases legalization has led to an increase in cannabis use among adolescents, even with age restrictions, while other studies have demonstrated a decrease or no change in cannabis use among adolescents (Ammerman et al., 2015; Stolzenberg et al., 2016; Wen et al., 2015). Given that there is limited evidence on the impact of legalization among adolescents in Canada, it is important to analyze and collect data on cannabis use among adolescents and examine if PHU engagement in school based prevention programing is associated with preventing and/or decreasing use.

Over the past six years, e-cigarette use by Canadian adolescents has continued to increase, yet there is little known about the long-term consequences of e-cigarette use in adolescents (Hammond et al. 2019; Richmond et al., 2018). Hammond et al. (2019) did a study comparing e-cigarette use in adolescents from Canada, the United States and England. The authors found that past 30-day e-cigarette use among adolescents aged 16-19 years increased by six percentage points between 2017 and 2018, a higher increase than both the United States and England. Furthermore, there has been an increasing number of reported cases of severe pulmonary disease related to using e-cigarettes to smoke cannabis (US Centers for Disease Control and Prevention, 2019). Research has also found that adolescents who use e-cigarettes are at a higher risk of subsequent smoking (Hammond et al., 2019). With the rising popularity of e-cigarettes, the unknown health consequences, and the association with cigarette smoking, it is important to monitor e-cigarette use and the effectiveness of prevention programing.

Tobacco use is the leading cause of preventable premature death around the world (World Health Organization, 2019). Cigarette smoking has decreased steadily for several decades, yet over the past few years research has shown a leveling off in tobacco use reduction, and even increases in some populations of adolescents. Research by Hammond et al. (2019) found an increase of 4.8 percentage points in adolescent past 30-day cigarette use in Canada between 2017 to 2018. This data is concerning as tobacco has multiple negative long-term health consequences for adolescents including an increased risk of cancer, addiction, an increased risk of continued use into adulthood, and an increased likelihood of other risky behavior such as drug and alcohol use (World Health Organization, 2019). This increasing rate of cigarette use is a public health concern and warrants close monitoring and action to reverse this trend.

Habits related to substance use during adolescence can have a lasting impact on the future health and substance use of adolescents. This study will provide a better understanding of the relationship between PHU engagement in school-based prevention programing and adolescent alcohol, cannabis, e-cigarette and cigarette use. The information gained through this study may then be used to inform future programing and guide the role of PHUs in secondary schools related to alcohol, cannabis, e-cigarette and cigarette use. Reducing adolescent alcohol, cannabis, e-cigarette and cigarette use will provide a lifelong positive influence on the health and wellbeing of adolescents.

Background

In this section the terminology used for the study will first be defined. Next, the prevalence of adolescent alcohol, cannabis, e-cigarette and cigarette use will be presented followed by the health impact of these substances. This section will conclude with a description of how public health is organized in each of the three Canadian provinces included in this study.

Terminology

Terms used in surveys and research around substance use are changing as regulations and availability of different substances in different forms are introduced. Therefore, it is important to clearly identify what is meant by the terms used in this study. For the purposes of this study, *alcohol use* will be defined as the consumption of any form of alcoholic beverage: beer, wine or spirits. *Binge drinking* will be defined as consuming five or more drinks of alcohol on one occasion. *Cannabis use* will refer to any form of cannabis use including smoking, edibles, e-cigarettes and dabbing. *E-cigarettes* will refer to an electronic device used to smoke e-juice. For the purposes of this paper the terms e-cigarette use and vaping will be synonymous. The 2018/19 Canadian Student Tobacco Alcohol and Drugs Survey (CSTADS) was the first-year data was

collected separating e-cigarettes with or without nicotine (CSTADS, 2019). However, the data collected for this study and the majority of research on e-cigarette use to date does not differentiate between e-cigarettes with or without nicotine therefore, the term e-cigarette use (or vaping) in this study will refer to an electronic device used to smoke e-juice which does not contain tobacco and may or may not contain nicotine. *Cigarettes* will refer to traditional cigarettes/smoking cigarettes which do contain tobacco and nicotine. While tobacco can be found in other products used by adolescents, for the purposes of this study tobacco use will refer to tobacco from cigarette use. Finally, the term PHU will be used in this study to refer to any public health unit, agency, authority or service in Alberta, BC and Ontario.

Prevalence

In this section of the thesis the prevalence and trends in Canadian adolescent alcohol, cannabis, e-cigarette and cigarette use will be presented. First, a brief overview of the CSTADS will be discussed. Next the provincial rates of student alcohol, cannabis, e-cigarette and cigarette use from the CSTADS will be discussed for Alberta, BC and Ontario. Finally, the adolescent prevalence rates of each substance (alcohol, cannabis, e-cigarettes and cigarettes) from the CSTADS as well as other Canadian studies, including the Cannabis, Obesity, Mental health, Physical activity, Alcohol use, Smoking and Sedentary behaviour (COMPASS) study, will be summarized. The CSTADS offers an accurate overall picture of Canadian student substance use while the smaller studies provide insights into the reasons behind the changing trends in adolescent substance use and provide information comparing Canadian adolescent substance use to other countries.

CSTADS

CSTADS is a biennial cross-sectional survey completed in nine Canadian provinces. This survey collects data from Canadian students on tobacco, alcohol and drug use as well as bullying, mental health and school connectedness. The survey uses three different types of consent protocols determined by the school board and school. First, an active parental permission procedure in which the parent of the student is sent an information letter and permission form to fill out online or to be returned to the school as a hard copy. Second, active information-passive permission method. This method involves sending an information letter home to the parent. If the parent chooses to have the student not participate in the study, they must contact the project staff. Third, student consent, if the student is of a certain age determined by the school/school board they can consent to participate. All students at any time can choose to withdraw. The most recent available survey was conducted from October 2018 to June 2019 and included 62,850 students in grades 7 to 12 attending private, public and Catholic schools. In earlier surveys grade 6 was also included (2014/15). Summary tables based on the data collected from this survey are available from the Government of Canada website (https://www.canada.ca/en/health-canada/services/canadian-student-tobacco-alcohol-drugs-survey.html). These tables display the data based on individual grades or in grade groupings (grades 7 to 12, grades 7 to 9 and grades 10 to 12) for all of Canada and by province/territory.

CSTADS by Province

This study used data collected from Alberta, BC and Ontario therefore data from the CSTADS specific to these provinces will be presented (see Appendix A). In each province, from 2016/17 to 2018/19, the rates of students reporting past 12-month cannabis use, past 30-day e-cigarette use and past 30-day cigarette use have all increased in grades 7-12 students (CSTADS,

2015; CSTADS, 2017; CSTADS, 2019). In BC, past 12-month alcohol use rates increased from 37.7% to 50.2% between 2016/17 and 2018/19 whereas past 12-month alcohol use rates in students from grades 7 to 12 decreased in Alberta and Ontario (CSTADS, 2015; CSTADS, 2017; CSTADS, 2019). Past 30-day e-cigarette use rates in students from grades 7 to 12 have more than doubled from 2016/17 to 2018/19 in both BC and Ontario and have increased in Alberta, but not to the same extent (see Appendix A). Past 30-day cigarette use decreased from 2014/15 to 2016/17 in grade 7 to 12 students but increased from 2016/17 to 2018/19 in each province. BC reported a twofold increase in 30-day cigarette use in students from grades 7 to 12 during this time, which was the greatest increase of the three provinces (CSTADS, 2017; CSTADS, 2019).

Alcohol Use Prevalence

Based on the CSTADS, past 12-month alcohol use and binge drinking has remained relatively unchanged from 2014/15 to 2018/19 among Canadian students from grades 7 to 12 (CSTADS, 2015; CSTADS, 2017; CSTADS, 2019). However, it is still reported that in Canada 63.5% of students in grades 10 to 12 have tried alcohol and 38.5% have engaged in binge drinking in the past 12-months. Similarly, using data collected from the ongoing Canadian longitudinal study, the COMPASS study, Holligan et al. (2020) found current alcohol use among students in grades 9 to 12 ranged from 52% to 58% and current binge drinking among grade 9 to 12 students ranged between 34% to 41% between 2012/13 and 2017/18. The authors also found that both current cannabis use and current smoking were associated with a 4.5-fold and 2-fold increase in likelihood of current alcohol use versus never use, respectively. Furthermore, current cannabis use and current smoking were also associated with a 4-fold and 2.5-fold increase in likelihood of current binge drinking versus never binge drinking, respectively (Holligan et al.,

2020). With the increasing trends in cannabis use and smoking rates among adolescents in Canada it is particularly important to monitor any changes in alcohol use prevalence.

Cannabis Use Prevalence

Past 12-month cannabis use among grade 7 to 12 students decreased from 2008 to 2017. In 2008/09 the CSTADS reported that 27.3% of grade 7 to 12 Canadian students used cannabis in the past 12-months; this decreased to 21.2%, 19.3% and 16.5% in 2010/11, 2012/13 and 2014/15, respectively (CSTADS, 2017; Leos-Toro et al., 2018). However, this trend reversed in 2017 with the announcement that cannabis would become legal in October 2018 in Canada. In 2018/19 past 12-month cannabis use in students from grades 7 to 12 increased to 18.1% and to 29.4% of grade 10 to 12 students (CSTADS, 2019) (see Appendix A). Using data from the COMPASS study, Zuckermann et al. (2019) looked at cannabis use in Alberta and Ontario secondary school students and found 12-month cannabis use increased from 24% to 27.5% between 2015/16 to 2017/18. It is suggested that when the legalization of cannabis was announced the public perception of cannabis changed. Occasional use of cannabis has become socially acceptable and this pro-cannabis messaging is associated with the increase in adolescent cannabis use (Järvinen & Demant, 2011; McKiernan & Fleming, 2017; Roditis et al., 2016; Zuckermann et al., 2019). This increase in use and possible change in perception warrants close monitoring of prevalence and prevention programs.

E-cigarette Use Prevalence

In 2014/15 only 5.7% of grade 7 to 12 students reported using an e-cigarette in the past 30-days; this increased to 10% in 2016/17 and doubled to 20.2% in 2018/19. Grade 10 to 12 students had an even higher rate and greater increase in past 30-day e-cigarette use rising from 8.9% to 29.4% between 2014/15 and 2018/19 (CSTADS, 2015; CSTADS, 2017; CSTADS,

2019) (see Appendix A). Hammond et al. (2019) measured the prevalence of e-cigarette use in adolescents in 2017 and 2018 from Canada, the United States and England. The authors found the largest increase in past 30-day e-cigarette use by adolescents aged 16 to 19 years in Canada with a 6% increase. In the United States the authors found a 5% increase and no increase in use was found in England (Hammond et al., 2019). Research into adolescent perceptions of e-cigarettes have found that many adolescents do not recognize that e-cigarettes still contain harmful chemicals similar to traditional cigarettes and that e-cigarettes may contain nicotine. Adolescents therefore do not recognize the potential harm and addictive properties of e-cigarettes, increasing their risk of harm (Amrock et al., 2016; Gorukanti et al., 2017; Walley et al., 2019). It is important to monitor e-cigarette use and the programs in place to educate adolescents on the dangers of e-cigarette use.

Cigarette Use Prevalence

Cigarette use rates have been steadily decreasing in Canada according to the CSDATS. However, the most recent data from the CSDATS illustrates that this trend is reversing. Past 30-day cigarette use in students from grades 7 to 12 decreased from 6.2% to 3.2% in 2014/15 to 2016/17 but in 2018/19 increased to 5.4% (CSTADS, 2015; CSTADS, 2017; CSTADS, 2019) (see Appendix A). Hammond et al. (2019) also looked at the change in the prevalence of cigarette smoking among adolescents in Canada, the United States and England in 2017 and 2018. Similar to the national findings from the CSDATS, the authors found that the percentage of adolescents reporting past 30-day cigarette use had increased by 4.8 percentage points (from 10.7% to 15.5%) between 2017 and 2018. Whereas in England and the United States, the percentage of adolescents reporting past 30-day cigarette use only increased by 0.8 percentage points (from 15.6% to 16.4%) and 1.2 percentage points (from 11% to 12.2%), respectively

(Hammond et al., 2019). In addition, when the authors performed a logistic regression analysis on the changes in prevalence of cigarette use from 2017 to 2018 adjusting for age, sex and ethnicity, Canada was the only country that demonstrated statistically significant results for past 30-day cigarette use (*AOR* = 1.60, 95% CI [1.32, 1.94], $p < .001$) (Hammond et al., 2019). With this unexplained increase in adolescent cigarette use it is important to monitor prevalence and the prevention programs in place.

Health Impact

Alcohol

Alcohol is a beverage which contains varying concentrations of pure alcohol. A standard alcoholic beverage contains approximately 14 grams of pure alcohol. Alcohol is a psychoactive and toxic substance with dependence producing properties (World Health Organization, 2018a). Worldwide alcohol use contributes to three million deaths a year. Alcohol consumption is the leading risk factor for premature death and disability in people between the ages of 15 to 49 and is responsible for 10% of all deaths in this age group (World Health Organization, 2018b). Research has found that adolescents who use alcohol are more likely to binge drink which is associated with greater health risks (Canadian Centre on Substance Use and Addiction, 2017). Alcohol use in adolescents has many significant negative health consequences including traffic accidents, unprotected sexual activity, suicide, mental health disorders, dependence and poor academic performance. Research has suggested that adolescents are more likely to engage in risky drinking due to peer pressure, unawareness of consequences and an unmatured impulse control (Bonnie et al., 2004; Gohari et al., 2019; Public Health Agency of Canada, 2018; World Health Organization, 2018a). Research has also found that the earlier the age of initiation of alcohol use the more likely they are to engage in heavy drinking (Gohari et al., 2019). Gohari et

al. (2019) looked at Ontario and Alberta high school students and found that the adolescents who consumed the greatest amount of alcohol had their first drink before age 14. Other research has found that adolescents who start drinking alcohol at an early age are more likely to continue to drink into adulthood (Pitkanen et al., 2005; Warner & White, 2003; Zakrajsek & Shope, 2006). Therefore, it is vital to ensure there are prevention programs targeting adolescents to delay and prevent alcohol misuse.

Cannabis

Cannabis is a psychoactive drug from the cannabis sativa plant used for medical or recreational purposes. Cannabis is known by many different names including marijuana. Cannabis contains hundreds of chemicals with over one hundred of them classified as cannabinoids. Cannabinoids bind to endocannabinoid receptors known as CB1 and CB2 in the brain and body (Ammerman et al., 2015). The main psychoactive cannabinoid in cannabis is tetrahydrocannabinol (THC). The amount of THC in cannabis determines the potency of the drug. Typically, the THC potency in dried cannabis is approximately 15% but this varies depending on the strain. Another well-known cannabinoid in cannabis is cannabidiol (CBD). CBD is not psychoactive and does not produce intoxication. CBD may even reduce the effects of THC. Cannabis can be taken by smoking, eating, drinking, vaporizing or dabbing (Ammerman et al., 2015; Health Canada, 2019).

During adolescence, the brain is still developing making adolescents more vulnerable to the effects of cannabis. Myelination and synaptic pruning continue to occur into the mid-20s particularly in the prefrontal lobes (Ammerman et al., 2015). Studies have demonstrated that heavy or regular use of cannabis during adolescence is associated with multiple cognitive deficits including decreased attention span and memory (Camchong et al., 2017). Camchong et al. (2017)

did a longitudinal study over 18 months examining the effects of cannabis on adolescent brain development. The authors found evidence of a decrease in resting functional connectivity intelligence and executive function in adolescent cannabis users over time. Furthermore, these effects are more likely to persist even after cannabis use has stopped (Lubman et al., 2015). Adolescents are also less likely to experience the psychoactive effects of cannabis, compared to adult users. This may result in adolescents using more cannabis than adults, further increasing their risk of harm and contributing even more to the negative long-term effects of cannabis (Mokrysz et al., 2016). With the recent legalization of cannabis and the increasing prevalence of use among Canadian adolescents it is imperative to ensure prevention programs are in place to mitigate the harmful consequences of adolescent cannabis use.

E-cigarette

E-cigarettes are battery powered devices made to look and feel like a cigarette. E-cigarettes contain a cartridge filled with a liquid solution sometimes called e-juice or e-liquid. This solution is usually made up of propylene glycol, vegetable glycerin, flavorings, additives and some e-liquids contain nicotine (Etter et al., 2013; Walley et al., 2019). A heating device within the e-cigarette heats the liquid into a vapor which the user then inhales. There are many different names used for e-cigarettes including vapes, vape pens, tank systems, mods or e-hookahs. E-cigarettes do not contain tobacco and do not burn tobacco, therefore they are thought to be less harmful than tobacco cigarettes. However, there is little research into the long-term effects of e-cigarette use (Richmond et al., 2018). Similar toxins and carcinogens found in cigarettes have also been found in e-cigarettes. A study comparing e-cigarette to cigarette use found comparable urine concentrations of metals and volatile organic compounds in people who used e-cigarettes and cigarettes (Walley et al., 2019). While e-cigarettes were considered a safer alternative to

tobacco burning cigarettes, they still contain chemicals that are detrimental to the health of adolescents.

In May 2018, the Tobacco and Vaping Products Act (TVPA) became a law allowing adults to legally purchase vaping products containing nicotine (Government of Canada, 2020b). Nicotine is an addictive substance and adolescents are especially susceptible to the addictive properties of nicotine, even with intermittent use (Leslie, 2020). Ninety percent of adults who smoke cigarettes started smoking before they were 18 years of age (Walley et al., 2019). Nicotine can also affect brain development, memory and concentration in adolescents (Leslie, 2020; National Academies of Science, Engineering and Medicine, 2018). Furthermore, studies looking at the contents of e-cigarettes have found discrepancies between actual nicotine levels and the nicotine levels identified on the manufacturer's label with some e-cigarettes containing more than 10% higher nicotine levels than stated on the label (Davis et al., 2015; Walley et al., 2019). This discrepancy and lack of regulation increases the health risks to adolescents including the likelihood of adolescent nicotine use and potential addiction.

There is also research examining the association between e-cigarette and cigarette use. Adults tend to use e-cigarettes as a method to quit smoking while adolescents more commonly use e-cigarettes before or along with smoking a cigarette (Chapman & Wu, 2014; Azagba et al., 2019). While research to date has demonstrated that vaping is a safer alternative to cigarette smoking for current smokers, it is not a safe choice for non-smokers. In spite of this, research has found that non-smoking adolescents are using e-cigarettes and that adolescents who vape are at higher risk of subsequent smoking (Aleyan et al., 2018; Czoli et al., 2014; Hammond et al. 2017; Soneji et al., 2017; Wills et al., 2017). Azagba et al. (2019) found that students who used e-cigarettes more frequently in the past month were significantly more likely to have smoked

cigarettes at least once in the past 30-days. Students were also less likely to smoke cigarettes if they had not used e-cigarettes in the past 30-days (Azagba et al., 2019). In Canada, smoking among adolescents has been decreasing for several decades, yet between 2015 and 2017 it remained steady while the use of e-cigarettes increased (CSTADS, 2017; Hammond et al. 2019). This is concerning due to the well-known negative consequences of cigarette smoking.

Recently in the United States there have been increasing incidences of acute lung injury related to e-cigarette use containing THC or cannabis oils. Over the last year there have been over 450 reported cases of severe pulmonary disease in the United States (Hammond, 2019). This is believed to be related to the chemicals within the e-cigarettes containing THC, however, due to the lack of regulation and reporting it is impossible to know for certain what is causing these adverse events (Hammond, 2019). Overall, the rise in popularity of e-cigarettes among Canadian adolescents, the link to cigarette smoking and the unknown long-term consequences warrant monitoring of adolescent e-cigarette use as well as preventative measures to prevent and reduce use.

Cigarettes

Cigarettes are pieces of finely cut tobacco wrapped in paper designed to be smoked. Tobacco is a plant which contains the psychoactive ingredient nicotine. Most commonly, tobacco is used to make cigarettes however, there are other products used by adolescents that contain tobacco including cigarillos, little cigars, cigars, water-pipes and smokeless tobacco such as chewing tobacco. Tobacco use kills more than eight million people a year worldwide and an estimated 100 Canadians die each day due to tobacco use (Rehm et al., 2006; World Health Organization, 2019). Tobacco has many well-known and researched negative health effects. Tobacco use is a major risk factor contributing to lung and cardiac disease and over 20 different

types of cancer. Tobacco use results in decreased lung function and increased resting heart rate and adolescents who smoke are three times more likely to suffer from shortness of breath. Tobacco also has negative mental health effects on adolescents. Adolescents who smoke are more likely to experience emotional or psychological issues and are more likely to engage in risky behaviors such as alcohol, cannabis and cocaine use and unsafe sex. Furthermore, most young people who smoke regularly will continue to smoke into adulthood (World Health Organization, 2019). Therefore, it is important to continue to discourage adolescents from smoking cigarettes.

Public Health in Canada

In Canada, health care is funded at both the federal and provincial levels. In order for a province/territory to receive funding from the federal government the province/territory must fulfill five criteria set out by the Canada Health Act related to how the province/territory implements their health services. The five main principles of the Canada Health Act are: public administration, comprehensiveness, universality, portability and accessibility (Government of Canada, 2020a). Federal funds are allocated to provinces/territories through the Canadian Health Transfer. Allocation of funds to each province/territory is on a per-capita basis. Health care is also funded by the province or territory. Alberta, BC and Ontario charge an additional health premium to supplement health care funding (Government of Canada, 2020a). The province or territory then decides how they want to allocate their funding for health care and what portion of funding will go to public health.

Public health as defined by the Public Health Agency of Canada (PHAC) is an organized combination of programs, services and policies all with the aim of promoting physical and mental health through the prevention of injury, disease and premature death (PHAC, 2018). The

PHAC is a federal agency led by the Minister of Health. The PHAC is part of the Health Portfolio along with Health Canada, the Canadian Institutes of Health Research, the Patented Medicine Prices Review Board and the Canadian Food Inspection Agency. The PHAC's focus is to prevent chronic disease and injury and respond to public health emergencies and infectious disease outbreaks. Within Canada, the federal, provincial and municipal levels of government are each responsible for different aspects of public health. Therefore, each province/territory will have different priorities, structures and mandates. This will impact how and if public health is engaged in prevention programs in schools.

Alberta

Alberta has a fully integrated health system which delivers most health services in Alberta called Alberta Health Services (AHS). AHS is a regional health authority responsible for the Alberta Health Region which encompasses the entire province. AHS is a corporate body which is governed by a board and the board is accountable to the Minister of Health. AHS includes programs and services offered at hospitals, clinics, continuing care facilities, cancer centres, mental health facilities and community health sites. AHS is broken down into focused areas called Strategic Clinical Networks (SCNs). One of the SCNs is the Population, Public and Indigenous Health (PPIH) SCN. PPIH focuses on health promotion, equity and disease prevention. PPIH SCN works with key partners in the community including academic institutions, however public health engagement in schools is not specifically mandated (Alberta Health Services, 2019).

British Columbia

In BC there are five regional health authorities that deliver health services including public health services. All activities including public health programs and services provided by

the regional health authorities are supported and funded by the Ministry of Health. Public health has two main principles: first, a focus on the health of the whole population; and second, a focus on health promotion and prevention of disease and injury (The Province of British Columbia, 2019). The regional health authorities are responsible for delivering health services, including public health services, according to the needs of the population within its respective region (The Province of British Columbia, 2019). In 2005 the Ministry of Health released the Framework for Core Functions in Public Health which outlined a key set of public health services to be carried out by the health authorities. Work in schools is included within the core functions. This document then formed the foundation of the Guiding Framework for Public Health developed in 2013 and revised in 2017. This framework outlines seven visionary goals to guide public health service delivery. However, public health engagement in schools is not included in this framework (The Province of British Columbia, 2019).

Ontario

In Ontario, public health is administered through the Ministry of Health and Long-Term Care (MOHLTC). The MOHLTC identifies public health standards for practice that are implemented by 34 local public health departments. The PHUs have three main foci: disease prevention, promotion of health, and protection from harm within their designated regions. The MOHLTC funds some programs at 100% and others at 75%, the remaining 25% is provided by local regions/municipalities (Ontario Public Health, 2019). While the province provides overall guidelines and standards of practice for all Ontario PHUs to follow, each region/locale has the autonomy to allocate their resources to best address the needs in their population. In Ontario, the Public Health Standards include collaborating with school boards and schools to promote the health of school-aged children and adolescents (MOHLTC, 2018).

Conclusion

As has been shown, each of these provinces organizes public health services differently with varied priorities and mandates according to the population health needs of the province/territory. Each province/territory allocates resources differently with different employee structures and proximities to schools. All these factors impact the role of public health in schools. This study will allow for a comparison between Alberta, BC and Ontario's public health engagement and impact in school-based substance use prevention programs.

Chapter 2

Literature Review

The purpose of this literature review is to evaluate the impact of school-based substance use prevention programs on substance use in adolescents. Many school boards mandate that schools provide substance use prevention programs and teaching in their curriculum, but it is not always implemented (Fletcher et al., 2008; Kumar et al., 2013; Ringwalt et al., 2008; Salas-Wright et al., 2019). Studies have also found that it is helpful to have outside organizations or health professionals assist in the implementation of substance use prevention programs (O'Brien et al., 2010; Porath-Waller et al., 2010; Rigg & Menendez, 2018; Sigfusdottir et al., 2011; Stapinski et al., 2017; The Joint Consortium for School Health, 2020; Thomas et al., 2015). However, very few studies were found that looked at the prevalence and effectiveness of outside organizations or health professionals providing implementation assistance in substance use prevention programs. This study will fill this gap in the literature and determine the impact of PHUs in substance use prevention programs in Canadian secondary schools. In this section, the methods, results and the findings of the literature search will be outlined.

Methods

In this section the search strategy, inclusion/exclusion criteria, the quality assessment, data extraction and data analysis used to complete the literature review will be described.

Search Strategy

Literature searches were conducted in three databases: Medical Literature Analysis and Retrieval System Online (MEDLINE or MEDLARS Online), Cumulated Index to Nursing and Allied Health Literature (CINAHL) and Educational Research Information Center (ERIC) using search terms relating to school-based alcohol, cannabis, e-cigarette or cigarette use prevention

programs (see Appendix B). The search was restricted to papers published in the last 10 years and the English language. Trends and societal norms around student substance use and the education environment change over time which may impact the effectiveness and focus of substance use prevention programs. For example, the rise in the popularity of e-cigarettes over the past two years and the legalization of cannabis in 2018 in Canada. Restricting the search to the last 10 years will help to ensure the research presented is relevant to the present trends in adolescent substance use and the current education system. The aim of this literature search was to determine if there is existing literature examining the role of PHUs in school-based prevention programs. To find any literature related to this subject, search terms related to PHUs were included in the initial search (see Appendix B). However, no studies were found looking at the role of PHUs in school-based prevention programs. Therefore, search terms related to PHUs were removed. The final search used search terms related to secondary schools, prevention and alcohol, cannabis, e-cigarette or cigarette use (see Appendix B).

Inclusion/Exclusion Criteria

Articles were included if they involved a school-based prevention intervention, included secondary school students or adolescents (ages 13 to 19 years) as participants, and the aim of the intervention was to reduce at least one of alcohol, cannabis, e-cigarette or cigarette use.

Quality Assessment

All articles were assessed for methodological quality. For systematic reviews, the Health Evidence quality assessment tool was used (Health Evidence, 2018). For cross-sectional studies, the checklist for observational cohort and cross-sectional studies published by the National Heart, Lung and Blood Institute (NHLBI) was used (NHLBI, 2020). One qualitative study was

included and was assessed for quality using the Critical Appraisal Skills Programme (CASP) checklist for qualitative research (CASP, 2018).

The Health Evidence quality assessment tool for systematic reviews is a tool which is made up of 10 questions to assess the methodological quality of a systematic review. Each question is answered as yes or no. The number of questions answered with a yes are counted to determine the overall level of study quality. A score of eight to ten is considered to be a review of strong methodological quality, a score of five to seven would be a moderate quality review and a study with a score of four or lower would be considered a weak review. The tool asks about the research question, inclusion criteria, search strategy, quality assessment of the included studies, methods and conclusions of the review (Health Evidence, 2018) (see Appendix D).

The NHLBI checklist for observational cohort and cross-sectional studies is a tool which outlines 14 questions/criteria to determine the methodological quality of observational cohort and cross-sectional studies. The tool asks about the research question, population, analyses, exposure, outcome measures and bias. Each question is answered with a yes, no, not clear or not applicable. This tool does not provide an overall level of methodological quality based on the number of questions answered with a yes (NHLBI, 2020) (see Appendix E).

The CASP Critical Appraisal Tool for Qualitative Research is a tool with 10 questions on the methodological quality of qualitative studies. The first section includes the first six questions and focuses on determining if the results are valid. This section asks questions about the research design and methods and if this is appropriate to answer the research question. The second section includes the last four questions concentrating on the results of the study. These questions ask about ethics, how the data analysis was completed and the final conclusions of the study (CASP,

2018). The tool does not provide an overall level of methodological quality based on the number of criteria met by the study being reviewed (see Appendix F).

Data Extraction

From each systematic review the quality of the included studies, number of included studies, study design, age and number of participants, intervention, comparison, outcome(s), results, follow-up period and intervention duration were extracted. For single studies the study design, number of participants, intervention, follow-up period and outcome, where applicable, were extracted.

Data Analysis

Data from the included systematic reviews was extracted and synthesized into a table (see Appendix G). Data from the single studies was summarized and are described below.

Results

Search

A total of 1,538 articles were found after removing duplicates (see Appendix C). After title and abstract screening, 309 studies were identified. The studies from this search were split into three topic areas: prevention program effectiveness, program prevalence, and program providers/collaborators. In the group of effectiveness studies, 28 of the titles were for systematic reviews and meta analyses. A decision was made to limit the full text screening of effectiveness studies to these 28 systematic reviews/meta-analyses. Systematic reviews provide the highest level of evidence, summarizing and combining the results of multiple single studies (DiCenso et al., 2005). However, the quality of the review and the quality of the included studies determine the accuracy and value of review findings. Therefore, the quality of the review and the quality of the included studies will be discussed along with the findings below (Guyatt et al., 2011; Moher

et al., 2009). Eighteen studies were found in the program prevalence group and ten in the program providers/collaborations group. After full text screening was completed 17 systematic reviews on the effectiveness of prevention programs, three studies on program prevalence and four studies on program providers/collaborations were included.

Exclusion

A total of 1,482 articles were excluded after screening the titles and abstracts. This included single studies on the effectiveness of school-based substance use prevention programs (n = 247). Thirty-two studies were excluded after full text screening. Studies were excluded because the study population did not include secondary school students (n = 3), the program was not school-based (n = 3), the study was on a specific population (n = 11), the study was an implementation study (n = 12) or the study was a school-based screening or cessation program (n = 3) (see Appendix C).

Quality Assessment

All the systematic reviews included in this literature review received a quality rating of strong or moderate (see Appendix D). The most common methodological limitation in the systematic reviews was the lack of quality assessment of primary studies (n = 10) and/or lack of transparency of the quality assessments (n = 12). For example, the authors of the systematic review may have stated that a quality assessment was completed for the included studies however, they did not provide details on the quality appraisal tool used or the results of the appraisal. The next most common limitation was the absence of a comprehensive search (n = 8). The cross-sectional single and qualitative studies were also of strong to moderate quality, achieving most of the criteria identified on the quality assessment tools (see Appendix E and F). In the NHLBI tool for the cross-sectional studies, there were several questions that were not

applicable because most of the studies included in this review used national surveys and did not measure an exposure. Of the questions that were applicable, the most common methodological limitation was a lack of sample size justification or power description (see Appendix E). The only question on the CASP tool that the qualitative study did not address with sufficient detail was the relationship between the researcher and participants (see Appendix F)

Study Findings

In this section the findings from the research will be presented. First, research evaluating the impact of school-based substance use prevention programs on preventing substance use in adolescents will be discussed. Second, research on the prevalence of school-based substance use prevention programs in secondary schools will be summarized and finally, research examining the type of program provider and research and guidelines on the impact of collaboration between the health and education sector will be reviewed.

Effectiveness of School-based Prevention Programs

Adolescent use of alcohol, drugs and tobacco is a worldwide health issue with well-known negative health outcomes (World Health Organization, 2014). Therefore, a substantial amount of research has been conducted to explore the most effective means to prevent or reduce the rate of adolescent substance use. One common setting in which prevention strategies are implemented is schools. Schools provide an effective and efficient means to reach multiple adolescents while their beliefs and values around substance use are forming (Faggiano et al., 2014). Overall, the studies included in this review found that school-based prevention programs can be an effective means to reduce and/or delay substance use in adolescents. This review will focus on first summarizing data from systematic reviews related to the effectiveness of the type of program and second examining specific factors influencing the effectiveness of the programs.

The search resulted in 17 systematic reviews. Nine include data on the effectiveness of the type of prevention program. One study looked at both alcohol and cannabis use, three focused on alcohol use, two on cannabis use (or illicit drug use including cannabis use), and three on tobacco use/smoking. Eight systematic reviews include data on various factors influencing the effectiveness of school-based prevention programs. These reviews focus on prevention programs for multiple substances (alcohol, cannabis and tobacco use). One review looked at both the type of program and the impact of specific factors for cannabis use. None of the reviews specifically mentioned prevention programs aimed at e-cigarette use and no reviews included studies that assessed the effectiveness of prevention programs on e-cigarette use. E-cigarettes have only recently become popular among adolescents, which may explain why no studies on e-cigarette use prevention programs were identified.

Type of Prevention Program

Most of the research looking at school-based prevention programs focuses on the effectiveness of the type of program compared to standard school curricula. Research related to adolescent school-based substance use prevention programs is generally categorized into four broad themes. First, a knowledge-based approach consists of substance use education. These types of programs provide information to adolescents with the assumption that with the right information and knowledge adolescents will choose to not use substances. Second, a social competence approach assumes that adolescents are more likely to use substances if they have poor social skills and a poor self-concept. These types of programs focus on social and cognitive skills to help adolescents improve self-esteem and develop skills to resist pro-drug influences. Third, a social norms approach involves both education about drugs and includes teaching refusal skills. These programs focus on correcting overestimated assumptions concerning the

prevalence of drug use and addresses media and peer influences. The aim of these programs is to make adolescents more aware of the impact of pro-drug influences and pressures they may experience, and to provide adolescents with tools to help resist these pressures. Finally, combined approaches are programs that use a combination of all three of the above approaches. For example, a combined approach program may include a lecture style education on drugs and/or alcohol, self-esteem building activities and resistance skills training (Faggiano et al., 2014; Thomas et al., 2013). Programs are also categorized by their intended audiences with some prevention programs being 'universal' (target all students in school, grade or class) while others focus on reaching students identified as 'high-risk' which includes those who are already using substances or deemed to be at high-risk for future substance use (Hodder et al., 2017).

Alcohol Prevention. Three systematic reviews included in this literature review focus on alcohol use alone and one systematic review focused on alcohol and cannabis use. The findings of these four reviews will be discussed here. First, Strøm et al. (2014) looked at 28 randomized controlled trials (RCTs) evaluating the effectiveness of various alcohol prevention programs in schools (see Appendix G). This review is of moderate quality (see Appendix D), however, the authors did not provide sufficient details on the quality of the included studies. Twelve of the studies reported continuous data on alcohol use (frequency and quantity of alcohol use) and 16 reported categorical data on alcohol use. Of the 12 studies reporting continuous data, the authors found a statistically significant reduction in the frequency and quantity of alcohol consumption in the intervention group for up to one-year post intervention (*Hedges'g* = 0.22, 95% CI [0.08, 0.36], $p < .01$). However, in the categorical data, the reduction in the frequency of alcohol consumption post intervention was not significant (*OR* = 0.94, $p = .25$) (see Appendix G). The interventions in these studies included knowledge, social competence and/or social influence

approaches, however, an analysis comparing the difference in effectiveness between the types of programs was not completed (Strøm et al., 2014).

Foxcroft & Tsertsvadze (2011) included 53 RCTs and clustered randomized controlled trials (C-RCTs) evaluating the impact of school-based prevention programs to reduce alcohol use (see Appendix G). This methodologically strong review (see Appendix D) was based on studies with an unclear risk of bias due to the low quality of reporting in the single studies. The authors used the Cochrane Risk of Bias Tool to assess the quality of the included studies. The programs in this study were described as educational and psychosocial. The educational programs were comparable to the knowledge-based approach described above and the psychosocial programs were comparable to the social competence and social norms approaches also described above. Programs included in the studies were either focused on alcohol use prevention alone or generic interventions such as programs to reduce drug use, promote health or other interventions such as screening programs with alcohol use as an outcome. Due to the heterogeneity of the studies a meta-analysis could not be performed. From the qualitative summary of results across studies the authors found that six of the 11 trials looking specifically at alcohol prevention programs showed statistically significantly greater reductions in alcohol misuse compared to the control groups. Fourteen of the 39 trials looking at generic interventions showed statistically significantly greater reductions in alcohol use compared to the control groups (see Appendix G). Overall, generic psychosocial and developmental programs showed the greatest potential effect in reducing alcohol use however, the results of the individual studies were inconsistent (Foxcroft & Tsertsvadze, 2011).

Hennessy & Tanner-Smith (2015) did a review looking at 17 RCTs and controlled quasi-experimental research studies examining the impact of brief alcohol interventions (BAIs) (see

Appendix G). These interventions included social competence and knowledge-based approaches but were limited to a duration of five hours or less. The authors of this methodologically strong review (see Appendix D) conducted sensitivity analyses taking into consideration the quality of the studies however, the tool used to measure the quality and the results of the quality assessments were not transparent. The authors found an overall statistically significant reduction in alcohol use post intervention ($\bar{g}$ = 0.34, 95% CI [0.11, 0.56]). In the subgroup analysis the authors found individually delivered BAI ($\bar{g}$ = 0.58, 95% CI [0.23, 0.92]; $p < .001$) to be effective however, there was no effect found on alcohol use in group-based BAI ($\bar{g}$ = -0.02, 95% CI [-0.17, 0.14]; $p = .72$) (Hennessy & Tanner-Smith, 2015) (see Appendix G). Strøm et al. (2014) also examined the effect of the intensity of the program and found that when the intensity of the program was considered, there were no significant differences in alcohol use between low and high intensity programs.

Lemstra et al. (2010) did a systematic review comparing knowledge-based and combined approach school-based prevention programs for students aged 10 to 15 years old (see Appendix G). The authors of this methodologically strong review (see Appendix D) assessed the quality of the studies based on 14 quality standards. To be included in the review, the studies were required to meet at least ten of the standards. However, the results of the quality assessment were not provided. Six studies met the inclusion criteria and were included in the review. Three of the studies examined knowledge only programs and three examined a combined approach. The authors found the combined approach programs resulted in a statistically significant mean absolute reduction of 12 days of alcohol usage per month (*MUR* = 0.88; 95% CI [0.87, 0.89]) compared to control. Whereas the knowledge only programs resulted in a non-statistically significant reduction in alcohol use of two days per month (*MUR* = 0.98; 95% CI [0.92, 1.04])

(see Appendix G). These results suggest that alcohol prevention programs of any intensity and focus which include aspects of both social competence, social norms or combined approaches may be effective in reducing adolescent alcohol use (Foxcroft & Tsertsvadze, 2011; Hennessy & Tanner-Smith, 2015; Lemstra et al., 2010; Strøm et al., 2014)

Cannabis Prevention. Two systematic reviews included in this literature review assessed cannabis use alone and Lemstra et al. (2010) (described above) focused on both alcohol and cannabis use. The findings from these three reviews will be discussed here. First, Faggiano et al. (2014) completed a systematic review on the effectiveness of school-based prevention programs for drug use. This methodologically strong review included 51 studies (see Appendix D). The authors used the Cochrane Risk of Bias Tool to evaluate the quality of each included study and found 32 studies to have a low risk of bias, 15 with an unclear risk of bias and four with a high risk of bias. Each study was categorized based on the outcome measure (cannabis, hard drug or any drug use) and the length of follow up (less than 12 months or greater than 12 months). Due to the heterogeneity of the studies not all studies were included in a meta-analysis. Of the studies that were included in the meta-analysis, social competence programs compared to control groups showed non-significant protective effects for cannabis use at both less than 12 months follow-up (*RR* = 0.90, 95% CI [0.81, 1.01]) and greater than 12 months follow-up (*RR* = 0.86, 95% CI [0.74, 1.00]). Combined approach programs for cannabis use at greater than 12 months follow-up showed statistically significant effects compared to control (*RR* = 0.83, 95% CI [0.69, 0.99]). While the effect size is good, it should also be noted that at the high end of the confidence interval the effect is much smaller. At less than 12 months follow-up, combined approaches for cannabis use favored the intervention compared to control but the effect was not statistically significant (*RR* = 0.79, 95% CI [0.59, 1.05]) (see Appendix G). Overall, combined

approach programs showed the greatest effects in reducing adolescent drug use compared to programs using the social competence and social norms approaches (Faggiano et al., 2014). Similarly, Porath-Waller et al. (2010) did a systematic review including 15 studies looking at school-based prevention programs for adolescent cannabis use (see Appendix G). Five of the studies examined prevention programs using the social norms approach and 10 of the studies examined programs using a combined approach. The authors found that the combined approaches had a statistically significant greater effect (d = 1.27, 95% CI [1.22, 1.33]) compared to the social-influence approach (d = 0.19, 95% CI [0.14, 0.23], p < .001) (see Appendix G). However, while this review is of moderate quality (see Appendix D), the authors did not report completing any quality appraisal of the included studies. Lemstra et al. (2010) also completed a systematic review comparing knowledge and combined approach alcohol and cannabis use prevention programs as described in the section above (see Appendix G). For cannabis use, the authors found a mean absolute reduction of seven days of usage per month with the combined approach prevention programs (MUR = 0.93, 95% CI [0.92, 0.94]). Only one study examined knowledge-based cannabis use prevention programs therefore a statistical pooling of the data was not completed for this sub-group. Overall, prevention programs using a combined approach showed the greatest effect for reducing adolescent cannabis use (Faggiano et al., 2014; Lemstra et al., 2010; Porath-Waller et al., 2010).

Tobacco Prevention. Three systematic reviews evaluated the impact of school-based tobacco prevention programs on student tobacco use. Two of the reviews examined the program approach and the third review studied the effectiveness of a popular prevention program in Europe called the Smoke Free Class (SFC) competition. Thomas et al. (2015) did a review looking at the effectiveness of school-based prevention programs based on the number of

students who remained never smokers at follow-up. Fifty RCTs met the inclusion criteria (see Appendix G). The authors of this methodologically strong review (see Appendix D) used the Cochrane Risk of Bias Tool to evaluate the risk of bias of the included studies and found the studies to be of low and unknown risk of bias. Interventions included smoking prevention programs using information, social influences, social competence and combined approaches. The authors found statistically significant program effects in combined approaches at less than one year follow-up (*OR* = 0.59, 95% CI [0.41, 0.85]) and greater than one year follow-up (*OR* = 0.60, 95% CI [0.43, 0.83]), all interventions at greater than one year follow-up (*OR* = 0.88, 95% CI [0.82, 0.95]) and social competence approaches at greater than one year follow-up (*OR* = 0.63, 95% CI [0.43, 0.96]) (Thomas et al., 2015). The authors found non-statistically significant effects in information only approaches (*OR* = 0.12, 95% CI [0.00, 14.87]), social influences at less than one year (*OR* = 0.97, 95% CI [086, 1.09]) and greater than one year (*OR* = 0.92, 95% CI [0.84, 1.00]) and overall at less than one year (*OR* = 0.91, 95% CI [0.82, 1.01]) (see Appendix G). Similarly, Thomas et al. (2013) also found combined approaches to be the most effective. In this review, 134 randomized control trials and cluster randomized control trials met the inclusion criteria which also included studies from the Thomas et al. (2015) review. Similar to the Thomas et al. (2015) review, this study was also of strong methodological quality (see Appendix D) and found the included studies to be of low and unknown risk of bias according to the Cochrane Risk of Bias Tool. The study interventions were categorized into six types (information giving, social competence, social norms, combined social competence and social norms, multimodal and other interventions) and three types of studies (pure prevention cohort, change in smoking behaviour over time and point prevalence of smoking). Forty-nine of the studies were included in the pure prevention cohort which followed the same cohort of never smokers from baseline to follow up.

In this group the authors found a statistically significant reduction in smoking initiation rates compared to control groups in schools that combined social competence and social influence curricula at less than one year follow-up (*OR* = 0.49, 95% CI [0.28, 0.87]) and greater than one year follow-up (*OR* = 0.50 95% CI [0.28, 0.87]), and at greater than one-year follow-up the social competence approach showed statistically significant results in reducing smoking (*OR* = 0.52, 95% CI [0.30, 0.88]). The pooled effect of any intervention at greater than one year follow-up was statistically significant (*OR* = 0.88, 95% CI [0.82, 0.96]) however, at less than one year, the pooled effect was nonsignificant (*OR* = 0.94, 95% CI [0.85, 1.05]). Information only (*OR* = 0.12, 95% CI [0.00, 14.87]) and social influences (*OR* = 1.00, 95% CI [0.88, 1.13]) approaches also showed nonsignificant results at less than one-year follow-up. The trials included in the change in smoking behaviour showed overall statistically significant results favouring the control at one year or less (*SMD* = 0.04, 95% CI [0.02, 0.06]) and at more than one year the results were nonsignificant (*SMD* = 0.02, 95% CI [0.00, 0.02]). The heterogeneity between the studies in the point prevalence of smoking group was too high for the data to be pooled (Thomas et al., 2013) (see Appendix G).

Specific programs to prevent adolescent smoking have also generated multiple studies across various settings and populations such as the SFC competition. The SFC competition is a popular school-based smoking prevention initiative used in various European countries. In this program classes are rewarded with a prize if all students in the class remain smoke-free. As opposed to more traditional programs that focus on negative long-term consequences to modify adolescent behavior, this program aims to reward the desired behavior, making it more attractive and worthwhile for students. This program is also thought to influence social norms by reducing the perceived normalization of smoking. Isensee and Hanewinkel (2012) conducted a review to

evaluate the SFC competition. Five studies were included in a meta-analysis (see Appendix G). This review was rated as moderate quality because the authors did not assess the quality of the included studies (see Appendix D). All studies were from European countries, included participants aged 11 to 14, were controlled or randomized controlled studies. A statistically significant difference in smoking initiation was found at follow-up between students in the intervention and the comparison group (*RR* = 0.86, 95% CI [0.79, 0.94], *p* = .001) (Isensee & Hanewinkel, 2012) (see Appendix G). Overall, prevention programming including social competence and combined approaches and the SFC competition demonstrated a positive effect toward reducing student smoking rates (Isensee & Hanewinkel, 2012; Thomas et al., 2013; Thomas et al, 2015).

Factors Influencing the Effectiveness of Prevention Programs

Research has also examined the impact of specific factors on the overall effectiveness of substance use prevention programs. This section will review this literature and outline the main factors which have been found to impact school-based substance use prevention programming. First, the review by Porath-Waller et al. (2010), described earlier, will be discussed. This review completed a secondary analysis looking at the factors associated with the effectiveness of cannabis use prevention programs. The remaining eight systematic reviews outlined in this section examine the influence of various factors on the effectiveness of any substance use prevention programs including alcohol, cannabis and/or smoking prevention. These factors include: the materials and presentation of the program, environmental resilience, how the program is incorporated into the school day, parental involvement, the impact of addressing multiple health risk behaviour in a single program and the developmental stage of the participants.

Cannabis Use.

***Interactive Programs*.** Porath-Waller et al. (2010) did a systematic review including 15 studies looking at school-based prevention for adolescent cannabis use (see Appendix G). The authors looked at both the effectiveness of the intervention (described above) and the factors that influenced the effectiveness of the programs. The authors found that interactive programs (d = 0.1, $p < .001$) resulted in a larger impact than lecture style programs ($d = 0.02$, $p < .001$) (Porath-Waller et al., 2010).

Multi-Substance Use Prevention.

***Program Presentation*.** Espada et al. (2015) did a review of 21 studies. The prevention programs in the studies included knowledge, social competence and social norms approaches (see Appendix G). The aim of the study was to examine different variables which may impact the effectiveness of the prevention programs such as the program theory, materials, information, administrator, and duration. This methodologically strong review (see Appendix D) was based on studies of moderate quality according to the nine criteria used by the authors to assess study quality. The authors found that for all substances (alcohol, tobacco, cannabis and other drug use) programs incorporating oral, written and audiovisual materials showed the greatest effect (d = 0.21, 95% CI [0.12, 0.3]). Analyses were also completed which looked at the overall effect of any prevention program. The authors found significant reductions in alcohol use ($d = 0.38$, 95% CI [0.27, 0.49], $p < .01$), cannabis use ($d = 0.19$, 95% CI [0.05, 0.32], $p < .01$) and tobacco use (d = 0.2, 95% CI [0.1, 0.3], $p < .01$) (see Appendix G).

Environmental Resilience Factors. Research has investigated the impact of the school environment on substance use in adolescents and its role in combination with prevention programming. Hodder et al. (2007) looked at the effectiveness of universal school-based

resilience interventions to reduce the prevalence of tobacco, alcohol or illicit substance use (including cannabis) by adolescents (see Appendix G). This methodologically strong review (see Appendix D) was based on studies with low risk of bias for alcohol and illicit drug use outcomes and high risk of bias for tobacco use outcomes. The authors used the Grades of Recommendation, Assessment, Development and Evaluation (GRADE) tool to evaluate the studies. The prevention programs investigated in this review addressed at least one individual resilience factor such as social skills and at least one environmental factor such as school connectedness or building healthy relationships within the school, community or family. Nineteen studies met the inclusion criteria. The authors found a statistically significant overall intervention effect in reducing adolescent illicit substance use when environmental resilience factors were addressed in prevention programs (*OR* = 0.78, 95% CI [0.66, 0.93], *p* = .007). However, no statistically significant intervention effects were found for tobacco (*OR* = 0.96, 95% CI [0.85, 1.08], *p* = .48) or alcohol use (*OR* = 0.86, 95% CI [0.73, 1.02], *p* = .08) (Hodder et al., 2017).

Peer-led Prevention Programs. MacArthur et al. (2016) did a review looking at the impact of peer-led substance use prevention programs (see Appendix G). Peer-led interventions involve a peer, someone with shared characteristics, teaching or sharing health information and behaviours. The peer-led intervention may be the only intervention or one aspect of a larger substance use prevention program. Seventeen studies met the inclusion criteria. Of these 17 studies, half were executed in a school setting. This methodologically strong review (see Appendix D) was based on studies of low quality. The authors used the Cochrane Risk of Bias Tool to assess the studies. Participants ranged in age from 11 to 19 years. The research behind this approach has found that young people give their peers greater credibility, learn from each

other and can act as positive role models (MacArthur et al., 2016). The authors found statistically significant reductions in the odds of weekly or monthly smoking (*OR* = 0.78, 95% CI [0.62, 0.99], *p* = .04), alcohol use (*OR* = 0.80, 95% CI [0.65, 0.99], *p* = .036) and cannabis use (*OR*= 0.7, 95% CI [0.5, 0.97], *p* = .034) (see Appendix G). However, the effect size is very small at the upper end of the confidence intervals, the amount of research on this topic is limited (particularly for cannabis use) and the overall quality of the included studies is poor (MacArthur et al., 2016).

Multiple Risk Behaviour Prevention Programs. MacArthur et al. (2018) did a review looking at the impact of interventions targeting multiple risk-taking behaviours in young people up to age 18 (see Appendix G). The authors of this methodologically strong review (see Appendix D) used the GRADE approach to assess the quality of the included studies and found the studies included in this review to be of moderate to low quality. The interventions of the included studies focused on preventing or reducing two or more risky behaviours such as tobacco use, alcohol use, illicit drug use (including cannabis use). Interventions were separated into individual-level, family-level, and school-level. Seventy studies met the inclusion criteria. Of these studies 28 of them were school-level interventions examining universal school-based prevention programs. In regards to the substance use outcomes, the authors found that multiple risk behaviour prevention programs compared to the control intervention reduced the odds of tobacco use (*OR* = 0.77, 95% CI [0.60, 0.97]) and alcohol use (*OR* = 0.72, 95% CI [0.56, 0.92]). For cannabis use, the odds of use were reduced in the intervention group however, the results were not statistically significant (*OR* = 0.79, 95% CI [0.62, 1.01], *p* = .06) (MacArthur et al., 2018) (see Appendix G). Similarly, Hale et al. (2014) did a review looking at interventions to reduce multiple health risk behaviors in adolescence such as substance use, sexual risk behaviour and aggressive behaviour (see Appendix G). The authors wanted to examine if interventions

aimed at a specific risky behaviour may also translate into reductions in other risky behaviours. The majority of the studies included in the review measured substance use (alcohol, drug and/or tobacco use) as the primary outcome and other health risk behaviours (sexual risk behaviour and aggressive behaviour) as secondary outcomes, even if the intervention did not address these behaviors directly. Fifty-five studies met the inclusion criteria. The authors of this moderate quality review (see Appendix D) used the Quality Assessment Tool for Quantitative Studies by Thomas (2003) to appraise each study and found most to be of strong to moderate quality. Nine studies were found to be of weak quality. All 55 of the studies aimed to reduce at least one of either tobacco, alcohol, or drug use. Forty-four of these studies were school-based studies evaluating 32 different school-based prevention programs. Due to the heterogeneity of the studies a meta-analysis was not done. The authors summarized the findings of the single studies in a narrative analysis. The authors found that all included studies showed statistically significant reductions in the intervention group compared to control in at least one of the outcomes measured (smoking, alcohol or drug use). Eighteen of the interventions demonstrated statistically significant reductions in two of the three substances measured and nine of the interventions reduced all three substances. The nine interventions resulting in a statistically significant reduction in smoking, alcohol and drug use, used combined approaches (see Appendix G). Overall, the authors concluded that multi-risk interventions which target multiple substances can also be effective in reducing other risky behaviour such as other substance use, sexual risk behaviour and aggressive behaviour (Hale et al., 2014).

Incorporating Prevention Programs into the School Curricula. Melendez-Torres et al. (2018) did a systematic review examining the effectiveness of incorporating substance use prevention programs into pre-existing academic curriculum (see Appendix G). For example, the

teacher would incorporate tobacco use prevention teaching into other subjects throughout the school-day such as math or science lessons. This study was rated as a methodologically moderate review (see Appendix D) and the included studies were of variable risk of bias due to the unclear reporting of the methods. Seven studies met the inclusion criteria. For the analysis, the participants were split into two age groups. The authors found a statistically significant effect of the intervention on reducing substance use for students aged 11 to 14 years (d = -0.09, 95% CI [-0.17, -0.01]) and for students aged 14 to 16 years (d = -0.06, 95% CI [-0.09, -0.02]) (see Appendix G). However, the authors did find that the specific methods of how substance use prevention was integrated into the academic school curricula was not clear. The type of program approach used to provide the health teaching to the students was also not specified, making these findings hard to replicate in other studies with different populations and in practice (MacArthur et al., 2018).

Parental Involvement. Newton et al. (2017) did a systematic review looking at the impact of including parents in school-based alcohol and other drug use (including cannabis) prevention programs (see Appendix G). Within these programs the students participated in a prevention program incorporating both the social competence and social norms approaches. Their parents also received specialized training in substance use prevention strategies such as parental monitoring, parent-child bonding, communication skills and/or rule setting to implement at home. Twenty-two studies of 13 trials including 10 different prevention programs met the inclusion criteria. This study was of moderate quality (see Appendix D) and included studies with a low risk of bias based on the quality appraisal of the authors using the Cochrane Risk of Bias Tool. Due to the heterogeneity of the studies a meta-analysis was not possible. Of the 10 programs evaluated in the included studies, nine programs resulted in statistically significant

delays or reductions in adolescent alcohol, drug and/or tobacco use in at least one study and these effects lasted from post-test to 72 months follow-up (Newton et al., 2017). However, the findings were inconsistent across studies. Some studies showed significant reductions and others did not, and it was not possible to explain why these differences occurred (see Appendix G).

Students' Developmental Stage. The age and developmental stage of the students participating in prevention programs may also be a factor influencing the effectiveness of the program. Existing school-based prevention program research includes a wide range of ages and developmental stages. Onrust et al. (2016) did a review looking at school-based prevention programs and their effectiveness at reducing smoking, alcohol, and drug use (see Appendix G). This review focused on examining the different characteristics of the prevention programs and their effectiveness on different age groups. The review included 241 studies evaluating 288 different programs. This review of moderate methodological quality (see Appendix D) assessed the quality of the included studies using the Cochrane Risk of Bias Tool. The authors found the studies to be of low risk of randomization and selective reporting bias, at moderate risk of other bias and of high risk of mishandling missing data. The authors accounted for the methodological quality of the included studies in each analysis completed in the review. Participants in the studies were divided into four age groups: elementary school students (kindergarten to grade 5), early adolescents (grades 6 and 7), middle adolescents (grades 8 and 9) and late adolescents (grades 10 to 12). For most of the included studies, outcome measures were collected within three months of the intervention. The authors found, for middle adolescents, the only statistically significant effect was refusal skills training to reduce alcohol use ($B = 0.14$; $p = .02$). The authors found, for late adolescents, universal programs for alcohol use including self control training ($B = -0.2$, $p = .02$), problem solving skills training ($B = -0.16$, $p = .03$), refusal skills ($B = -0.41$, $p =$

.01), social influence (B = -0.57, p = .01), cognitive behaviour therapy (B = -0.32, p = .01) and parental involvement (B = -0.29, p = .02) were effective in reducing alcohol use. Health education alone reduced alcohol use, however the effect was not statistically significant (B = -0.19, p = .05). For late adolescents, universal programs including self-control (B = -.23, p = .02) for drug use and programs including social norms (B = -.23, p = .02) and peer education (B = -.74, p = .01) for smoking were found to be effective in reducing drug use and smoking compared to the control (see Appendix G). The authors concluded that the late adolescent age group is focused on their individuality and future compared to younger age groups. In late adolescence students are building their own identity and developing skills to help transition into adulthood and therefore programs based on a social competence approach such as teaching refusal skills achieve greater results compared to middle adolescents where peer influences play a greater role in behaviour choices (Onrust et al., 2016). The review by Porath-Waller et al., 2010 (described above) also found that, across all the types of programs studied in their review, programs for high school students were more effective at reducing substance use (d = 0.39, 95% CI [0.30, 0.49]) compared to programs for middle school students (d = 0.17, 95% CI [0.13, 0.21], p < .001) (see Appendix G). Overall, this research found age and developmental stage of students are important factors in program effectiveness, and therefore must be considered in the development and implementation of prevention programs (Onrust et al., 2016).

Conclusion. In conclusion, there is considerable available evidence evaluating multiple school-based substance use prevention programs. Overall, based on the research presented here it appears that school-based interventions that provide more than just knowledge to students and instead incorporate different interactive and social skills are the most effective interventions. However, it is important to note that the effect size found in most of the reviews was extremely

small even if it was found to be statistically significant. The confidence intervals were also generally wide with the high end of the confidence interval almost crossing the line of no effect. Therefore, in some cases, these programs would only provide small protective effects. Also, most of these studies were conducted outside of Canada and included students from elementary, middle, and secondary schools.

Prevalence of School Based Prevention Programs

Research has demonstrated that school-based prevention programs can be effective in reducing student alcohol, cannabis, and tobacco use. However, it is also important to evaluate if schools are incorporating these programs into their curricula and if students are participating. Ringwalt et al. (2008) did a study in the United States looking at how many school districts provided high school students with evidence-based substance use prevention programs during the 2004-2005 school year. This was the only study of this nature found in this literature review. The randomly selected sample was stratified by population density, school size and school district poverty level. The selected districts were sent a questionnaire which asked them to identify programs they implemented in the school from a provided list of evidence-based prevention programs as well as space to identify additional programs used by the school not on the list. There was an 83.9% response rate. They found that only 10.3% of school districts were using evidence-based prevention programs in at least one of their high schools and 56.5% of school districts had at least one high school with other prevention programs. The authors found that school districts that were large and predominantly African American and Hispanic were more likely to implement evidence-based prevention programs. They also found that inner-city districts were more likely to receive additional funding for drug prevention and therefore were able to afford dedicated staff to implement evidence-based prevention programs. However, the

survey was sent to a district employee (not the schools) therefore, it is possible that they may not have been aware of all the programs resulting in an under representation of the available programs (Ringwalt et al., 2008). It is also important to note that this study was done 12 years ago and therefore may not be representative of the situation in schools today.

Participation in the substance use prevention programs is also a vital component to reducing adolescent smoking and drug use. Salas-Wright et al. (2019) conducted a study looking at trends across the United States of adolescent participation in substance use prevention programs. The study looked at both school-based and community-based programs. The authors examined 15 years of cross-sectional data from the National Survey on Drug Use and Health from 2002 to 2016. A statistically significant decline in participation in substance use prevention programs was observed between 2002 and 2016. There were even greater statistically significant declines in participation among specific subgroups such as Black youth (18%), younger adolescents (19%), Latino youth (22%), youth from low income families (23%), youth in rural areas (22%) and youth reporting no past year substance use (20%). Overall, for the entire sample there was a 16.5% proportional decline in school-based participation in substance use prevention programs from 2002 to 2016. However, this study does not provide any insight into the type or duration of the programs. The data for this study were gathered from a single question on a National Survey which asked adolescents if they had any special classes related to drugs or alcohol in school (Salas-Wright et al., 2019).

Fletcher et al. (2010) did a qualitative research study with students and teachers in four schools in England. The study was of high-quality meeting nine out of 10 of the CASP quality criteria for qualitative research (see Appendix F). The authors found that while drug prevention programs and policies exist in the school most of the students interviewed did not remember

receiving any drug education. The teachers also acknowledged that drug education was not a priority in their schools and that the policies and practices around drug prevention were rarely implemented. However, this study had a small sample size and was conducted in England which may limit the generalizability to Canadian schools but does give some insight into the potential gap that may occur between policies and practice.

In the end there are not many studies looking at the prevalence of and participation in substance use prevention programs. Of the three studies described here, two were over nine years old and all three were from different countries. Therefore, it is unlikely that these studies represent what is happening in Canadian secondary schools. However, this research still provides insight into what other groups of students and schools are experiencing. Without this type of research in Canadian secondary schools we currently do not understand what the gap is between policy and practice in school-based substance use prevention programs.

School-Based Prevention Program Providers and Collaborations

Research has taken into consideration the type of provider and its impact on prevention program effectiveness. This is commonly researched as a secondary analysis within an effectiveness study. Three of the systematic reviews described above also examined the impact of the type of provider and Rigg and Menendez (2018) wrote a report summarizing the data available on the type of providers for school-based substance use prevention programs. These studies will be discussed first. In the second part of this section, reports on the impact of collaboration between health and education sectors in Iceland and Australia will be presented. The Joint Consortium for School Health in Canada and its role in health and education sector collaborations will also be discussed. However, no research was found examining the impact or prevalence of such collaborations in Canada.

Providers. There are multiple choices for who will carry out the school-based prevention program. Some common program providers include classroom teachers, mental health professionals, and police. Unfortunately, there is little research available examining the effectiveness of different program providers (Rigg & Menendez, 2018). However, some of the systematic reviews described earlier also examined the impact of the type of provider. The review by Espada et al. (2015) looked at 21 studies. Of the 21 studies 16 had professionals implementing the prevention program, two had both teachers and professionals and three did not specify. This review found a statistically significant effect in programs facilitated by professionals alone ($d = 0.25$, $p < .01$) and programs facilitated by both professionals and teachers ($d = 0.48$, $p < .01$). The review by Porath-Waller et al. (2010) found that programs led by teachers and programs led by facilitators other than teachers such as health professionals or program specialists both resulted in statistically significant reductions in student cannabis use compared to students in the control groups. However, programs facilitated by teachers had significantly poorer outcomes ($d = 0.57$, 95% CI [0.54, 0.61], $p = .01$), in terms of cannabis use, compared to programs led by a facilitator other than teachers ($d = 0.74$, 95% CI [0.61, 0.87], $p = .01$). Finally, the review by Thomas et al. (2015) found that programs delivered by adults resulted in a statistically significant reduction in smoking compared to programs delivered by peers. These studies further demonstrate the potential benefits of collaboration between public health professionals and schools, as well as the importance of who is implementing the program (Espada et al., 2015; Porath-Waller et al., 2010; Thomas et al., 2015; Rigg & Menendez, 2018).

Collaboration. In other countries collaborations between the health sector and school boards have been implemented with positive results. O'Brien et al. (2010) did a study looking at a new initiative implemented in Maine in the United States. The schools in Maine established a

statewide school and community partnerships network to address physical activity, nutrition, and tobacco use. In addition to this initiative some of the schools also employed a school health coordinator (SHC). The role of the SHC is to organize, facilitate, implement, and collaborate with outside health organizations to promote the health of students in schools. The authors found that, in the schools with the SHC, the odds of having a school-based tobacco use prevention program was almost two times higher than those schools without a SHC ($OR = 2.08$, $p = .013$). Similarly, in Iceland after experiencing a sharp rise in adolescent substance use a nationwide transdisciplinary health promotion approach was adapted in the school and community setting. This approach involved the collaboration of different social and health workers including public health professionals. After the implementation of this approach Iceland experienced a 60% decline in adolescent alcohol, cannabis, and tobacco use (Sigfusdottir et al., 2011). In both these research papers the findings were gathered through policy records and national surveys.

In Australia, another approach was adapted to bring together education and health. Stapinski et al. (2017) did a study evaluating an online database implemented in Australia called the Positive Choices Portal. The authors found that the top three barriers reported by teachers preventing them from providing effective substance use education were a lack of confidence, support, and time. To address these barriers the Positive Choices Portal provides teachers with up-to-date information on evidence-based prevention programing, information, support and educational resources for drug and alcohol information. Teachers who used the Positive Choices Portal were more likely to consider whether a resource had been tested in schools and shown to be effective and were more likely to select an evidence-based drug education resource to use compared to teachers who reported not using the portal. However, the results were not statistically significant and were collected from a survey sent out to a small sample of teachers.

This study does suggest that with access to information and support outside of the school, teachers may be more inclined to include evidence-based substance use prevention programs in their classrooms (Stapinski et al., 2017).

In Canada, school-based health promotion is encouraged through the collaboration of school boards and the health sector by the Pan-Canadian Joint Consortium for School Health (JCSH). The JCSH is a membership of 25 government departments/ministries and the PHAC. The aim of the JCSH is to strengthen cooperation among members to support healthy schools, increase effective and efficient collaboration between the health and education sectors and promote and support a comprehensive school health approach (CSH) (The Joint Consortium for School Health, 2020). CSH is an internationally recognized framework to promote school health in a holistic way, incorporating the entire school community. The CSH is a mechanism which schools can use to address issues such as physical activity, positive mental health, or injury prevention. The CSH is based on the World Health Organization's Ottawa Charter for Health Promotion (1986). It may also be referred to as 'health promoting school', 'healthy schools' or 'coordinated school health'. The CSH is made up of four interconnected components: teaching and learning, social and physical environment, partnerships and services, and policy. While many provinces have reported using the CSH approach, there is no surveillance of how schools are implementing this framework. There are a variety of studies and national surveys that measure student health, but very few that measure school-based health programs or the impact of the collaboration between the health and education sectors (The Joint Consortium for School Health, 2020).

Conclusion. In the end, collaboration between the health and education sector is encouraged yet little research has been done looking at the impact of this collaboration on

substance use prevention programing in schools. The two studies described in this section demonstrate that there may be a benefit to outside health organizations supporting education professionals to improve their ability to provide effective substance use prevention programs. However, these studies have small sample sizes and were done outside of Canada and therefore further research is needed to assess if these approaches would work in Canada.

Overall Conclusion

In summary, there is a myriad of research on school-based substance use prevention programs. In general, the majority of systematic reviews have found that combined and social competence approaches for school-based prevention programs have demonstrated the greatest effect in reducing student substance use across multiple countries and settings. However, the research has showed the effect to be moderate at best and in many instances very small (Faggiano et al., 2014; Hennessy & Tanner-Smith, 2015; Isensee & Hanewinkel, 2015; Lemstra et al., 2010; Porath-Waller et al., 2010; Strøm et al., 2014). Along with the type of program, other factors such as the level of interaction, types of materials used, who delivers the program, the involvement of peers or parents, the environment, the developmental stage of the adolescent, the number of risk behaviours addressed in the program and how the program is incorporated into the school day can all impact the effectiveness of the program (Espada et al., 2015; Hale et al., 2014; Hodder et al., 2015; MacArthur et al., 2016; MacArthur et al., 2018; Melendez-Torres et al., 2018; Newton et al., 2017; Onrust et al., 2016). However, most of these studies were not conducted in Canada but rather the United States, Europe, and Australia and while these programs may be effective in other countries, they may not be generalizable to other adolescent populations. There is also limited research looking into the prevalence of these programs in schools. The few studies that have explored this topic have found little participation in and

availability of evidence-based prevention programs in schools (Fletcher et al., 2010; Kumar et al., 2013; Ringwalt et al., 2008; Salas-Wright et al., 2019). There is also some research examining the role of collaboration between the health and education sector which shows promising results however, more research is needed in this area (O'Brien et al., 2010; Sigfusdottir et al., 2011; Stapinkski et al., 2017; Rigg & Menendez, 2018). The aim of the study presented in this thesis is to begin to fill this gap by examining the impact of PHU engagement in school-based substance use prevention programs on student substance use.

Chapter 3

Research Problem

Alcohol, cannabis, e-cigarettes and cigarettes are increasingly being used by adolescents in Canada. These substances have serious negative health consequences for adolescents. Furthermore, substance use often begins during adolescence (World Health Organization, 2014). Therefore, it is important to target preventative efforts during adolescence to prevent and/or delay alcohol, cannabis, e-cigarette and cigarette use. One method to achieve this is through school-based programs. While the evidence shows that not all school-based prevention programs are effective in all settings, there is a growing body of research demonstrating significant decreases in adolescent substance use with school-based prevention. One aspect of school-based prevention programs that has been demonstrated to be effective is having an adult, who is not the teacher, lead the program. This suggests a role for PHUs in school-based prevention programing. However, there is limited research demonstrating the engagement of PHUs in school prevention, the methods they use, or the impact their engagement has on preventing or reducing substance use among adolescents.

Research Questions

This study will look at alcohol, cannabis, e-cigarette and cigarette use among adolescents, the existing school-based prevention programs, and if and how PHUs engage with schools related to these programs to determine the impact on alcohol, cannabis, e-cigarette and cigarette use. Four research questions will be addressed in this study: 1) Do schools report having any PHU engagement in prevention programming at their school? 2) Do schools report having any PHU engagement in a) alcohol and/or cannabis use and b) e-cigarette and/or tobacco use prevention programming at their school? 3) What school characteristics predict a school reporting PHU engagement in a) alcohol and/or cannabis use and b) e-cigarette and/or tobacco

use prevention programming at their school? 4) Is PHU engagement in school-based alcohol and/or cannabis use and e-cigarette and/or tobacco use prevention programming associated with the likelihood of a student being a current a) alcohol, b) cannabis, c) e-cigarette or d) cigarette user, controlling for school-level and student level demographic characteristics? Overall, the aim of the study is to discover if there is an association between PHU engagement in school-based prevention programs and student alcohol, cannabis, e-cigarette and cigarette use in Alberta, BC and Ontario secondary schools.

The COMPASS Study

This study will use the data collected from the COMPASS study. The COMPASS study is an ongoing prospective cohort study. This study collects hierarchical longitudinal data from a convenience sample of secondary schools with students from grades 9 to 12 across Ontario, Alberta and BC in Canada. The COMPASS study began in 2012 collecting data over the 2012/13 academic year (Leatherdale et al., 2014). COMPASS is supported with funding from the Canadian Institutes of Health Research (CIHR) (OOP-110788, MOP-114875, PJT-148562, PJT-149092 and PJT-159693) and Health Canada (#1617-HQ-000012).

Participants

Participants are school boards (public and catholic), schools and students. School boards and schools were purposefully sampled. In order to be eligible for the study the school board had to be an English-speaking secondary school board. Once school board approval was obtained schools within that board were asked to participate. If a school was not part of a board, for example private schools, the school was asked directly to participate. For a school to be eligible to participate in the study it had to be an English-speaking secondary school with students from grades 9 to 12 and the school had to permit the use of active-information passive-consent

parental permission protocols. The main reason school boards and schools declined participation in the study was due to competing research demands (Leatherdale et al., 2014). Of all the eligible students across Alberta, BC and Ontario, 80.2% participated in the COMPASS study over the 2018/19 data collection year. The participation rate in each province was 82.4%, 79.8% and 78.2% in Alberta, BC and Ontario respectively.

From the schools that were eligible and agreed to participate, students were recruited using active-information passive-consent permission protocols. The parent(s) or guardian(s) of eligible students were mailed information about the study and asked to contact the recruitment coordinator if they did not want their child to participate in the study. At any time during the study the student was able to withdraw (Leatherdale et al., 2014).

Data Collection

Data was collected using the COMPASS Student Questionnaire (Cq) and the COMPASS School Programs and Policies Questionnaire (SPP).

Research Methods

Design

This study used a cross-sectional hierarchical linked student- and school-level data collected from the COMPASS study (Leatherdale et al., 2014). All procedures in the COMPASS study received ethics approval from the University of Waterloo Research Ethics Board (ORE 30118), as well as all participating school board review panels. A full description of the COMPASS host study is available online (www.compass.uwaterloo.ca) and in print (Leatherdale et al., 2014).

Setting

The data for this study were collected from a convenience sample of secondary schools (grades 9 to 12) in Alberta (n = 8), BC (n = 15) and Ontario (n = 61), during Wave seven (2018-19) of the COMPASS study. Wave seven data was selected for use because the 2018/19 data was collected during the academic year immediately following the legalization of cannabis in Canada via Bill C-45 (Government of Canada, 2018) on October 17, 2018. Quebec was not included in this study because of the unique and comprehensive relationships that exist between PHUs and schools in Quebec. Quebec schools are mandated to participate in knowledge translation and exchange activities such as the COMPASS study. When a school in Quebec participates in the COMPASS study the school board representatives, school-level representatives, public health experts and a COMPASS researcher all meet to discuss the findings from the COMPASS study for the school. Schools in Quebec are therefore aware of the health promotion needs of their school and are offered immediate support in the planning and implementation of evidence-based health interventions from the public health professional. The focus of this study was to evaluate if PHUs are engaged in school-based substance use prevention programs and the impact of this engagement on student substance use. However, because of the nature of the relationship between COMPASS research staff, public health and schools in Quebec it is already known that when a Quebec school is participating in the COMPASS study, they will have PHU engagement. Including Quebec in this study would have skewed the results and masked the underlying issues of low engagement seen in other provinces (Brown et al., 2019).

Participants

Within the 84 participating schools, student-level data were collected from 44,378 grade 9 to12 students in Ontario (n = 30,675), Alberta (n = 3,301) and BC (n = 10,402). Using active-

information, passive-consent parental permission protocols, eligible consenting students completed the COMPASS questionnaire (Cq) during class time.

Data Collection

School-Level Data

SPP Questionnaire. The SPP questionnaire was completed by a school administrator who knew the most about the school's policies and programs. This questionnaire is a modified version of the Health School Planner (HSP) tool which has been previously validated (Leatherdale et al., 2014). The 58-item questionnaire collects data regarding relevant programs and or policies that relate to the data collected on the student questionnaire (student health and behaviour). The SPP questionnaire also measures any changes to policies, practices or resources. The questionnaire is administered online. Each administrator is sent an email with a personalized link to the SPP questionnaire. A COMPASS recruitment coordinator reviews responses and follows up with the school administrator if additional details are required. The schools receive a $250 honorarium after the completed SPP questionnaire has been submitted to the COMPASS staff. Relevant policy handbooks are also collected if additional document review is required (Leatherdale et al., 2014).

Demographics. Neighborhood-level characteristics surrounding each participating school were collected from the 2016 Canadian Census using postal codes within corresponding school boundaries. Like other studies, this information will provide data on the urbanicity and socio-economic status (SES) of the school (Zuckermann et al., 2019). Schools in a location with a population from 100,000 or greater and a population density of at least 400 per square kilometer were defined as large urban. Schools in a location with a population between 30,000 to 99,999 and a population density of at least 400 per square kilometer were defined as medium urban, and

schools in a location with a population less than 30,000 or a population density under 400 per square kilometer were defined as small urban. The median household income for the school catchment area acted as a proxy for SES (Statistics Canada, 2020). School enrollment data for the 2018/19 academic year for each participating school was also collected.

Public Health Unit Engagement. In the SPP questionnaire school administrators were asked about their level of engagement with PHUs. PHU engagement in schools will be defined as any form of collaboration between the local PHU and the school. For the purposes of this study, a school identified as having PHU engagement would indicate that the schools local PHU was involved in developing, implementing, planning, supporting and/or providing resources for programs and/or curricula related to alcohol, cannabis, e-cigarette and/or tobacco use prevention (MOHLTC, 2018). For each of the school policies and practices measured in the SPP questionnaire the school was asked about the level of PHU engagement. These questions were used to identify schools with or without PHU engagement. School administrators were asked '*During the past 12 months, what role did your local Public Health Unit play when working with your school on addressing [specific health behaviour] for students?'* School administrators were given four options to choose from and were asked to select all that applied to their school: 1) '*No contact with local Public Health Unit'*; 2) '*Provided information/resources/programs (e.g., posters, toolkits)*'; 3) '*Solved problems jointly'*; and 4) '*Developed/implemented program activities jointly'*. If school administrators selected the first option, the school was defined as having no engagement with a PHU. If option two, three and/or four were selected, the school was defined as having overall engagement with PHUs. However, this question does not address each outcome separately, as alcohol and cannabis use behaviours are addressed in one question and e-cigarette and tobacco use behaviours in another question. Therefore, the data analysis for

this study assessed PHU engagement in alcohol and/or cannabis use prevention programs together and PHU engagement in e-cigarette and/or tobacco use prevention programs together. School administrators were also asked: *'Other than classes/curriculum, does your school offer any programs that address [specific health behaviour] prevention?*' If school administrators answered '*yes*', then the follow-up question '*Who runs these programs*?' was asked. School administrators could select from three options: 1) '*Programs run by school'* 2) '*Programs run by external organization'*; and 3) '*Programs run by Public Health Unit'*. If school administrators selected option three the school was analyzed as having overall engagement with a PHU. Furthermore, the level of PHU engagement was assessed based on the school administrator's response to the above questions. The school was identified as having one of four levels of PHU engagement. School administrators who reported PHUs '*Provided information/resources/programs (e.g., posters, toolkits)*', '*Solved problems jointly'*, '*Developed/implemented program activities jointly'* or '*Programs run by Public Health Unit'* was assessed as having a level one, two, three or four engagement with PHUs, respectively. Schools categorized as having the first level of engagement with PHUs had the least amount of engagement and schools with the fourth level of engagement had the greatest amount of engagement with PHUs.

Student-Level Data

COMPASS Questionnaire. The Cq is the questionnaire used by COMPASS to collect student level data. This 72-item questionnaire collects information pertaining to student health, behaviour and demographic data. The questionnaire is completed during class time and took approximately 30 to 40 minutes to complete. Teachers distribute a paper format of the questionnaire and read instructions to the students. The students place their completed

questionnaire in individual sealed envelopes which are returned to COMPASS data collectors. The COMPASS data collectors are trained research staff and graduate students. Questions regarding student cannabis and e-cigarette use are consistent with the questions used on national surveys (Leatherdale et al., 2014). Self-reported smoking questions were validated by Wong et al. (2012). Wong et al. (2012) compared self-reported smoking levels to cotinine urine levels. Cotinine is a metabolite of nicotine and is a widely accepted objective measure of smoking (Wong et al., 2012). The authors found that 91.6% of participants who were classified as smokers based on their cotinine concentration also reported being cigarette smokers. Overall, the sensitivity and specificity of self-reported smoking status in male and female participants between the ages of 12 to 19 years were found to be 81.6% and 96.9% respectively.

Current Binge Drinking. Participating students were asked to report *'In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?'* Students were asked to respond with one of the following eight options: 1) *'I have never done this'; 2) 'I did not have 5 or more drinks on one occasion in the last 12 months'*; 3) *'less than once a month'*; 4) *'Once a month'*; 5) *'2 to 3 times a month'*; 6) *'once a week'*; 7) '*2 or 5 times a week'*; 8) *'daily or almost daily'*. Consistent with previous research (CSTADS, 2019; Gohari et al., 2019; Williams et al., 2020), a student was considered a current binge drinker if they reported having five or more drinks on one occasion at least once a month. If a student reported *'I have never done this'*, *'I did not have 5 or more drinks on one occasion in the last 12 months'* or *'less than once a month'* they were considered a non-current user.

Current Drinking. To measure alcohol use students were asked *'In the last 12 months, how often did you have a drink of alcohol that was more than just a sip?'* Students were asked to respond with one of the following ten options: *1) 'I have never drunk alcohol'; 2) 'I did not*

drink alcohol in the last 12 months'; 3) 'I have only had a sip of alcohol'; 4)' less than once a month'; 5) 'once a month'; 6) '2 or 3 times a month'; 7) 'once a week;' 8) '2 or 3 times a week'; 9) '4 to 6 times a week' or 10) 'every day'. Consistent with previous research (Gohari et al., 2019; Williams et al., 2019), a student was considered a current drinker if they reported having a drink of alcohol that was more than just a sip, at least once a month. If a student responded *'I have never drunk alcohol', 'I did not drink alcohol in the last 12 months', 'I have only had a sip of alcohol'* or *'less than once a month'* they were considered a non-current user.

Cannabis Use. To measure cannabis use, students were asked '*In the last 12 months how often did you use marijuana or cannabis (a joint, pot, weed, hash)?*' Students were asked to respond with one of the following nine options: 1) '*I have never used marijuana'*; 2) '*I have used marijuana, but not in the last 12 months*'; 3) '*Less than once a month'*; 4) '*Once a month'*; 5) '*2 or 3 times a month'*; 6) '*once a week'*; 7) '*2 or 3 times a week';* 8) *'4 to 6 times a week'* or 9) *'Every day'*. Consistent with previous research (Williams et al., 2019), a student was considered a current cannabis user if they reported using cannabis at least once a month. If a student reported '*never'* using cannabis, *'I have used marijuana but not in the last 12 months'* or *'less than once a month'* they were considered a non-current user.

E-cigarette Use. To measure e-cigarette use, students were asked '*On how many of the last 30 days did you use an e-cigarette?'* Students were asked to respond with one of the following eight options 1) '*None'*; 2) '*1 day'*; 3) '*2 to 3 days'*; 4) '*4 to 5 days'*; 5) '*6 to 10 days'*; 6) '*11 to 20 days'*; 7) '*21 to 29 days*' or 8) '*30 days (every day)*'. Consistent with previous research (Aleyan et al., 2019; Cole et al., 2019; Williams et al., 2019), a student was considered a current e-cigarette user if they reported smoking an e-cigarette at least once in the last 30 days. If

the student responded that they did not use any e-cigarettes over the last 30 days, they were considered a non-current user.

Current Smoking. To measure cigarette use students were asked '*On how many of the last 30 days did you smoke one or more cigarettes?*' Students were asked to respond with one of the following eight options 1) '*none';* 2) '*1 day'*; 3) '*2 to 3 days'*; 4) '*4 to 5 days'*; 5) '*6 to 10 days'*; 6) '*11 to 20 days'*; 7) '*21 to 29 days'* or 8) '*30 days (every day)*'. Consistent with previous research (Aleyan et al., 2019; Cole et al., 2019; Williams et al., 2019), a student was considered a current cigarette user if they reported smoking a cigarette at least once in the last 30 days. If the student responded that they did not use any cigarettes over the last 30 days, they were considered a non-current user.

Demographics. This study also considered self-reported demographic data collected by the COMPASS student questionnaire. At the beginning of the student questionnaire students are asked questions to describe themselves. This study used data collected from the following questions: '*What grade are you in?*', '*Are you male or female*?', '*How would you describe yourself*?' 1) '*White'*, 2) '*Black'*, 3) '*Asian'*, 4) '*Hispanic'*, 5) '*Other/Mixed'.*

Data Analysis

For the data analysis, PHU engagement with school-based prevention programs was the independent variable, and alcohol, cannabis, e-cigarette and cigarette use were the dependent variables. Alcohol, cannabis, e-cigarette and cigarette use were measured as current user or non-current user as described earlier. PHU engagement in school-based prevention programs was measured as no PHU engagement, any PHU engagement or one of four levels of PHU engagement. SAS version 9.4 was used to analyze the data and the alpha was set to 0.05.

Descriptive Statistics

Descriptive statistics were conducted initially to describe the sample. Counts, percentages and chi-square tests were calculated for dichotomous and categorical variables: PHU engagement, grade, gender, self-identified ethnicity, province and urbanicity. Mean, standard deviation and t-tests were calculated for the continuous variables: SES and school size. The prevalence of current alcohol, cannabis, e-cigarette and cigarette use among the sample was described. For each substance, the counts and percentages of students along with a chi-square test or t-test for each descriptive variable were also presented.

Research Question One: Do schools report having any PHU engagement in prevention programming at their school?

To answer this question data from the COMPASS SPP questionnaire was used. The number of schools that stated they had PHU engagement in any of their health programs was counted and presented as a percentage of all participating schools.

Research Question Two: Do schools report having any PHU engagement in a) alcohol and/or cannabis use and b) e-cigarette and/or tobacco use prevention programming at their school?

To answer this question data from the COMPASS SPP questionnaire was used. Schools which reported engagement with public health specifically in the corresponding prevention programs (alcohol and/or cannabis and e-cigarette and/or tobacco use prevention programs) were counted and presented as a percentage of the entire sample of schools (with or without public health engagement). Schools with PHU engagement in both alcohol and/or cannabis and e-cigarette and/or tobacco use prevention programs, schools with no PHU engagement in either programs and schools with PHU engagement in only one of these programs were also counted.

Finally, the level of PHU engagement in alcohol and/or cannabis and e-cigarette and/or tobacco use prevention programs was counted and presented.

Research Question Three: What school characteristics predict a school reporting PHU engagement in a) alcohol and/or cannabis use and b) e-cigarette and/or tobacco use prevention programming at their school?

To answer this question data from the COMPASS SPP questionnaire related to PHU engagement in alcohol, cannabis, e-cigarette and tobacco use prevention programs along with the school-level independent variables (province, urbanicity, SES and school size) were analyzed. Chi-square tests were done with the categorical school-level variables (province and urbanicity) and t-tests with the continuous variables (SES and school size). Each school-level variable was tested for associations with PHU engagement in alcohol and/or cannabis use prevention programming and e-cigarette and/or tobacco use prevention programming.

Research Question Four: Is PHU engagement in school-based alcohol and/or cannabis use and e-cigarette and/or tobacco use prevention programming associated with the likelihood of a student being a current a) alcohol, b) cannabis, c) e-cigarette or d) cigarette user, controlling for school-level and student level demographic characteristics?

To answer this question student and school level data were analyzed with a multilevel logistic regression analysis using generalized estimating equations (GEE) with exchangeable working correlation to cluster by school. A GEE is used to estimate the parameters of a regression model when a potential correlation exists between subjects. GEE methods are robust even when the covariance structure is mis-specified and can therefore account for dependence between subjects, even when the exact structure of the correlation is unknown. This analysis using GEE accounts for the clustering of similar students within a school (Fitzmaurice &

Ravichandran, 2008), based on the assumption that students within the same school may be more alike compared to students from other schools. The analysis included ten models. There were two models for each substance. The first model looked at the relationship between substance use outcomes and any level of PHU engagement and the second model looked at the relationship between the different levels of PHU engagement. Each model controlled for school level and student level demographic characteristics. Each multilevel logistic regression involved three stages. First an unadjusted model examined the bivariate relationship between PHU engagement and substance use, without controlling for any other variables. The second model added in the school level control variables. The third, fully adjusted model includes both student and school control variables. This model determined the association between the student level and school level variables and the outcome (student alcohol, cannabis, e-cigarettes or cigarette use). The result of these analyses produced the odds ratio of students using alcohol (cannabis, e-cigarettes or tobacco) in schools with given levels of PHU engagement compared to similar students from schools without PHU engagement, controlling for student and school level variables (Austin & Merlo, 2017).

Chapter 4
Results

In this section the results from the data analysis will be summarized. First, the sample size and missing data will be discussed. Next the descriptive statistics will be presented for the school-level variables, student-level variables and both school and student level variables for each of the substance use measures. Finally, the results for each research question will be described.

Sample

The full sample consisted of 84 schools and 44,378 students. For the SPP questionnaire collected from schools, there was no missing data. For the student-level data there was demographic data missing for 1,001 students and missing outcome data for 1,228. Any students with missing data were excluded from the analysis, representing 5% missing data. Five percent or lower is considered an acceptable percentage of missing data to achieve an unbiased sample (Dong & Peng, 2013; Jakobsen et al., 2017; Schafer, 1999). The final sample consisted of 42,149 students.

Descriptive Statistics

The descriptive statistics will be presented in three different sections: school-level, student level and descriptive statistics for each substance. The school-level and student-level descriptive statistics provide the number of schools for each of the school-level variables and the number of students for each of the school and student-level variables. In the third section each substance will be examined separately. The chi-square and t-test analyses for each substance and the school and student-level variables will be discussed along with the number and percentage of students reporting use for each school and student-level variable (see Appendix H).

School-Level Variables

The school level descriptions show the number and percentage of schools and students in each province, the urbanicity of the school location and the number of students in those schools who participated in COMPASS during the 2018/19 academic year, the SES of the school population and the mean school enrollment size. The majority of the schools (73%, *n* = 61) and students (69%, *n* = 29,181) were from Ontario. Over half the students in this study were from large urban centers (57%, *n* = 24,110) (see Appendix H, Table H1). Based on the 2016 Canadian census data, the average median household income for the neighborhoods surrounding the participating schools was $72,660. Finally, mean enrollment size for all the included schools was 528 students, the lowest school enrollment size was 83 and the largest was 1,305 (see Appendix H, Table H2).

Student-Level Variables

The student descriptive statistics show the number and percentage of students in each grade, gender and ethnicity and the number of students who did or did not report current use of alcohol, cannabis, e-cigarettes and/or cigarettes. There was a relatively equal distribution of students from each of the four grades and between male (*n* = 21,256) and female (*n* = 20,893) participants. Over half the participating students self-reported as white (59%, *n* = 24,750), 18% (*n* = 7,452) reported as other/mixed, 16% (*n* = 6,770) as Asian, 4% (*n* = 1,822) as Black and 3% (*n* = 1,355) as Hispanic. Alcohol and e-cigarette use had the highest percentage of students reporting current use. For both alcohol and e-cigarette use, 29% of students reported past 30-day use (*n* = 12,103 and *n* = 12,135 for alcohol and e-cigarette use respectively). Binge drinking had the next highest rate of students reporting use (17%, *n* = 7,110) followed by cannabis use (16%,

n = 6,768). Current cigarette use had the lowest percentage of students reporting use (8%, *n* = 3,265) (see Appendix H, Table H3).

Descriptive Statistics by Student Substance Use

To provide greater insight into the characteristics of students who use alcohol, cannabis, e-cigarettes and cigarettes and the schools they attend, the school and student level descriptive statistics were examined for each substance measured in this study. For the categorical variables, a chi-square test was preformed to measure the association between the school and student level variables and student substance use. For the continuous variables, a t-test was preformed to determine if there was a statistically significant difference between students reporting substance use and school income and size. The only categorical variables not found to be statistically significantly associated with substance use were: any PHU engagement with binge drinking $X^2(1, N = 42{,}149) = 0.31$, $p = .578$, alcohol use $X^2(1, N = 42{,}149) = 3.24$, $p = .072$ and cannabis use $X^2(1, N = 42{,}149) = 1.13$, $p = .288$. The remaining categorical variables were found to be statistically significantly associated with student substance use. For the continuous variables, there was no significant difference between students reporting cannabis use and school median income $t(42{,}147) = -1.05$, $p = .294$ and students reporting cigarette use and school median income $t(42{,}147) = -1.01$, $p = .311$. The remaining continuous variables all demonstrated statistically significant differences between student substance users and non-users (see Appendix H, Table H4, Table H5, Table H6, Table H7 and Table H8).

Current Binge Drinking. Seventeen percent of students from schools with no PHU engagement (*n* = 2,379) and 17% of students from schools with PHU engagement (*n* = 4,731) reported binge drinking in the last 30-days. Schools in Alberta (27%, *n* = 854) and schools from small urban/rural areas (24%, *n* = 2,594) reported the highest percentage of student use. Female

students (15%, *n* = 3,223) reported less use compared to male students (18%, *n* = 3,887). Grade 12 students had the highest reported rate of current binge drinking (26%, *n* = 2,374) and grade 9 students reported the lowest (8%, *n* = 852). Students self-reporting as White reported the highest percentage of current binge drinking (19%, *n* = 4,808) (see Appendix H, Table H4).

Current Alcohol Use. Students from schools without PHU engagement reported lower rates of alcohol use (28%, *n* = 4,005) compared to students from schools with PHU engagement (29%, *n* = 8,098). Schools in Alberta (40%, *n* = 1,264) and from small urban areas (38%, *n* = 4,102) reported the highest rate of current alcohol use among students. Female students reported slightly lower rates of alcohol use (28%, *n* = 5,835) compared to males (30%, *n* = 6,268). Grade 9 students had the lowest reported rate of alcohol use (16%, *n* = 1,775) and grade 12 students had the highest rate of alcohol use (41%, *n* = 3,682). Students self-reporting as White reported the highest percentage of current drinking (34%, *n* = 8,330) (see Appendix H, Table H5).

Current Cannabis Use. Sixteen percent of students from schools without PHU engagement (*n* = 2,246) and 16% of students from schools with PHU engagement (*n* = 4,522) reported using cannabis at least once a month. BC had the lowest percentage of students reporting cannabis use (12%, *n* = 1,144) compared to Ontario (17%, *n* = 5,058) and Alberta (18%, *n* = 566). Students from schools in medium and small urban/rural areas had the same percentage of students reporting use (20%), while students from large urban areas reported lower use (13%, *n* = 3,207). Students in grade 12 had the highest percentage of reported use (23%, *n* = 2,113) and students in grade 9 the lowest (9%, *n* = 935). Female students (14%, *n* = 2,886) had a lower rate of use compared to male students (18%, *n* = 3,882). Students who self-reported as Black had the highest percentage of students reporting cannabis use (22%, *n* = 401) (see Appendix H, Table H6).

Current E-Cigarette Use. Schools reporting no PHU engagement had a lower percentage of students reporting current e-cigarette use (28%, *n* = 3,600) compared to students from schools with PHU engagement (29%, *n* = 8,535). Alberta had the highest percentage of students reporting e-cigarette use (35%, *n* = 1,110) compared to Ontario (30%, *n* = 8,885) and BC (22%, *n* = 2,140). Students from medium (35%, *n* = 2,508) and small urban/rural locations (35%, *n* = 3,786) reported an 11-percentage point higher rate of e-cigarette use compared to schools from large urban centers (24%, *n* = 5,841). The rate of e-cigarette use increased as grade increased from 21% of grade 9 students (*n* = 2,314) to 35% of grade 12 students (*n* = 3,113). Males reported a five-percentage point higher rate of use (31%, *n* = 6,646) compared to female students (26%, *n* = 5,489). Students who self-reported as White had the highest percentage of use (32%, *n* = 8,021) followed closely by those who reported as Other/Mixed (31%, n = 2,336), Hispanic (30%, *n* = 405) and Black (26%, *n* = 470) (see Appendix H, Table H7).

Current Cigarette Use. Schools reporting no PHU engagement had a higher percentage of students reporting current cigarette use (9%, *n* = 1,149) compared to students from schools reporting PHU engagement (7%, *n* = 2,116). Alberta had the highest percentage of reported users (12%, *n* = 374) compared to Ontario (8%, *n* = 2,276) and BC (6%, *n* = 615). Schools from small urban/rural areas had the highest percentage of reported use (12%, *n* = 1,308) and students from large urban areas had the lowest use (6%, *n* = 1,336). The percentage of student users increased as the students increased in grade with 12% (*n* = 1,065) of grade 12 students reporting use compared to 5% (*n* = 499) of students in grade 9. The percentage of males who reported using cigarettes (9%, *n* = 1,839) was slightly higher than the percentage of females (7%, *n* = 1,426). Students who self-reported as Other/Mixed ethnicity reported the highest rate of use (12%, *n* = 891) (see Appendix H, Table H8).

Summary. Overall, the rate of any substance use was similar between schools with and without PHU engagement. Students from schools in small urban/rural areas reported the highest percentage of use for all substances. Schools from medium urban locations reported the same rates of use as schools in small urban/rural areas for cannabis and e-cigarette use and schools from large urban areas reported lower rates of substance use for all substances by six to 15 percentage points. For all substances, use increased as student grade increased, and males reported higher use compared to females. Rates of substance use varied by ethnicity.

Research Question One: Do schools report having any PHU engagement in prevention programming at their school?

Overall, 87% (*n* = 73) of schools reported PHU engagement in at least one of the seven health domains; physical activity, healthy eating, bullying, sedentary behaviour, mental health, tobacco and e-cigarette use and alcohol and cannabis use (see Appendix I, Table I1). Of these schools, 34% (*n* = 25) reported engagement in all seven health domains (see Appendix I, Table I2). Healthy eating programs had the highest number of schools reporting PHU engagement (82%, *n* = 60) and sedentary behaviour had the least number of schools reporting PHU engagement (47%, *n* = 34) (see Appendix 1, Table I3). PHU engagement in any health domain was also examined based on the school-level variables; province, urbanicity, SES and size.

Of all the schools reporting PHU engagement 77% (*n* = 56) were from Ontario, 16% (*n* = 12) were from BC and 7% (*n* = 5) were from Alberta. Within each province, 92% of schools in Ontario, 63% of schools in Alberta and 80% of schools in BC reported PHU engagement. Of all the schools reporting PHU engagement, the smallest percentage of schools were from medium urban locations (14%, *n* = 10), 46% (*n* =34) were from large urban locations and 40% (*n* = 29) were from small urban/rural locations. Within each level of urbanicity, 92% of schools from

large urban centers reported PHU engagement, 88% from small urban/rural areas and 71% from medium urban locations. For this research question, median household income and school enrollment size were divided into quartiles to provide more meaningful data. Of all the schools reporting PHU engagement the highest percent (27%, $n = 20$) were from the lowest income quartile and the lowest percent of schools reporting PHU engagement were from the highest income quartile (22%, $n = 16$). Of the schools from the lowest income quartile 95% reported PHU engagement and of the schools from the highest income quartile 76% reported PHU engagement. Finally, the highest percentage of schools reporting PHU engagement were from schools with the highest enrollment size (27%, $n = 20$). Of the schools in the highest enrollment quartile, 95% reported PHU engagement (see Appendix I, Table I4).

Research Question Two: Do schools report having any PHU engagement in a) alcohol and/or cannabis use and b) e-cigarette and/or tobacco use prevention programming at their school?

Alcohol and/or Cannabis Use Prevention Programming

Overall, 64% of schools ($n = 54$) reported PHU engagement in alcohol and/or cannabis use prevention programming (see Appendix J, Table J1). Of these schools, 28% ($n = 15$) reported having the PHU run the prevention program, the highest level of PHU engagement (level four), and 44% ($n = 24$) of schools reported that the PHU provided information/resources, the lowest level of PHU engagement (level one) (see Appendix J, Table J2).

E-cigarette and/or Tobacco Use Prevention Programming

Sixty-seven percent of schools ($n = 56$) reported PHU engagement in e-cigarette and/or tobacco use prevention programming (see Appendix J, Table J3). Of these schools, 27% ($n = 15$)

reported that the PHU ran the prevention program (level four), and 41% (n = 23) reported that the PHU provided information/resources (level one) (see Appendix J, Table J4).

Alcohol and/or Cannabis Use and E-cigarette and/or Tobacco Use Prevention Programming

Schools reporting both alcohol and/or cannabis use and e-cigarette and/or tobacco use prevention programming were also counted. Of all 59 schools that reported PHU engagement in at least one of these programs, eight schools (14%) reported having PHU engagement in only one and 51 schools (86%) reported having PHU engagement in both (see Appendix J, Table J5).

Research Question Three: What school characteristics predict a school reporting PHU engagement in a) alcohol and/or cannabis use and b) e-cigarette and/or tobacco use prevention programming at their school?

Alcohol and/or Cannabis Use Prevention Programming

For the categorical variables, the only variable with a statistically significant association with PHU engagement was the province in which the school resides $X^2(2, N = 84) = 14.66$, $p < .001$. Ontario had the greatest percentage of schools reporting PHU engagement (75%, n = 46). In Alberta, only one school reported PHU engagement (13%) and in BC less than half the schools reported engagement with PHUs (47%, n = 7). The urbanicity of the school's location was not significantly associated with PHU engagement in schools $X^2(2, N = 84) = 1.22$, $p = .542$ (see Appendix K, Table K1). For the continuous variables, there was a statistically significant difference in median income between schools that did and did not report PHU engagement $t(82) = 2.78$, $p = .007$. Schools reporting PHU engagement had a lower median income (M = \$69,150/year) compared to schools not reporting PHU engagement (M = \$78,990/year). There was no significant difference in school enrollment size between schools with and without PHU engagement $t(82) = -0.75$, $p = .456$ (see Appendix K, Table K2).

Counts of schools reporting the different levels of PHU engagement in alcohol and/or cannabis use prevention programming were also calculated. Ontario had the largest percentage of schools with the highest level of PHU engagement (30%, $n = 14$). Alberta had no schools reporting the highest level of PHU engagement and BC had one school (14%). Schools from medium urban locations had the highest percentage of schools reporting the highest level of PHU engagement (33%, $n = 3$); however, large urban (27%, $n = 7$) and small urban/rural schools (26%, $n = 5$) had similar rates (see Appendix K, Table K3). Schools which reported no PHU engagement came from areas with the highest median income (M = $78,990/year). Schools which reported the lowest level of PHU engagement (level one) came from areas with the lowest median income (M = $66,390/year), however the schools which reported level three (M = $68, 940/year) and level four (M = $68,640/year) had just slightly higher median incomes. Schools which reported the second level of engagement had the highest median school income (M = $78,570). Mean school size was relatively evenly distributed across all levels of PHU engagement with a 129-person difference between the highest and lowest mean enrollment size (see Appendix K, Table K4).

E-cigarette and/or Tobacco use Prevention Programming

Similar to the results for alcohol and/or cannabis use prevention programming, province, $X^2(2, N = 84) = 17.23$, $p < .001$ and SES, $t(82) = 2.11$, $p = .038$ were statistically significantly associated with PHU engagement and urbanicity, $X^2(2, N = 84) = 0.29$, $p = .864$ and school size, $t(82) = -1.05$, $p = .298$ were not. Ontario had the highest percentage of schools reporting PHU engagement (79%, $n = 48$) followed by BC (47%, $n = 7$) and Alberta had the lowest (13%, $n = 1$) (see Appendix K, Table K5). Schools who reported PHU engagement also had a lower median

income (*M* = $70,080/year) compared to schools who did not report PHU engagement (*M* = $77,830/year) (see Appendix K, Table K6).

Counts of schools reporting the various levels of PHU engagement were also reported. For province, only one school in Alberta (13%) reported PHU engagement at the second level, the rest of the schools from Alberta reported no PHU engagement (87%, *n* = 7). In BC more than half of the schools reported no PHU engagement (53%, *n* = 8). Among schools in BC that did report PHU engagement, four reported the lowest level of engagement (57%) and one school reported PHU engagement at each level two, three and four. In Ontario the greatest percentage of schools reported level one engagement (40%, *n* = 19). For urbanicity, schools from small urban/rural locations had the greatest percentage of schools reporting no PHU engagement (36%, *n* = 12). Of the schools reporting engagement, schools from large urban locations had the greatest percentage of schools reporting the highest level of PHU engagement (32%, *n* = 8) (see Appendix K, Table K5 and Table K7). For SES, schools that reported no PHU engagement had the highest median income (*M* = $77,830/year) and schools that reported the highest level of engagement had the lowest median income (*M* = $66,430/year). For school size, there was a 157-person difference between the lowest and highest mean enrollment size across the different levels of PHU engagement (see Appendix K, Table K8).

Research Question Four: is PHU engagement in school-based alcohol and/or cannabis use and e-cigarette and/or tobacco use prevention programming associated with the likelihood of a student being a current a) alcohol, b) cannabis, c) e-cigarette or d) cigarette user, controlling for school-level and student-level demographic characteristics?

A multi-level logistic regression was completed for each outcome measure to determine the odds of a student using each substance when PHUs were engaged in either school based

alcohol and/or cannabis use prevention programs or e-cigarette and/or tobacco use prevention programs.

PHU Engagement in Alcohol and/or Cannabis Use Prevention Programming

Current Binge Drinking. Model one examined current binge drinking and any level of PHU engagement. As shown in Table L1, Model one, the results show no statistically significant association between PHU engagement compared to no PHU engagement and student binge drinking (*AOR* =1.07; 95% CI [0.88, 1.31], $p = .487$) (see Appendix L, Table L1). Model two examined current binge drinking and the level of PHU engagement. As shown in Table L2, model two, a student attending a school reporting PHUs 'solved problems jointly' (level two engagement) had a greater odds of binge drinking compared to a similar student from a school with no PHU engagement. This finding was statistically significant (*AOR* = 1.51, 95% CI [1.24, 1.83], $p < .001$). Similar results were observed in the unadjusted model and remained statistically significant as the model adjusted for school and student level variables. A statistically significant association was not observed between binge drinking and any other level of PHU engagement from the unadjusted to the final model (see Appendix L, Table L2).

Current Alcohol Use. Model three examined current alcohol use and any level of PHU engagement. As shown in Table L3, model three, the results show no statistically significant association between PHU engagement compared to no PHU engagement and student alcohol use (*AOR* = 1.09, 95% CI [0.91, 1.30], $p = .331$) (see Appendix L, Table L3). Model four examined current alcohol use and the level of PHU engagement. As shown in Table L4, model four, a student attending a school reporting PHUs 'solved problems jointly' (level two engagement) had a greater odds of using alcohol compared to a similar student from a school with no PHU engagement. This finding was statistically significant (*AOR* = 1.46, 95% CI [1.22, 1.74], $p <$

.001). Similar results were observed in the unadjusted model and remained statistically significant as the model adjusted for school and student level variables. A statistically significant association was not observed between alcohol use and any other level of PHU engagement from the unadjusted to the final model (see Appendix L, Table L4).

Current Cannabis Use. Model five examined current cannabis use and any level of PHU engagement. As shown in Table L5, model five, the results show no statistically significant association between PHU engagement compared to no PHU engagement and student cannabis use (*AOR* = 1.02, 95% CI [0.88, 1.18], *p* = .79) (see Appendix L, Table L5). Model six examined current cannabis use and the level of PHU engagement. As shown in Table L6, model six, a student attending a school reporting PHUs 'solved problems jointly' (level two engagement) had a greater odds of using cannabis compared to a similar student from a school with no PHU engagement. This finding was statistically significant (*AOR* = 1.37, 95% CI [1.07, 1.74], *p* = .012). Similar results were observed in the unadjusted model and remained statistically significant as the model adjusted for school and student level variables. The OR for any PHU engagement and the other levels of PHU engagement all showed non-significant ORs in the unadjusted model and these results remained non-significant as the school and student-level variables were added to the model (see Appendix L, Table L6).

PHU Engagement in E-cigarette and/or Tobacco Use Prevention Programming

Current E-cigarette Use. Model seven examined current e-cigarette use and any level of PHU engagement. As shown in Table L7, model seven, the results show no statistically significant association between PHU engagement compared to no PHU engagement and the odds of a student using e-cigarettes (*AOR* = 1.00, 95% CI [0.86, 1.16], *p* = .983) (see Appendix L, Table L7). Model eight examined current e-cigarette use and the level of PHU engagement. As

shown in Table L8, model eight, the results show no significant association between any of the levels of PHU engagement compared to no PHU engagement and student e-cigarette use. The OR for any PHU engagement and all four levels of engagement in the unadjusted model were also non-significant and remained non-significant as the model adjusted for school and student level variables (see Appendix L, Table L8).

Current Cigarette Use. Model nine examined current cigarette use and any level of PHU engagement. As shown in Table L9, model nine, the results show no statistically significant association between PHU engagement compared to no PHU engagement and student cigarette use (*AOR* = 0.9, 95% CI [0.68, 1.18], $p = .431$) (see Appendix L, Table L9). Model ten examined current cigarette use and the level of PHU engagement. As shown in Table L10, model 10, the results show no significant association between any of the levels of PHU engagement compared to no PHU engagement and student cigarette use. In the unadjusted model the odds of a student using cigarettes was statistically significantly lower for a student from a school reporting 'programs run by PHU' (level four engagement) compared to a similar student from a school with no PHU engagement however, when the school and student-level variables were adjusted for the *AOR* was no longer significant. The *OR*s in the unadjusted model for both any PHU engagement and the remaining levels of PHU engagement were non-significant and remained non-significant as the model adjusted for school and student level variables (see Appendix L, Table L10).

Research Question Five: Is PHU engagement in school-based alcohol and/or cannabis use and e-cigarette and/or tobacco use prevention programs in low or high-use schools associated with a student being a current a) alcohol, b) cannabis, c) e-cigarette or d) cigarette user?

Research question five was added to this study as an additional analysis to try to better understand the results of research question four; specifically, the results which showed a statistically significant increase in the odds of a student binge drinking, using alcohol or using cannabis in schools which reported PHUs 'solved problems jointly' in school-based alcohol and/or cannabis use prevention programming (see Appendix L). One possible explanation is that the schools reporting that PHUs 'solved problems jointly', could have recently requested the help of the PHU because the school noted an increase in student substance use. This may be the reason the results show a statistically significant higher odds of student use compared to students in schools with no PHU engagement. To explore this unexpected finding further, the same multi-level regression analysis using GEE with exchangeable working correlation as described in the data analysis section above for research question four (see page 60-61) was used. However, in this analysis the schools and students were separated into low and high-use schools. The percentage of students using alcohol, cannabis, e-cigarettes and cigarettes was calculated for each school. Students attending schools which reported substance use rates below the mean rate of substance use were analyzed in the low-use group and students from schools above the mean were analyzed in the high-use group. The results of this additional analyses will be presented below.

PHU Engagement in Alcohol and/or Cannabis Use Prevention Programming

Current Binge Drinking. Model one examined current binge drinking and any level of PHU engagement. As shown in Table M1, model one, the results show no statistically significant association between PHU engagement compared to no PHU engagement and student binge drinking in either low or high-use schools (see Appendix M, Table M1). Model two examined current binge drinking and the level of PHU engagement. As shown in Table M2, model two, a student attending a low-use school reporting PHUs 'provided information/resources' (level one) had a lower odds of binge drinking compared to a similar student from a low-use school with no PHU engagement. This result was statistically significant (*AOR* = 0.78, 95% CI [0.61, 1.00], p = .047). However, a student from a low-use school reporting PHUs 'solving problems jointly' (level two) had a greater odds of binge drinking compared to a similar student from a low-use school with no PHU engagement. This result was statistically significant (*AOR* = 1.61, 95% CI [1.26, 2.05], $p < .001$). In high-use schools, the results show no statistically significant association between any level of PHU engagement, compared to no PHU engagement, and student binge drinking (see Appendix M, Table M2).

Current Alcohol Use. Model three examined current alcohol use and any level of PHU engagement. As shown in Table M3, model three, the results show no statistically significant association between PHU engagement compared to no PHU engagement and student alcohol use in either low or high-use schools (see Appendix M, Table M3). Model four examined current alcohol use and the level of PHU engagement. As shown in Table M4, model four, a student attending a low-use school reporting PHUs 'solved problems jointly' (level two) had a greater odds of alcohol use compared to a similar student from a low-use school with no PHU engagement. This was a statistically significant result (*AOR* = 1.59, 95% CI [1.30, 1.94], $p <$

.001). In high-use schools, level two PHU engagement no longer had a statistically significant effect on current alcohol use (see Appendix M, Table M4).

Current Cannabis Use. Model five examined current cannabis use and any level of PHU engagement. As shown in Table M5, model five, the results show no statistically significant association between PHU engagement compared to no PHU engagement and student cannabis use in either low or high use schools (see Appendix M, Table M5). Model six examined current cannabis use and the level of PHU engagement. As shown in Table M6, model six, a student attending a low-use school reporting PHUs 'developed/implemented programs jointly' (level three engagement) had a greater odds of using cannabis compared to a similar student from a low-use school with no PHU engagement. This was a statistically significant result (*AOR* = 1.26, 95% CI [1.00, 1.59], $p = .049$). Whereas in high-use schools, a student attending a school reporting PHUs 'developed/implemented programs jointly' (level three engagement) had a lower odds of using cannabis compared to a similar student from a high-use school with no PHU engagement. This was a statistically significant result (*AOR* = 0.82, 95% CI [0.69, 0.98], $p = .026$). The second level of PHU engagement was no longer statistically significantly associated with cannabis use for students from either low or high-use schools. (see Appendix M, Table M6).

PHU Engagement in E-cigarette and/or Cigarette Use Prevention Programming

Current E-cigarette Use. Model seven examined current e-cigarette use and any level of PHU engagement. As shown in Table M7, model seven, the results show no statistically significant association between PHU engagement compared to no PHU engagement and the odds of a student using e-cigarettes in either low or high-use schools (see Appendix M, Table M7). Model eight examined current e-cigarette use and the level of PHU engagement. As shown in

Table M8, model eight, the *AOR* for all levels of engagement in both low or high-use schools showed non-significant results (see Appendix M, Table M8).

Current Cigarette Use. Model nine examined current cigarette use and any level of PHU engagement. As shown in Table M9, model nine, a student attending a high-use school reporting any level of PHU engagement had a lower odds of using cigarettes compared to a similar student from a high-use school with no PHU engagement. This was a statistically significant result (*AOR* = 0.79, 95% CI [0.64, 0.99], *p* = .04) (see Appendix M, Table M9). Model ten examined current cigarette use and the level of PHU engagement. As shown in Table M10, model 10, a student attending a high-use school reporting PHUs 'provided information/resources' (level one) had a lower odds of using cigarettes compared to a similar student from a high-use school with no PHU engagement. This was a statistically significant result (*AOR* = 0.74, 95% CI [0.58, 0.93], *p* = .011). The remaining levels of PHU engagement in high-use schools and all levels in low-use schools showed non-significant results (see Appendix M, table M10).

Conclusion

This study shows that PHUs are engaged in schools and PHU engagement in school-based substance use prevention programs can significantly reduce student substance use in some circumstances. However, there are also situations in which PHU engagement is linked to increased use for some substances. Overall, 87% of schools reported PHU engagement in at least one of the measured health domains and 34% of those schools were engaged in all seven health domains. Seventy percent of schools reported PHU engagement in alcohol and/or cannabis use and e-cigarette and/or tobacco use prevention programming. Statistically significantly lower odds of student substance use were seen when PHUs 'provided information/resources' (level one

engagement) in low-use schools for binge drinking and in high-use schools for cigarette use. Statistically significantly lower odds of cigarette use were also seen with any PHU engagement in high-use schools and when PHUs 'developed/implemented programs jointly' (level three engagement) in high-use schools for cannabis use. However, statistically significantly greater odds of student substance use were seen when PHUs 'solved problems jointly' (level two engagement) in any school for binge drinking, alcohol use and cannabis use and in low-use schools for binge drinking and alcohol use. Statistically significant greater odds of cannabis use were also seen when PHUs 'developed/implemented programs jointly' (level three engagement) in low-use schools. The remaining results showed no statistically significant effects.

Chapter 5

Discussion

This section will discuss the findings of this study, the study population, the limitations and the implications for practice and future research.

Study Findings

PHU Engagement in Any Health Domain

As part of the COMPASS study each participating school is assigned a knowledge broker from the COMPASS research team. The role of the knowledge broker is to provide a summary of the COMPASS findings for the school, recommendations to improve student health and provides the school with the contact information of their local PHU (Brown et al., 2019). This ensures that each participating school has an equal opportunity to engage with their local PHU in their health promotion programs. This study found that 87% of schools reported some level of PHU engagement in at least one health domain (physical activity, healthy eating, bullying, sedentary behaviour, mental health, tobacco and e-cigarette use and alcohol and cannabis use) and 34% of schools reported PHU engagement in all seven health domains. However, 13% of schools reported no PHU engagement and of the schools reporting PHU engagement, 66% did not have PHU engagement across all health domains. This is the first study of this kind to measure PHU engagement in school-based health programs and therefore no literature was found to compare these findings to. These results draw attention to the fact that there are schools with no PHU engagement and in the schools with PHU engagement, there is variability in the number of health domains in which PHUs are engaged. It is important for the health and education sectors to build partnerships and collaborate to enhance student health and wellness at this crucial stage of life (JCSH, 2020; PHAC, 2018). The school setting provides opportunity to teach

students healthy habits and encourage positive health behaviours. The PHAC works with and supports the JCSH (JSCH, 2020), described earlier, which is in place to promote and enable relationships between the health and education sectors in Canada. The mandate of the JCSH is to strengthen cooperation between the health and education sectors through the Comprehensive School Health model to promote school health in every health domain (JCSH, 2009; JCSH, 2020). Yet based on these findings, PHUs appear to be underutilized with respect to healthy behaviour programming in schools. This study highlights the need for enhanced relationships between PHUs and schools to ensure every school is engaging with their local PHU in all health domains.

PHU Engagement in Substance Use Prevention Programs

Sixty-four percent of schools reported engagement in alcohol and/or cannabis use prevention programs and 67% reported engagement in e-cigarette and/or tobacco use prevention programs. Substance use can have serious lifelong health consequences for adolescents and with the increasing rates of substance use in Canadian adolescents it is important that PHUs are engaged with schools to address this issue (CSTADS, 2019; Health Canada, 2019; Health Canada, 2020; World Health Organization, 2018b). Studies have found that school-based prevention programs can reduce substance use, yet many schools may not have the time or resources to invest in these programs (O'Brien et al., 2010; Sigfusdottir et al., 2011; Stapinski et al., 2017). PHUs may be able to fill these gaps by providing the resources, knowledge and supports that schools need to provide students with effective evidence-based health promotion programs (Ontario Public Health, 2019; PHAC, 2018).

Both the JCSH and the PHAC have provided guidelines to assist public health, education and other professionals in their work to reduce adolescent substance use. The PHAC presented a

public health approach to addressing student substance use in The Chief Public Health Officers Report on the State of Public Health in Canada in 2018. This approach involves both population and individual-level interventions. The population interventions include broad interventions that benefit the greatest number of people, such as school-based prevention programming, and interventions that target the underlying social and economic inequities that lead to poor health outcomes. Individual-level interventions include interventions which focus on specific high-risk populations (PHAC, 2018). The JCSH published a knowledge kit: Addressing Substance Use in Canadian Schools. This document emphasizes that health education alone is not enough and that it is important to encompass the whole school environment in complex issues such as substance use prevention. The comprehensive whole-school approach not only means that all school staff are involved in the prevention programming, but it also means building partnerships and engaging with families and community agencies such as PHUs (JCSH, 2009). Based on the findings from this study, there is a need and opportunity to build on these partnerships and encourage greater PHU engagement in school-based substance use prevention programs.

PHU Engagement and Student Substance Use

When PHU engagement was analyzed at any level, no significant reduction in student substance use was seen. However, when PHU engagement was analyzed at different levels, it was found that when PHUs 'solved problems jointly' (level two engagement) with schools the odds of a student binge drinking, using alcohol or cannabis increased. No other level of PHU engagement had a statistically significant effect on student substance use. There are a few important aspects to be noted from these findings. First, there are situations in which PHU engagement in school-based substance use prevention programs increased the odds of a student using a substance. The finding that PHU engagement was linked to increased use was surprising,

and not intuitive. However, similar findings have been reported by others. For example, Ploeg et al. (1996) did a systematic review looking at the effectiveness of adolescent suicide prevention curricula programs and found both beneficial and harmful effects including one study which found an increase in hopelessness and maladaptive coping in males post intervention (Ploeg et al., 1996). Another example is from the systematic review by Thomas et al. (2013), described above. From the subgroup analysis of studies which measured a change in smoking behaviour over time the authors found statistically significant results favouring the control at one year or less follow-up (*SMD* = 0.04, 95% CI [0.02, 0.06]) (see appendix G). Second, in this study, there were also situations where PHU engagement decreased or had no effect on student substance use. This is consistent with the literature on the effectiveness of school-based substance use prevention programs. There are many systematic reviews which have found school-based prevention programs to be effective in reducing student substance use (Espada et al., 2015; Isensee & Hanewinkel, 2015; Lemstra et al., 2010; MacArthur et al., 2016; Onrust et al., 2016), however there are also several systematic reviews that have found certain prevention programs to be ineffective (Faggiano et al., 2014; Hodder et al., 2015 & Thomas et al., 2015). There are many factors that influence the effectiveness of school-based substance use prevention programs such as the program approach, the materials and presentation of the program, environmental resilience, how the program is incorporated into the school day, parental involvement, the impact of addressing multiple health risk behaviours in a single program and the developmental stage of the participants (Espada et al., 2015; Faggiano et al., 2014; Hale et al., 2014; MacArthur et al., 2018; Melendez-Torres et al., 2018; Newton et al., 2017; Onrust et al., 2016; Porath-Waller et al., 2010; Thomas et al., 2013; Thomas et al., 2015). However, the content, implementation and environment surrounding the prevention programs used by the participating schools in this study

is unknown. The focus of this study was to measure PHU engagement in the prevention program and not the effectiveness of the programs themselves, yet these variables will still have influenced the findings of this study. Therefore, some of the cases where PHU engagement increased student substance use, may have been influenced by these other factors which have been shown to decrease program effectiveness.

PHU Engagement in Low and High-use Schools and Student Substance Use

This study also found that when schools were divided into low and high-use schools, the effect of PHU engagement on student substance use was different for each group of schools. In general, PHU engagement in low-use schools increased the odds of student alcohol and cannabis use whereas PHU engagement in high-use schools demonstrated a greater effect in reducing the odds of a student binge drinking, using cannabis and smoking cigarettes. These results suggest the risk level of the school is important and may impact the effectiveness of PHU engagement on student substance use. This is consistent with the literature on school-based substance use prevention programs. Research has found that certain school-based prevention programs achieve greater results when focused on high-risk populations compared to the general student population and require less resources compared to a universal prevention program (Onrust et al., 2016).

One exception to this pattern was when PHUs engaged at the first level with low-use schools, the likelihood of a student binge drinking was statistically significantly lower compared to a similar student from a low-use school with no PHU engagement (see Appendix M). The first level of PHU engagement is ‘providing information/resources’. Based on the school’s response to this question, it would seem likely that the PHU was simply providing materials and information similar to a knowledge-based prevention program. Yet the existing literature on school-based substance use prevention programs has found knowledge-based programs to be

ineffective (Faggiano et al., 2014; Onrust et al., 2016; Thomas et al., 2013; Thomas et al., 2015). Since this study did not collect data on the content provided by the PHU, it is possible that the information/resources were used by the school as part of a larger more effective prevention program such as a combined approach prevention program in which case, we would expect to see a decreased odds of student binge drinking.

It is also important to note that while this study found situations in which PHU engagement statistically significantly decreased the odds of student substance use. The effect size was small at the high end of the confidence interval for binge drinking (*AOR* = 0.78, 95% CI [0.61, 1.00], *p* = .047), cannabis use (*AOR* = 0.82, 95% CI [0.69, 0.98], p=.026) and cigarette use (*AOR* = 0.79, 95% CI [0.64, 0.99], *p* = .04) (see Appendix M). This indicates that the impact of PHU engagement on student substance use may be of small effect even if found to be statistically significant. This is not surprising, as similar small effect sizes were also found in systematic reviews examining the effectiveness of school-based prevention programs for alcohol use (MacArthur et al, 2018; Melendez-Torres et al., 2018) cannabis use (Faggiano et al., 2014; Thomas et al., 2013; Thomas et al., 2015) and cigarette use (Isensee & Hanewinkel, 2015).

There are also two patterns seen in the association between PHU engagement and student substance use that may be of value to guide future relationships between PHUs and schools. First, the highest level of PHU engagement (level four) was not statistically significantly associated with a change in any substance use whereas PHU engagement at the first to third levels did result in a significant change in various substances. This suggests that even if the PHU is not running the program there is still a benefit when schools work with PHUs to obtain information/resources or jointly plan and implement programs. This is somewhat contradictory to previous research but in line with the guidelines from the JCSH and the PHAC which

encourage collaboration and partnership between schools and health professionals. Previous research has found that employing a health professional to run the prevention program has demonstrated greater reductions in student substance use compared to a teacher running the program (Espada et al., 2015; Porath-Waller et al., 2010). Based on this research it would be expected to see that schools reporting PHUs running the program would show a greater effect on student substance use, however this was not seen in this study. There are two factors that may have contributed to this inconsistency. First, there are a lot of unknown factors about the prevention programs implemented in the schools from this study. Secondly, there is limited research on program providers in school-based substance use prevention programs and the research that does exist, does not take into consideration various levels of engagement with health professionals (Rigg & Menendez, 2018). To the best of my knowledge, this is the first study to measure the impact of different levels of engagement in school-based substance use prevention programs from health professionals and therefore provides a unique understanding on the role of health professionals in school-based substance use prevention programs. Overall, the findings from this study suggest that PHUs should focus their limited resources on high-risk schools and on working with schools rather than running the prevention program to achieve the greatest benefit. Second, for e-cigarette use across any of the analyses, PHU engagement in e-cigarette and/or tobacco prevention programs made no significant impact on student e-cigarette use. This finding is not surprising as the increase in e-cigarette use among adolescents is a new issue and therefore schools may not have developed or implemented prevention programs to address e-cigarette use yet. With the increasing rates of e-cigarette use among Canadian adolescents and the unknown long term health consequences of e-cigarette use it will be important for PHUs to engage with schools on this issue (Aleyan et al., 2018; Azagba et al.,

2019; CSTADS, 2020; Czoli et al., 2014; Hammond et al., 2019; Soneji et al., 2017; Wills et al., 2017).

PHU Engagement and Province

For alcohol and/or cannabis use prevention programming, 75% of schools from Ontario, 47% of schools from BC and 13% of schools from Alberta reported PHU engagement (see Appendix K, Table K1). For e-cigarette and/or tobacco use prevention programming, 79% of schools from Ontario, 47% of schools from BC and 13% of schools from Alberta reported PHU engagement. (see Appendix K, Table K5). This trend was also seen in overall PHU engagement in any health domain. In Ontario 92% of schools reported PHU engagement in at least one health domain whereas 80% of schools from BC and 63% of schools from Alberta reported PHU engagement in at least one health domain. Overall, these findings show that PHU engagement in any health domain and in substance use prevention programs varies between provinces, with schools from Ontario reporting the highest rates of PHU engagement.

In Ontario, the Ontario Public Health Standards mandate that PHUs are engaged in schools, whereas in Alberta and BC, PHUs do not have this same mandate (Alberta Health Services, 2019; MOHLTC, 2018; The Province of British Columbia, 2019). The Ontario Public Health Standards explicitly state that PHUs are to partner and collaborate with school boards and schools to promote the health of school-aged children in various health domains including substance use (MOHLTC, 2018). This may be one of the reasons why such variation in PHU engagement in any health domain was observed across the provinces. This study did not examine why PHUs engaged in some health domains and not others however, the Ontario Public Health Standards also state that PHU interventions should be informed by the health needs of the school population (MOHLTC, 2018). How the PHU engages with schools and in what health domains is

not specifically directed. The PHU has the autonomy to determine priority populations and school communities at greatest risk of negative health outcomes and allocate resources to these areas (MOHLTC, 2018). Therefore, it is logical to theorize that PHUs focused their limited resources on the health domains they determined would benefit the most from their support (Fletcher et al., 2010). This may explain the lower PHU engagement in substance use prevention. However, in the Chief Public Health Officer's Report on the State of Public Health in Canada 2018, Dr. Theresa Tam did emphasize the importance of substance use prevention and described this time as a 'key moment' in Canada to review the state of substance use prevention initiatives and programs. Dr. Tam also highlighted the need for comprehensive prevention approaches requiring the collaboration and partnerships of multiple sectors including the health and education sectors (PHAC, 2018). Based on the direction from this report and the rising levels of adolescent substance use it is vital that PHUs engage with all schools on substance use prevention programming to prevent adolescent substance use.

PHU Engagement and SES

The median incomes from the households within the school boundaries were used as a proxy for SES. This study found that 95% of schools from lower income neighborhoods reported PHU engagement and only 76% of schools from the highest income neighborhoods reported PHU engagement in any health domain (see Appendix I, Table I4). This trend was also found for PHU engagement in substance use prevention programming, schools reporting PHU engagement had lower average median incomes compared to the schools that reported no PHU engagement (see Appendix K, Table K2 and K6). The PHACs report on Preventing Problematic Substance Use in Youth (2018) also emphasizes the need to create equitable social and economic conditions to address the underlying causes of many poor health outcomes including problematic substance

use (PHAC, 2018). This may be one of the reasons PHUs are focusing their limited resources on lower income schools. In contrast, research from the United States found higher rates of student participation in substance use prevention programs in schools from higher income neighborhoods (Kumar et al., 2013; Salas-Wright et al., 2019). However, there is a limited amount of research on the prevalence of school-based substance use prevention programs and PHU engagement in schools and how these resources are allocated.

PHU Engagement and Urbanicity

Schools from small urban/rural locations also reported the lowest percentage of PHU engagement in both alcohol and/or cannabis use prevention programs and e-cigarette and/or tobacco use prevention programs. However, urbanicity was not found to be a significant predictor of PHU engagement in schools (see Appendix K). Studies from the United States have also found that schools from rural locations were less likely to have evidence-based substance use prevention programs and student participation in these programs compared to schools from large urban areas (Ringwalt et al., 2008; Salas-Wright et al., 2019). This may be because it is logistically more difficult for PHUs to engage with schools in rural locations compared to schools in urban locations. However, this study found urbanicity to be a significant predictor of student substance use and found the rates of student substance use for all substances was highest in small urban/rural locations (see Appendix H). This suggests that there may be a greater need for more PHU engagement in school-based substance use prevention programs in small urban/rural schools.

Study Sample

Student level variables

Many studies have examined the trends and characteristics associated with adolescent substance use. Consistent with this literature and national surveys, this study also found that for every substance measured, substance use increased with grade, males reported higher rates of use compared to females and substance use varied with ethnicity (Chen & Jacobson, 2012; CSTADS, 2019; Cotto et al., 2010, Lee et al., 2015; Kumar et al., 2013; Moore et al., 2015; Patrick et al., 2012; Peiper et al., 2016; Schepis et al., 2011). Research has found that it can be more effective to address substance use early (PHAC, 2018) and that the developmental stage of students impacts the effectiveness of prevention programs (Onrust et al., 2016). Onrust et al. (2016), described earlier, found that substance use prevention programs showed greater effectiveness in late adolescents (grades 10 to 12). Taking this research into consideration it may be beneficial for PHUs to focus prevention programs on grade 10 students. This would provide prevention programs to students before the increase in substance use rates seen in grades 11 and 12 and at a point where the students are at a developmental stage to benefit from the program (Onrust et al., 2016; PHAC, 2018). Rates of substance use were also different based on gender and ethnicity and these variables may impact the effectiveness of substance use prevention programs (Chen & Jacobson, 2012; Windsor et al., 2015). Research looking at the role of gender on the effectiveness of substance use prevention programs is mixed. Some research has found no significant differences in program effectiveness between males and females (Thomas et al., 2013) while other research has found certain prevention programs to be more effective for males or females (Foxcroft et al., 2011). Therefore, it is important for PHUs to ensure the programs in place are evidence-based and take into consideration the characteristics of the population they are working with.

Province

Most of the schools (73%, *n* = 61) and students (69%, *n* = 29,181) were from Ontario. Fifteen schools were in BC (18%) and eight schools were in Alberta (9%). Alberta had the highest percentage of students reporting substance use for all substances measured (see Appendix H).

Urbanicity

Forty-four percent (*n* = 37) of schools were from large urban centers, 17% (*n* = 14) from medium urban and 39% (*n* = 33) from small urban/rural. For every substance, students from schools in small urban/rural locations reported the highest percentage of substance use (see Appendix H). This is consistent with the findings from the Canadian Centre on Substance Abuse, Urban and Rural Student Substance Use Technical Report published in 2015 for alcohol use and cannabis use in BC and Alberta (McInnis et al., 2015). In Ontario, cannabis rates were similar between students living in urban and rural locations (McInnis et al., 2015).

SES

The median income for all schools participating was $72,660/year (*SD* = 16.17) which is slightly higher than the 2015 median household income for Canada, $70,336/year (Statistics Canada, 2017). There was a statistically significant difference in the number of students reporting current binge drinking, alcohol and e-cigarette use and median income but not for cannabis or cigarette use. For every substance measured, students from schools with a higher average median income were more likely to report substance use (see Appendix H). The literature has found conflicting information on the relationship between SES and substance use. Some literature has found adolescents with lower SES have higher rates of student substance use whereas other research has found results, similar to this study, in which adolescents with higher SES have higher rates of adolescent substance use (Bachman et al., 2011; Pampel et al., 2010;

Shackleton et al., 2019). For example, a study from Canada found that people from low-income neighborhoods over the age of 12 were less likely to drink alcohol compared to people from high-income neighborhoods (PHAC, 2018). Another study by Humensky (2010) also found that higher parental income is associated with increased rates of binge drinking and cannabis use among adolescents. These findings are consistent with the results from this study. It is possible that the students in this study, from higher income families, have greater access to substances and therefore are more likely to engage in substance use. The reasons adolescents use substances is a complex interplay of various factors with income being just one of these factors. This may be the reason there is such variability in the research on the association between substance use and SES.

Limitations

The data from this study was collected from two separate tools: one from schools (SPP) and the other from students (Cq). Each set of data has its own unique limitations that will be discussed in this section.

School-Level Data

There are two main limitations from the school-level data collected from the COMPASS SPP. First, it was not possible to determine the type and intensity of the prevention programs carried out at the schools from the SPP. Second, the question used to measure PHU engagement on the SPP combined alcohol and cannabis use prevention programs together and e-cigarette and tobacco use prevention programs together. Therefore, it is unknown if the school prevention program was focused on one of these substances or both. To reduce some of the ambiguity, the impact of PHU engagement was analyzed for each substance separately with the corresponding prevention program. However, while this does provide a better idea of the impact of prevention

programming on each substance it is still possible that some of the findings from this study may be misleading. For example, the association between e-cigarette use and PHU engagement in e-cigarette use and/or tobacco use prevention programs was analyzed and found to have no significant effect. However, it is unknown if the PHU was engaged in an e-cigarette prevention program, tobacco use prevention program or both prevention programs. This finding could be misleading because even though it would suggest that PHU engagement has no effect on student e-cigarette use, it is plausible that the PHU was only engaged in tobacco use prevention and that is why there was no effect on e-cigarette use. Similar situations could also be true for the other substances measured in this study. Future research examining the impact of PHU engagement in each substance use prevention program independently would provide greater clarity and confidence to guide PHU decisions over resource allocation in schools.

Student-Level Data

A strength of the student level data was the large sample of students from three different Canadian provinces: Alberta, BC and Ontario. The student-level data was self-reported and is therefore subject to a risk of under-reporting, social desirability, and recall bias (Biemer & Witt, 1997). However, the student questionnaire used for data collection in COMPASS is based on previously validated measures to help mitigate the risk of bias (Wong et al., 2012). Another limitation of the student level data is the inability to distinguish between e-cigarette use with or without nicotine. Students were asked if they have used e-cigarettes however, measures were not in place to record if the e-cigarettes contained nicotine. Under the TVPA before May 2018 it was illegal to sell e-cigarettes containing nicotine in Canada (Government of Canada, 2020b). E-cigarettes containing nicotine are now readily available and are therefore more easily accessible to Canadian adolescents. National surveys such as the CSTADS are now differentiating between

e-cigarette use with and without nicotine. The CSTADS data collected on student e-cigarette use in 2018/19 separated e-cigarette use into two separate categories: e-cigarettes with nicotine and e-cigarettes without nicotine (CSTADS, 2019). With e-cigarettes now containing nicotine and the many negative health consequences of nicotine use in adolescents, it will be important for future research to differentiate e-cigarette use with and without nicotine to accurately capture the prevalence of nicotine consumption in adolescents (Health Canada, 2020; National Academies of Science, Engineering and Medicine, 2018; Walley et al., 2019). Finally, this study was cross-sectional and therefore no temporal or causal relationships or associations are possible. However, this study does still provide valuable information on PHU engagement in schools and the impact on student substance use which can be used to inform future practice.

Implications for Practice

There are multiple important implications for practice identified from this study. First, this study found that PHUs are not engaged in all schools and in all health domains, including substance use prevention. Therefore, PHUs may want to consider engaging in more schools and health domains in the future. This will help to more fully support schools and their ability to improve the health of students across all health domains. Second, this study found that province and SES were statistically significantly associated with PHU engagement in schools. Ontario had that highest percentage of schools reporting PHU engagement. This is likely because PHU engagement in Ontario schools is mandated (MOHLTC, 2018). Therefore, this may be something that the PPIH SCN in Alberta and the regional health authorities in BC want to consider incorporating into their standards and recommendations in the future to encourage engagement and collaboration between the health and education sectors (JCSH, 2020).

SES was statistically significantly associated with PHU engagement in schools and with student alcohol and e-cigarette use. Schools reporting lower average median income were more likely to also report PHUs engagement (see Appendix K), yet for all substances higher rates of use were reported from students in schools reporting higher incomes (see Appendix H). Similarly, schools from small urban/rural locations reported the lowest rates of PHU engagement (see Appendix K), yet for all substances students from schools in small urban/rural locations reported the highest rates of substance use (see Appendix H). PHUs may want to take this into consideration when they are allocating resources, to ensure schools from higher income neighborhoods and schools in small urban/rural locations are also receiving suitable levels of PHU engagement in substance use prevention programs.

There are potential benefits for schools to partner with PHUs to support substance use prevention program development and delivery. However, the benefits are not guaranteed. The type of prevention program, the level of PHU engagement and the risk level of the participating students all impact the success of PHU engagement. The literature has shown that not all prevention programs will be effective in all situations (Faggiano et al., 2014; MacArthur et al., 2016; Onrust et al., 2016; Thomas et al., 2013; Thomas et al., 2015). This study found that, in some cases, a student attending a school with PHU engagement had a greater odds of substance use compared to a student from a school without PHU engagement. This study also found that students from high-risk schools demonstrated greater benefit from PHU engagement in substance use prevention programming compared to students from low-use schools. Therefore, it is important that school-based substance use prevention programs are evidence-based, informed by behavioral theory, and tailored to the specific needs of schools and students. For example, students and schools with different risk levels require different types of programs and different

levels of PHU engagement. In the Ontario Public Health Standards, it is mandated that public health interventions are informed by the evidence of the intervention effectiveness and by the identification of school communities at high risk of negative health outcomes (MOHLTC, 2018). This study demonstrated how important it is for PHUs and schools to take both these requirements into consideration when working together. The knowledge gained from this study, along with the existing literature on the effectiveness of substance use prevention programs, has provided important insights to help guide future partnerships between PHUs and schools to ensure that the appropriate prevention programs are in place for the participating students to achieve the greatest effect on student substance use.

Implications for Future Research

This is the first study to investigate the impact of PHU engagement in school-based substance use prevention programs in Canada. The results of this study provide a better understanding of the extent and impact of PHU engagement with schools and will help to inform the level of engagement and the school characteristics which will benefit the most from PHU engagement. Based on the findings and limitations of this study there are some implications for future research that will help build on the results of this study. First, this research was done with a small sample of schools. While the sample of schools was adequately powered and significant associations were found when schools were split into low and high-use schools, ideally future research would include a larger sample of schools to further increase the reliability and precision of the results. Second, the study was cross-sectional therefore cause and effect cannot be concluded from this study. Future research may consider examining this relationship longitudinally. This would achieve a greater understanding of the impact of PHU engagement in schools and further guide PHUs on where to focus their limited resources. Third, this study was

also unable to examine prevention programs for each substance separately. Future research may consider doing this to provide greater clarity as to the effectiveness of the prevention program and the impact of PHU engagement in schools. This study did not investigate the type of substance use prevention program being implemented in schools. Future research and surveillance on the types of prevention programs being administrated and whether these programs are evidence-based would also provide a valuable indication of the quality of substance use prevention programs in schools. This data would also provide useful information to help guide future PHU engagement in school-based substance use prevention programs. Finally, this study demonstrated that there is variability in PHU engagement across schools and provinces. More in-depth research on the relationship between PHUs and schools and the differences between provinces would help to better understand how different PHUs allocate resources for substance use prevention programs in schools and the types of programs they provide to schools. For example, a mixed methods study examining students substance use and PHU engagement quantitatively, similar to this study, but with an additional qualitative component exploring the opinions and experiences of both school administrators and public health professionals on how and why PHUs engage with schools. This type of research would provide a better understanding of the partnership between the health and education sectors in Canada and could be used to strengthen and build future relationships between schools and health professionals.

Conclusion

Substance use in Canadian adolescents is rising. Alcohol, cannabis, e-cigarette, and cigarette use can all have serious lifelong health consequences for adolescents such as cognitive deficits, lung disease, and premature death (Camchong et al., 2017; Leslie, 2020; Lubman et al., 2015 & World Health Organization, 2018b). This is a serious public health issue which needs to

be addressed. It is imperative to have effective programs in place to prevent the use of alcohol, cannabis, e-cigarettes and cigarettes among adolescents. One way to facilitate this is through the collaboration between the health and education sectors. This study examined the association between PHU engagement in school-based alcohol, cannabis, e-cigarette and tobacco use prevention programs and alcohol, cannabis, e-cigarette and cigarette use among secondary school students in Alberta, BC, and Ontario. The findings from this study provide important insights into the prevalence of PHU engagement in schools. This study also demonstrated that there are situations in which PHU engagement is effective in reducing student substance use and there are also situations where it is not. Therefore, it is important for PHUs to consider their level of engagement and the risk level of the schools and students to ensure that their engagement with schools is effective. The knowledge gained from this study can be used to improve collaboration between the health and education sectors to facilitate the implementation of effective school-based substance use prevention programs to better prevent and reduce student substance use.

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Appendix A

Table A1

Canadian student tobacco alcohol and drug survey data

		Canada			Alberta			British Columbia			Ontario		
		2014/15	2016/17	2018/19	2014/15	2016/17	2018/19	2014/15	2016/17	2018/19	2014/15	2016/17	2018/19
Alcohol Use (past 12-month at least a sip)	Grade 7-12	39.5%	44.0%	44.1%	31.1%	46.8%	38.6%	38.2%	37.7%	50.2%	36.1%	40.1%	39.4%
	Grade 7-9	19.6%	23.1%	24.9%	-	-	-	-	-	-	-	-	-
	Grade 10-12	58.3%	64.5%	63.5%	-	-	-	-	-	-	-	-	-
Binge Drinking (past 12-month 5 or more drinks on one	Grade 7-12	23.7%	24.2%	23.4%	17.0%	27.4%	20.8%	24.7%	22.5%	31.3%	20.9%	20.3%	18.6%
	Grade 7-9	8.4%	8.4%	8.8%	-	-	-	-	-	-	-	-	-
	Grade 10-12	8.1%	39.9%	38.5%	-	-	-	-	-	-	-	-	-
Cannabis Use (past 12-month use)	Grade 7-12	16.5%	16.7%	18.1%	11.5%	16.0%	17.0%	20.3%	18.7%	25.2%	16.1%	15.1%	15.7%
	Grade 7-9	5.7%	5.5%	7.0%	-	-	-	-	-	-	-	-	-
	Grade 10-12	26.8%	27.9%	29.4%	-	-	-	-	-	-	-	-	-

Table A1 Continued

		Canada			Alberta			British Columbia			Ontario		
		2014/15	2016/17	2018/19	2014/15	2016/17	2018/19	2014/15	2016/17	2018/19	2014/15	2016/17	2018/19
E-cigarette Use (Past 30-day use)	Grade 7-12	5.7%	10.0%	20.2%	4.8%	14.5%	19.9%	7.1%	12.5%	27.6%	4.3%	6.6%	17.8%
	Grade 7-9	3.2%	5.4%	11.1%	2.5%	6.8%	9.8%	3.6%	6.1%	15.4%	1.8%	2.8%	7.6%
	Grade 10-12	8.9%	14.6%	29.4%	7.8%	22.2%	30.4%	11.0%	18.1%	38.5%	6.8%	9.9%	26.4%
Cigarette Smokers (Past 30-day use)	Grade 7-12	6.2%	3.2%	5.4%	4.5%	3.3%	4.7%	7.0%	2.5%	5.5%	5.6%	2.6%	4.4%
	Grade 7-9	2.3%	1.0%	2.2%	2.0%	0.7%	1.4%	2.1%	-	1.7%	1.3%	0.3%	0.8%
	Grade 10-12	11.2%	5.4%	8.8%	7.9%	5.8%	8.3%	12.5%	4.3%	9.0%	10.1%	4.4%	7.5%

Appendix B

Table B1

Search terms

Category	Terms
Population	
Adolescent	Adolescent, student
Public Health Unit	Public health unit, public health authority, public health agency, public health services, public health administration
Intervention	
School-based prevention programs	School, school-based prevention, prevention programs
Public Health Unit Engagement	Public health unit, Public health, Public health agency, public health organization, healthcare professionals
Outcome	
Alcohol use	Alcohol, alcohol consumption, alcohol drinking, underage drinking
Cannabis use	Cannabis, Marijuana, Drug use, Illicit drug
E-cigarette use	E-cigarette, Vaping, electronic nicotine delivery systems
Cigarette use	Cigarette, Smoking, Tobacco
General substance use	Substance use

Table B2

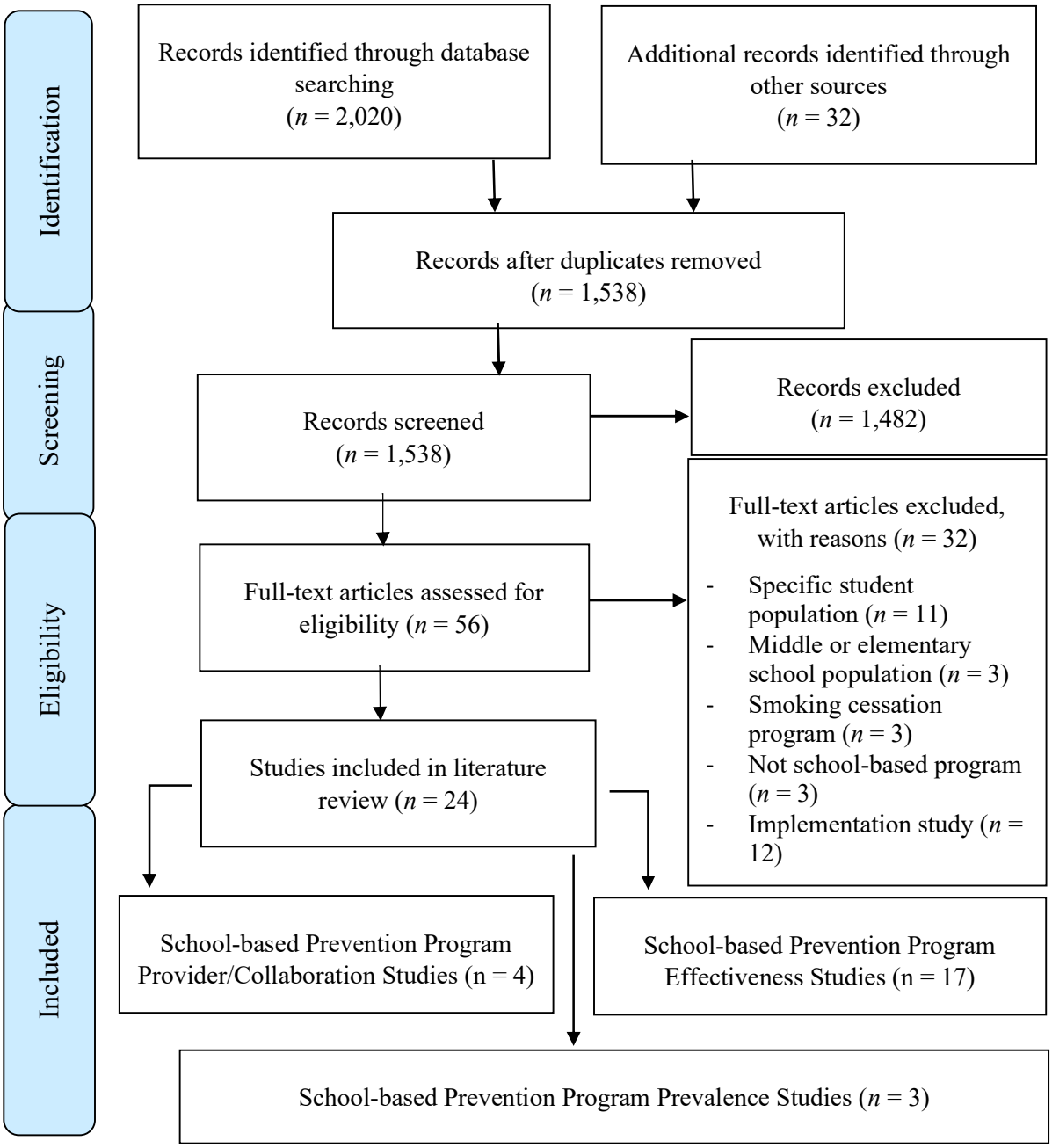
Database search with search terms and results

Database	Search Terms	Limits	Results
Medical Literature Analysis and Retrieval System Online (MEDLINE or MEDLARS Online)	(High School*.mp OR School Base*.mp OR Secondary School*.mp) AND (exp Alcohol Drinking/ OR exp Smoking/) AND (Prevent*.mp)	Last 10 years	851
Cumulated Index to Nursing and Allied Health Literature (CINAHL)	(MH Students, High School OR MH Schools, Secondary OR School Base*) AND (MH Smoking+ OR MH Electronic Cigarettes OR MH Tobacco Products OR MH Cannabis OR MH Tobacco OR MH Alcohol Drinking+) AND (Prevent*)	Last 10 years	726
Educational Research Information Center (ERIC)	prevent* AND (high school* OR secondary school* OR school base*) AND (smok* OR cannabis OR marijuana OR tobacco OR cigarette* OR Alcohol OR electronic cigarette OR substance) AND (program* OR intervention* OR curricul*)	Last 10 years	443

Appendix C

Table C1

PRISMA 2009 flow diagram



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org.

Appendix D

Table D1

Health Evidence quality assessment tool

Article	Q1: Clearly focused research question	Q2: Provision of inclusion criteria	Q3: Comprehensive search strategy	Q4: Search strategy covers adequate number of years	Q5: Level of evidence clearly illustrated	Q6: Quality assessment of primary studies	Q7: Are quality assessments transparent?	Q8: Did reviewers assess appropriateness of combining study results (i.e., test of homogeneity, or assess similarity of results in some other way)?	Q9. Weighting	Q10. Interpretation of results	Total Score
Espada et al. (2015)	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	8 Strong
Faggiano et al. (2014)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	9 Strong
Foxcroft et al. (2011)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	9 Strong
Hale et al. (2014)	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	7 Moderate
Hennessy & Tanner-Smith (2015)	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	8 Strong
Hodder et al. (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	10 Strong
Isensee et al. (2012)	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes	Yes	7 Moderate
Lemstra et al. (2010)	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	8 Strong
MacArthur et al. (2016)	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	8 Strong
MacArthur et al. (2018)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	9 Strong
Melendez-Torres et al. (2018)	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	Yes	7 Moderate
Newton et al. (2017)	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	7 Moderate
Onrust et al. (2016)	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	7 Moderate
Porath-Waller et al. (2010)	Yes	Yes	No	No	Yes	No	No	Yes	Yes	Yes	6 Moderate
Strom et al. (2014)	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes	Yes	7 Moderate
Thomas et al. (2013)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	10 Strong
Thomas et al. (2015)	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	8 Strong

Appendix E

Table E1

National Heart, Lung and Blood Institute Quality Assessment Tool for observational cohort and cross-sectional studies

Criteria	O'Brien et al. (2010)	Ringwalt et al. (2008)	Salas-Wright et al. (2019)
1. Was the research question or objective in this paper clearly stated?	Yes	Yes	Yes
2. Was the study population clearly specified and defined?	Yes	Yes	Yes
3. Was the participation rate of eligible persons at least 50%?		Yes	Yes
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	Yes	Yes	Yes
5. Was a sample size justification, power description, or variance and effect estimates provided?	Yes	No	No
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	Not Clear	Not Applicable	Not Applicable
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	Yes	Not Applicable	Not Applicable
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?	Not Applicable	Not Applicable	Not Applicable
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	No	Yes	Not Applicable
10. Was the exposure(s) assessed more than once over time?	No	Not Applicable	Not Applicable
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes	Not Applicable	Yes
12. Were the outcome assessors blinded to the exposure status of participants?	Not Clear	Not Applicable	Not Applicable
13. Was loss to follow-up after baseline 20% or less?	Not Clear	Not Applicable	Not Applicable
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	No	Yes	Yes

Table E1 Continued

Criteria	Stapinski et al. (2017)	Sigfusdottir et al. (2011)
1. Was the research question or objective in this paper clearly stated?	Yes	Yes
2. Was the study population clearly specified and defined?	Yes	Yes
3. Was the participation rate of eligible persons at least 50%?	Not Clear	Yes
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	Yes	Yes
5. Was a sample size justification, power description, or variance and effect estimates provided?	No	No
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	Not Applicable	Not Applicable
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	Not Applicable	Yes
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?	Not Applicable	Not Applicable
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes	Not Applicable
10. Was the exposure(s) assessed more than once over time?	Not Applicable	Not Applicable
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes	Yes
12. Were the outcome assessors blinded to the exposure status of participants?	Not Applicable	Not Applicable
13. Was loss to follow-up after baseline 20% or less?	Not Clear	Not Applicable
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	Yes	Not Clear

Appendix F

Table F1

Critical Appraisal Skill Programme critical appraisal tool for qualitative research

Criteria	Fletcher et al. (2010)
Section A: Are the results valid?	
1. Was there a clear statement of the aims of the research?	Yes
2. Is a qualitative methodology appropriate?	Yes
3. Was the research design appropriate to address the aims of the research?	Yes
4. Was the recruitment strategy appropriate to the aims of the research?	Yes
5. Was the data collected in a way that addressed the research issue?	Yes
6. Has the relationship between researcher and participants been adequately considered?	No
Section B: What are the results?	
7. Have ethical issues been taken into consideration?	Yes
8. Was the data analysis sufficiently rigorous?	Yes
9. Is there a clear statement of findings?	Yes
10. How valuable is the research?	Yes

Appendix G

Table G1

Literature review summary table

Article	Quality Assessment Score	Quality of included studies	Number of Studies	Types of studies	Test for Heterogeneity	Participants age	Intervention	Comparison	Outcome	Results	Follow-Up	Intervention Duration
Espada et al. (2015)	8	Quality assessment of 9 criteria. Average quality rating of moderate.	21 (18 articles, 3 thesis) (n= 9,149)	Experimental and quasi-experimental	Eggers regression test	10-19 (n= 10,956)	School-based Knowledge Social Competence Social Norms and Combined approaches	Control group (specifics not described)	All substances	Programs incorporating Oral, written and audiovisual materials $d = 0.21$, 95% CI [0.12, 0.3]	6 months – 2 years	Not specified
									Alcohol	d = 0.38, 95% CI [0.27, 0.49], $p < .01$		
									Tobacco	d = 0.20, 95% CI [0.10, 0.30], $p < .01$		
									Cannabis	d = 0.19, 95% CI [0.05, 0.32], $p < .01$		
Faggiano et al. (2014)	9	Cochrane Risk of Bias Tool 32 studies with a low, 15 with an unclear and 4 with a high risk of bias.	51 (n= 127,146)	RCTs	Chi^2 test and I^2 statistic	11-13 (n= 127, 146)	Universal school-based Knowledge Social Competence Social Norms and Combined approaches	Usual curricular activities or no intervention	Marijuana use (continuous and categorical outcome measures)	Combined approach: at 12+ months follow-up RR = 0.83, 95% CI [0.69, 0.99] at <12 months follow-up RR = 0.79, 95% CI [0.59, 1.05] Social competence approach: at 12+ months follow-up, RR = 0.86 95% CI [0.74, 1.00] at <12 months follow-up, RR = 0.9 95% CI [0.81, 1.01]	2 groups: Greater than 12 months and less than 12 months	Less than one year to over one school year

Table G1 Continued

Article	Quality Assessment Score	Quality of included studies	Number of Studies	Types of studies	Test for Heterogeneity	Participants age	Intervention	Comparison	Outcome	Results	Follow-Up	Intervention Duration
Foxcroft & Tsertsvadze(2011)	9	Cochrane Risk of Bias Tool Unclear risk of bias due to poor reporting quality	53 (total participants not stated)	RCTs C-RCTs	Chi square statistic and p-value; I^2 statistic	5-18	Universal school-based Knowledge Psychosocial	Any alternative prevention program or standard curricula	Alcohol use	Qualitative Analysis: 14/39 generic interventions (not specific to alcohol) found significant reductions in alcohol use compared to control and 6/11 alcohol use prevention programs found significant reductions in alcohol misuse compared to control	1 month – 12 years	One 50-minute session to 3 years
Hale et al. (2014)	7	Quality assessment tool for quantitative studies Most rated strong and moderate 9 rated as weak	44 School-based studies (total participants not stated)	RCTs	Authors stated heterogeneity was high but no other data reported	10 – 19	Universal or Selective School-based Social Competence approach	Not specified	Alcohol use, Smoking and Illicit drug use	Qualitative Analysis: 32 different school-based interventions 18 had significant effects for smoking, alcohol or illicit drug use reduction and 9 had significant reductions in all three substances	6+ months	4 – 140 sessions over 10 weeks to 8 years

Table G1 Continued

Article	Quality Assessment Score	Quality of included studies	Number of Studies	Types of studies	Test for Heterogeneity	Participants age	Intervention	Comparison	Outcome	Results	Follow-Up	Intervention Duration
Hennessy & Tanner-Smith (2015)	8	Stated quality assessed by no further data provided.	17 (total participants not stated)	RCTs Controlled quasi-experimental research design	I^2 statistic	*M* = 15.58 years	Brief alcohol interventions (BAI): Cognitive Behavioural skills training, Knowledge, Motivational enhancement approaches	No treatment or treatment as usual	Alcohol use	Overall significant effect $\bar{g}$ = 0.34, 95% CI [0.11, 0.56] Subgroup analysis found only individually delivered BAI to be significantly effective $\bar{g}$ = 0.58, 95% CI [0.23, 0.92], p < .001 No effect found on alcohol use in group-based BAI ($\bar{g}$ = -0.02, 95% CI [-0.17, 0.14]; p=.72)	Up to 6 months	Shorter than 5 hours total
Hodder et al. (2015)	10	Used GRADE. Found studies for alcohol and drug use as moderate quality and studies for tobacco use as low quality. Sensitivity analysis done.	19 13 in meta analysis 6 in narrative analysis (n=51,867)	RCTs C-RCTs	Examination of forest plots and calculation of the I^2 statistic and Tau2 statistic	5-18	Universal school-based interventions addressing individual and environmental resilience protective factors	No intervention , usual practice, attention only or alternative intervention	Tobacco use (n=15)	No significant overall intervention effect OR = 0.96, 95% CI 0.85-1.08, *p* = 0.48	Immediately post intervention, 1 year and greater than one year	Ranged from 2 days to 10 years
									Alcohol use (n=17)	No significant overall intervention effect OR = 0.86, 95% CI [0.73, 1.02], *p* = .08		
									Illicit substance use (n=11)	Overall intervention effect OR 0.78, 95% CI 0.66-0.93, *p* = .007		

Table G1 Continued

Article	Quality Assessment Score	Quality of included studies	Number of Studies	Types of studies	Test for Heterogeneity	Participants age	Intervention	Comparison	Outcome	Results	Follow-Up	Intervention Duration
Isensee & Hanewinkel (2015)	7	No reported quality assessment	5 in meta analysis (n= 16,302)	RCTs C-RCTs	I^2 statistic	11 – 14	Smoke Free Class Competition. Participating classes commit to not smoking for up to 6 months. Successful classes can win prizes in a lottery.	No intervention	Current smoking	Reduced risk of current smoking Pooled RR = 0.86, 95% CI [0.79, 0.94] p = .001	6 months – 2 years	NA
Lemstra et al. (2010)	8	14 quality standards used to rate the quality of the studies. Required 10/14 for inclusion	6 (n= 11,926)	RCTs, prospective cohort/ longitudinal studies	NA	10 - 15	Knowledge based approach and combined approach	No intervention	Mean absolute reduction of marijuana usage per month	Mean absolute reduction of 7 days of marijuana usage per month MUR = 0.93, 95% CI [0.92, 0.94]	Greater than or equal to 1 year	NA
									Mean absolute reduction of alcohol usage per month	Combined Approach: Mean absolute reduction of 12 days of alcohol usage per month MUR = 0.88, 95% CI [0.87, 0.89] Knowledge-based approach: non-significant reduction in alcohol use of 2 days per month MUR = 0.98; 95% CI [0.92, 1.04]		
MacArthur et al. (2016)	8	Cochrane risk of bias tool. Found studies to be of low quality.	17 (n= 13 706)	RCTs	Chi square statistic and I^2 statistic	11 – 18	Peer led interventions	No intervention	Alcohol Use (n=6)	OR = 0.80; 95% CI [0.65, 0.99], p = .036	End of intervention – 7 years	2 weeks– 2 years
									Cannabis use (n=3)	OR = 0.70, 95% CI [0.50, 0.97], p = .034		
									Weekly or monthly smoking (n=7)	OR = 0.78, 95% CI [0.62, 0.99], p = .040		

Table G1 Continued

Article	Quality Assessment Score	Quality of included studies	Number of Studies	Types of studies	Test for Heterogeneity	Participants age	Intervention	Comparison	Outcome	Results	Follow-Up	Intervention Duration
MacArthur et al. (2018)	9	Used GRADE. Found studies to be of low to moderate quality	70 (total participants not stated)	RCTs	I^2 statistic	Up to 18	Universal and selective individual, family and school level programs	Control intervention or usual practice	Alcohol Use (n=8)	OR = 0.72, 95% CI [0.56, 0.92]	6+ months	6 months – 10 years
									Cannabis use (n=5)	OR = 0.79, 95% CI [0.62,1.01] p = .06		
									Tobacco use (n=9)	OR = 0.77, 95% CI [0.60, 0.97]		
Melendez-Torres et al. (2018)	7	Risk of bias assessed on 8 criteria. Found studies to be of variable and unclear quality due to the lack of reporting.	7 (total participants not stated)	RCTs	I^2 statistic	4-18	Interventions incorporated into pre-existing academic curricula Knowledge, social influence and social competence approaches	Control intervention or usual practice	Alcohol, tobacco and drug use	In students age 11 – 14 (5 studies): d = −0.09, 95% CI [−0.17, −0.01]	Immediately post intervention – 8 years post intervention	NA
										In students age 14-16 (3 studies): d = −0.06, 95% CI [−0.09, −0.02]		
Newton et al. (2017)	7	Cochrane risk of bias tool. Found studies to be of low risk of bias.	22 studies 10 different programs (n= 27,627)	RCTs	Authors stated heterogeneity high therefore a meta-analysis was not done. No further details provided.	10 – 18	Universal Student and Parent components Social influence, social learning and/or life skills training principles	Standard health education or minimal contact	Reducing or delaying use:	Narrative review synthesis (no meta-analysis)	Post-test – 72 months	NA
									Alcohol	8/10 programs were efficacious in reducing alcohol		
									Cannabis	3/6 reported significant reductions in cannabis use		
									Tobacco	6/7 programs were associated with smoking reduction		

Table G1 Continued

Article	Quality Assessment Score	Quality of included studies	Number of Studies	Types of studies	Test for Heterogeneity	Participants age	Intervention	Comparison	Outcome	Results	Follow-Up	Intervention Duration
Onrust et al. (2016)	7	Cochrane risk of bias tool. Found studies to be of moderate quality. Sensitivity analysis done.	241 studies (n= 436,180)	RCTs and controlled trials	I^2 statistic	14-18	Universal programs	Control condition (no intervention, standard health education)	Reduction in alcohol use	Self control training (B -0.2, p = .02) Problem solving skills training (B -0.16, p = .03) Health education (B=-.19m p = .05) Refusal skills (B -0.41, p = .01) Social influence (B -0.57, p = .01) Cognitive behaviour therapy (B -0.32, p = .01) Parental involvement (B -0.29, p = .02)	NA	NA
									Reduction in drug use	Self-control (B = -.23, p = .02) Social norms (B = -.23, p = .09)		
									Reduction in smoking	Self-control (B = -.23, p = .09) Social norm (B = -.23, p = .02) Peer education (B = -.74, p = .01)		
Porath-Waller et al. (2010)	6	No quality assessment reported.	15 (n= 15,571)	Experimental or quasi-experimental	Cochran's Q test	12-19	School based cannabis use prevention Knowledge Social Competence Social Influence and Combined approaches	Alternative intervention or usual practice	Self-reported cannabis use	Combined approach (d = 1.27, 95% CI [1.22, 1.33]) compared to social influence (d = 0.19, 95% CI [0.14, 0.23], p < .001) Interactive programs (d = 0.10, p < .001) compared to than lecture style programs (d = 0.02, p < .001) Programs for high school students (d = 0.39, 95% CI [0.30, 0.49]) compared to middle school students (d = 0.17, 95% CI [0.13, 0.21], p < .001)	NA	Split into 15 sessions or less and 15 sessions or more

Table G1 Continued

Article	Quality Assessment Score	Quality of included studies	Number of Studies	Types of studies	Test for Heterogeneity	Participants age	Intervention	Comparison	Outcome	Results	Follow-Up	Intervention Duration
Strom et al. (2014)	7	No quality assessment reported.	28 (n= 39,289)	RCTs	Cochran's Q test	Under 18	Universal school-based prevention programs: knowledge, social competence and/or social influence approaches	Not specified	Alcohol use continuous (frequency and quantity) n=12 Alcohol use categorical n=16	Statistically significant difference in continuous outcome studies favouring intervention Hedges' g = 0.22, 95% CI [0.08, 0.36], $p < .01$ The categorical data results found no statistically significant difference (OR = 0.94, $p = .25$)	Split into three groups <3months , 4-13 months, >13 months Overall1 – 40 months	Split into Medium intensity (6 – 10 hours) and high intensity (11->15 hours)
Thomas et al. (2013)	10	Cochrane risk of bias tool - found studies to be of low and unknown risk of bias. Sensitivity analysis done.	134 (85 included in analysis split into three groups) (n= 428,293)	RCTs C-RCTs	I^2 statistic	5 – 18	School-based tobacco use prevention Social Competence Social Influence and Combined approaches	No interventi on, standard health education or existing tobacco preventio n program	Reduction in initiation of smoking	Pure Prevention Cohort Group: Combined approaches at <1-year OR 0.49, 95% CI [0.28, 0.87] and >1-year OR 0.50 95% CI [0.28, 0.87] Social competence approach at >1-year OR = 0.52, 95% CI [0.30, 0.88] Any intervention at > 1-year follow-up (OR = 0.88, 95% CI [0.82,0.96]) at < 1 year OR = 0.94 95% CI [0.85, 1.05] Information only at < 1 year OR = 0.12, 95% CI [0.00, 14.87] Social influence approach at <1 year (OR = 1.00, 95% CI [0.88, 1.13]). Change in Smoking Behaviour Cohort Group: Overall statistically significant results favouring the control at one year or less (SMD = 0.04, 95% CI [0.02, 0.06]) and at more than one year the results were nonsignificant (SMD = 0.02, 95% CI [-0.00, 0.02]).	6 months to 12 years	One hour to 36 classes spread over 3 years

Table G1 Continued

Article	Quality Assessment Score	Quality of included studies	Number of Studies	Types of studies	Test for Heterogeneity	Participants age	Intervention	Comparison	Outcome	Results	Follow-Up	Intervention Duration
Thomas et al. (2015)	8	Cochrane risk of bias tool - found studies to be of low and unknown risk of bias. Sensitivity analysis done.	50 (n=143,495)	RCTs C-RCTs	I^2 statistic	5 – 18	School-based tobacco use prevention Social Competence Social Influence and Combined approaches Multimodal	No curricula, usual practice or active non-relevant practice	Remain a never smoker at follow-up	Combined approaches at <1 year OR = 0.59 95% CI [0.41, 0.85] at >1 year OR = 0.60, 95% CI [0.43, 0.83]) All interventions pooled at >1 year OR = 0.88, 95% CI [0.82, 0.95] and at <1 year OR = 0.91, 95% CI [0.82, 1.01] Knowledge only approach OR = 0.12 [0.00, 14.87] Social influence approach at <1year OR = 0.97, 95% CI [086, 1.09]) and >1year OR = 0.92, 95% CI [0.84, 1.00] Social Competence at >1 year OR = 0.63, 95% CI [0.43, 0.96]	Greater than 6 months	3 days to 36 months

Appendix H

Descriptive Statistics

Table H1

Categorical school level variables

		Schools		Students	
		n	%	*n*	%
Province	Alberta	8	9%	3,161	8%
	British Columbia	15	18%	9,807	23%
	Ontario	61	73%	29,181	69%
Urbanicity	Large Urban	37	44%	24,110	57%
	Medium Urban	14	17%	7,235	17%
	Small Urban/Rural	33	39%	10,804	26%
Public Health Unit Engagement in Alcohol and Marijuana Use Prevention	No Engagement	30	36%	14,223	34%
	Engagement	54	64%	27,926	66%
Public Health Unit Engagement in Tobacco and E-cigarette Use Prevention	No Engagement	28	33%	12,928	31%
	Engagement	56	67%	29,221	69%
Total		84	100%	42,149	100%

Table H2

Continuous school level variables

	Schools		Students	
	M	*SD*	*M*	*SD*
School Median Income ('000s)	72.66	16.17	72.95	17.64
School Enrolment Size ('00s)	5.28	2.57	6.51	2.65

Table H3

Student level variables

		Students	
		n	%
Grade	9	11,029	26%
	10	11,434	27%
	11	10,668	25%
	12	9,018	21%
Sex	Female	20,893	50%
	Male	21,256	50%
Ethnicity	White	24,750	59%
	Black	1,822	4%
	Asian	6,770	16%
	Hispanic	1,355	3%
	Other/Mixed	7,452	18%
Substance Use	Current Alcohol User	12,103	29%
	Current Binge Drinker	7,110	17%
	Current Cannabis User	6,768	16%
	Current E-cigarette User	12,135	29%
	Current Cigarette User	3,265	8%

Table H4

Student binge drinking by school level and student level variables

		Current Binge Drinker					
		n	%	*Total*	*df*	X^2	*p*-value
Total		7,110	17%	42,149			
School Level Variables – Categorical:							
Public Health Unit Engagement in Alcohol and Marijuana Use Prevention	Any Engagement:						
	No Engagement	2,379	17%	14,223	1	0.31	.578
	Any Engagement	4,731	17%	27,926			
	Level of Engagement:						
	1: Provided Resources	2,099	16%	13,378	4	149.56	<.001
	2: Solved Problems Jointly	835	24%	3,481			
	3: Developed/ Implemented Programs Jointly	536	18%	3,012			
	4: Programs run by public health unit	1,261	16%	8,055			
Province	Alberta	854	27%	3,161	2	474.45	<.001
	British Columbia	1,094	11%	9,807			
	Ontario	5,162	18%	29,181			
Urbanicity	Large Urban	3,039	13%	24,110	2	770.33	<.001
	Medium Urban	1,477	20%	7,235			
	Small Urban/Rural	2,594	24%	10,804			
School Level Variables – Continuous:		*M*	*SD*		*df*	*t*	p-value
School Median Income ('000s)		73.74	16.96		42,147	-4.13	<.001
School Enrolment Size ('00s)		6.01	2.51		42,147	17.60	<.001
Student Level Variables:		*n*	%		*df*	X^2	p-value
Grade	9	852	8%	11,029	3	1411.92	<.001
	10	1,645	14%	11,434			
	11	2,239	21%	10,668			
	12	2,374	26%	9,018			
Sex	Female	3,223	15%	20,893	1	61.48	<.001
	Male	3,887	18%	21,256			
Ethnicity	White	4,808	19%	24,750	4	626.72	<.001
	Black	301	17%	1,822			
	Asian	448	7%	6,770			
	Hispanic	243	18%	1,355			
	Other/Mixed	1,310	18%	7,452			

Table H5

Student alcohol use by school level and student level variables

		Current Alcohol User					
		n	%	Total	*df*	X^2	*p*-value
Total		12,103	29%	42,149			
School Level Variables – Categorical:							
Public Health Unit Engagement in Alcohol and Marijuana Use Prevention Programming	Any Engagement:						
	No Engagement	4,005	28%	14,223	1	3.24	.072
	Any Engagement	8,098	29%	27,926			
	Level of Engagement:						
	1: Provided Resources	3,597	27%	13,378	4	161.60	<.001
	2: Solved Problems Jointly	1,307	38%	3,481			
	3: Developed/ Implemented Programs Jointly	916	30%	3,012			
	4: Programs run by Public Health Unit	2,278	28%	8,055			
Province	Alberta	1,264	40%	3,161	2	650.36	<.001
	British Columbia	1,915	20%	9,807			
	Ontario	8,924	31%	29,181			
Urbanicity	Large Urban	5,550	23%	24,110	2	928.11	<.001
	Medium Urban	2,451	34%	7,235			
	Small Urban/Rural	4,102	38%	10,804			
School Level Variables – Continuous:		*M*	SD		*df*	*t*	*p*-value
School Median Income ('000s)		73.43	17.27		42,147	-3.57	<.001
School Enrolment Size ('00s)		6.09	2.49		42,147	20.79	<.001
Student Level Variables:		*n*	%	Total	*df*	X^2	*p*-value
Grade	9	1,775	16%	11,029	3	1717.02	<.001
	10	2,972	26%	11,434			
	11	3,674	34%	10,668			
	12	3,682	41%	9,018			
Sex	Female	5,835	28%	20,893	1	12.53	<.001
	Male	6,268	30%	21,256			
Ethnicity	White	8,330	34%	24,750	4	1202.68	<.001
	Black	431	24%	1,822			
	Asian	837	12%	6,770			
	Hispanic	386	29%	1,355			
	Other/Mixed	2,119	28%	7,452			

Table H6

Student current cannabis use by school level and student level variables

		Current Cannabis User					
		n	%	Total	*df*	X^2	*p*-value
Total		6,768	16%	42,149			
School Level Variables – Categorical:							
Public Health Unit Engagement in Alcohol and Marijuana Use Prevention	Any Engagement:						
	No Engagement	2,246	16%	14,223	1	1.13	.288
	Any Engagement	4,522	16%	27,926			
	Level Engagement:						
	1: Provided Resources	1,967	15%	13,378	4	87.25	<.001
	2: Solved Problems Jointly	735	21%	3,481			
	3: Developed/ Implemented Programs Jointly	478	16%	3,012			
	4: Programs run by public health unit	1,342	17%	8,055			
Province	Alberta	566	18%	3,161	2	183.61	<.001
	British Columbia	1,144	12%	9,807			
	Ontario	5,058	17%	29,181			
Urbanicity	Large Urban	3,207	13%	24,110	2	317.4	<.001
	Medium Urban	1,428	20%	7,235			
	Small Urban/Rural	2,133	20%	10,804			
School Level Variables – Continuous:		*M*	SD		*df*	*t*	*p*-value
School Median Income ('000s)		73.16	16.96		42,147	-1.05	.294
School Enrolment Size ('00s)		6.15	2.51		42,147	12.23	<.001
Student Level Variables:		*n*	%	Total	*df*	X^2	*p*-value
Grade	9	935	9%	11,029	3	937.69	<.001
	10	1,660	15%	11,434			
	11	2,060	19%	10,668			
	12	2,113	23%	9,018			
Sex	Female	2,886	14%	20,893	1	154.79	<.001
	Male	3,882	18%	21,256			
Ethnicity	White	4,175	17%	24,750	4	772.17	<.001
	Black	401	22%	1,822			
	Asian	381	6%	6,770			
	Hispanic	207	15%	1,355			
	Other/Mixed	1,604	22%	7,452			

Table H7

Student current e-cigarette use by student descriptive statistics

		Current E-Cigarette User					
		n	%	Total	*df*	X^2	*p*-value
Total		12,135	29%	42,149			
School Level Variables – Categorical:							
Public Health Unit Engagement in Tobacco and E-cigarette Use Prevention	Any Engagement:						
	No Engagement	3,600	28%	12,928	1	8.11	.004
	Any Engagement	8,535	29%	29,221			
	Level of Engagement:						
	1: Provided Resources	3,792	29%	13,269	4	78.13	<.001
	2: Solved Problems Jointly	1,309	35%	3,774			
	3: Developed/ Implemented Programs Jointly	1,137	27%	4,242			
	4: Programs run by public health unit	2,297	29%	7,936			
Province	Alberta	1,110	35%	3,161	2	333.12	<.001
	British Columbia	2,140	22%	9,807			
	Ontario	8,885	30%	29,181			
Urbanicity	Large Urban	5,841	24%	24,110	2	572.73	<.001
	Medium Urban	2,508	35%	7,235			
	Small Urban/Rural	3,786	35%	10,804			
School Level Variables – Continuous:		*M*	*SD*		*df*	*t*	*p*-value
School Median Income ('000s)		73.25	17.07		42,147	-2.2	.028
School Enrolment Size ('00s)		6.24	2.51		42,147	13.27	<.001
Student Level Variables:		*n*	%		*df*	X^2	*p*-value
Grade	9	2,314	21%	11,029	3	538.51	<.001
	10	3,258	29%	11,434			
	11	3,450	32%	10,668			
	12	3,113	35%	9,018			
Sex	Female	5,489	26%	20,893	1	128.2	<.001
	Male	6,646	31%	21,256			
Ethnicity	White	8,021	32%	24,750	4	978.98	<.001
	Black	470	26%	1,822			
	Asian	903	13%	6,770			
	Hispanic	405	30%	1,355			
	Other/Mixed	2,336	31%	7,452			

Table H8

Student current cigarette use by schools and student level variables

		Current Cigarette User					
		n	%	Total	*df*	X^2	*p*-value
Total		3,265	8%	42,149			
School Level Variables – Categorical:							
Public Health Unit Engagement in Tobacco and E-cigarette Use Prevention	Any Engagement:						
	No Engagement	1,149	9%	12,928	1	33.99	<.001
	Any Engagement	2,116	7%	29,221			
	Level of Engagement:						
	1: Provided Resources	940	7%	13,269	4	98.48	<.001
	2: Solved Problems Jointly	390	10%	3,774			
	3: Developed/ Implemented Programs Jointly	298	7%	4,242			
	4: Programs run by public health unit	488	6%	7,936			
Province	Alberta	374	12%	3,161	2	103.81	<.001
	British Columbia	615	6%	9,807			
	Ontario	2,276	8%	29,181			
Urbanicity	Large Urban	1,336	6%	24,110	2	458.57	<.001
	Medium Urban	621	9%	7,235			
	Small Urban/Rural	1,308	12%	10,804			
School Level Variables – Continuous:		*M*	*SD*		*df*	*t*	*p*-value
School Median Income ('000s)		73.25	15.48		42,147	-1.01	.311
School Enrolment Size ('00s)		5.8	2.69		42,147	15.96	<.001
Student Level Variables		*n*	%		*df*	X^2	*p*-value
Grade	9	499	5%	11,029	3	406.37	<.001
	10	758	7%	11,434			
	11	943	9%	10,668			
	12	1,065	12%	9,018			
Sex	Female	1,426	7%	20,893	1	49.18	<.001
	Male	1,839	9%	21,256			
Ethnicity	White	1,843	7%	24,750	4	367.61	<.001
	Black	185	10%	1,822			
	Asian	242	4%	6,770			
	Hispanic	104	8%	1,355			
	Other/Mixed	891	12%	7,452			

Appendix I

Research Question One Results

Table I1

Frequency of schools indicating public health unit engagement in any health domain

Reported PHU Engagement	*n*	%
No	11	13%
Yes	73	87%
Total	84	100%

Table I2

The Number of health domains with public health unit engagement within a school

Number of Health Domains with Reported Public Health Unit Engagement	*n*	%
1	9	12%
2	3	4%
3	8	11%
4	5	7%
5	12	16%
6	11	15%
7	25	34%
Total	73	100%

Table I3

Frequency of school indicating engagement in each health domain

Health Domain	*n*	% (of schools with engagement)	% (of total schools)
Physical Activity	57	78%	68%
Healthy Eating	60	82%	71%
Bullying	40	55%	48%
Sedentary Behaviour	34	47%	40%
Mental Health	58	79%	69%
Tobacco and E-Cigarettes	56	77%	67%
Alcohol and Marijuana	54	74%	64%

Table I4

Frequency of schools indicating any engagement by school characteristics

			Public Health Unit Engagement	
		Total	*n*	%
Province	Alberta	8	5	7%
	British Columbia	15	12	16%
	Ontario	61	56	77%
	Total	84	73	100%
Urbanicity	Large Urban	37	34	46%
	Medium Urban	14	10	14%
	Small Urban/Rural	33	29	40%
	Total	84	73	100%
School Median Income	Q1: 31753 - 62922	21	20	27%
	Q2: 62923 - 69512	21	19	26%
	Q3: 69513 - 82833	21	18	25%
	Q4: 82834 - 114133	21	16	22%
	Total	84	73	100%
School Enrolment Size	Q1: 83 - 324	21	18	25%
	Q2: 325 - 515	21	16	22%
	Q3: 516 - 690	21	19	26%
	Q4: 691 - 1305	21	20	27%
	Total	84	73	100%

Appendix J

Research Question Two Results

Table J1

Schools reporting public health unit engagement in alcohol and/or cannabis use prevention programming at their school

Public Health Unit Engagement	*n*	%
No	30	36%
Yes	54	64%
Total	84	100%

Table J2

The level of public health unit engagement in alcohol and/or cannabis use prevention programming reported by schools

Level of Public Health Unit Engagement	*n*	%
Level 1	24	44%
Level 2	8	15%
Level 3	7	13%
Level 4	15	28%
Total	54	100%

Table J3

Schools reporting public health unit engagement in e-cigarette and/or tobacco use prevention programming at their school

Public Health Unit Engagement	*n*	%
No	28	33%
Yes	56	67%
Total	84	100%

Table J4

The level of public health unit engagement in e-cigarette and/or tobacco use prevention programming reported at schools

Level of Public Health Unit Engagement	*n*	%
Level 1	23	41%
Level 2	8	14%
Level 3	10	18%
Level 4	15	27%
Total	56	100%

Table J5

Schools reporting public health unit engagement in only one or in both alcohol and/or cannabis and e-cigarette and/or tobacco use prevention programming at their school

Public Health Unit Engagement	*n*	%
One	8	14%
Both	51	86%
Total	59	100%

Appendix K

Research Question Three Results

Table K1

Categorical School characteristics and schools reporting public health unit engagement in alcohol and/or cannabis use prevention programming

		Overall Engagement			Chi-Square		
		n	%	Total	df	X^2	p-value
Total		54	64%	84			
Province	Alberta	1	13%	8	2	14.66	<.001
	British Columbia	7	47%	15			
	Ontario	46	75%	61			
Urbanicity	Large Urban	26	70%	37	2	1.22	.542
	Medium Urban	9	64%	14			
	Small Urban/Rural	19	58%	33			

Table K2

Continuous School characteristics and schools reporting public health unit engagement in alcohol and/or cannabis use prevention programming

	Overall Engagement						
	No		Yes			t-test	
	M	*SD*	*M*	*SD*	df	*t*	p-value
School Median Income ('000s)	78.99	13.8	69.15	16.44	82	2.78	.007*
School Enrolment Size ('00s)	5	2.42	5.44	2.65	82	-0.75	.456

Table K3

Categorical school characteristics and the level of reported public health unit engagement in alcohol and/or cannabis use prevention programming

		Level of Engagement								
		1		2		3		4		
		n	%	*n*	%	*n*	%	*n*	%	Total
Total		24	44%	8	15%	7	13%	15	28%	54
Province	Alberta	0	0%	1	100%	0	0%	0	0%	1
	British Columbia	5	71%	1	14%	0	0%	1	14%	7
	Ontario	19	41%	6	13%	7	15%	14	30%	46
Urbanicity	Large Urban	12	46%	3	12%	4	15%	7	27%	26
	Medium Urban	5	56%	1	11%	0	0%	3	33%	9
	Small Urban/Rural	7	37%	4	21%	3	16%	5	26%	19

Table K4

Continuous school characteristics and the level of reported public health unit engagement in alcohol and/or cannabis use prevention programming

	Level of Engagement									
	0		1		2		3		4	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
School Median Income ('000s)	78.99	13.8	66.39	14.12	78.57	16.09	68.94	9.03	68.64	21.61
School Enrolment Size ('00s)	5	2.42	5.87	2.78	4.57	2.86	4.58	2.07	5.62	2.63

Table K5

Categorical school characteristics and schools reporting public health unit engagement in e-cigarette and/or tobacco use prevention programming

		Overall Engagement			Chi-Square		
		n	%	Total	*df*	X^2	*p*-value
Total		56	67%	84			
Province	Alberta	1	13%	8	2	17.23	<.001*
	British Columbia	7	47%	15			
	Ontario	48	79%	61			
Urbanicity	Large Urban	25	68%	37	2	0.29	.864
	Medium Urban	10	71%	14			
	Small Urban/Rural	21	64%	33			

Table K6

Continuous school characteristics and schools reporting public health unit engagement in e-cigarette and/or tobacco use prevention programming

	Overall Engagement				t-test		
	No		Yes				
	M	*SD*	*M*	*SD*	*df*	*t*	*p*-value
School Median Income ('000s)	77.83	13.93	70.08	16.71	82	2.11	.038*
School Enrolment Size ('00s)	4.87	2.34	5.49	2.67	82	-1.05	.298

Table K7

Categorical school characteristics and level of reported public health unit engagement in e-cigarette and/or tobacco use prevention programming

		Level of Engagement								
		1		2		3		4		
		n	%	*n*	%	*n*	%	*n*	%	Total
TOTAL		23	41%	8	14%	10	18%	15	27%	56
Province	Alberta	0	0%	1	100%	0	0%	0	0%	1
	British Columbia	4	57%	1	14%	1	14%	1	14%	7
	Ontario	19	40%	6	13%	9	19%	14	29%	48
Urbanicity	Large Urban	10	40%	2	8%	5	20%	8	32%	25
	Medium Urban	5	50%	3	30%	0	0%	2	20%	10
	Small Urban/Rural	8	38%	3	14%	5	24%	5	24%	21

Table K8

Categorical school characteristics and level of reported public health unit engagement in e-cigarette and/or tobacco use prevention programming

	Level of Engagement									
	0		1		2		3		4	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
School Median Income ('000s)	77.83	13.93	69.78	14.86	74.4	21.99	72.77	11.59	66.43	19.78
School Enrolment Size ('00s)	4.87	2.34	6.08	2.66	4.96	2.3	4.51	2.99	5.53	2.67

Appendix L

Table L1

Model one: Current binge drinking and any level of public health unit engagement in school-based alcohol and/or cannabis use prevention programming.

		Unadjusted			Add school factors			Add student factors		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Public Health Unit Engagement	No (ref)									
	Yes	0.99	0.78, 1.26	.941	1.14	0.95, 1.38	.162	1.07	0.88, 1.31	.487
Province	Ontario (ref)									
	Alberta				1.33	0.98, 1.80	.065	1.31	0.93, 1.85	.125
	British Columbia				0.85	0.63, 1.15	.301	0.89	0.68, 1.16	.390
Urbanicity	Large Urban (ref)									
	Medium Urban				1.60	1.23, 2.08	<.001*	1.47	1.10, 1.98	.01*
	Small Urban/Rural				2.16	1.65, 2.84	<.001*	1.86	1.37, 2.52	<.001*
SES	School Median Income ('000s)				1.00	0.99, 1.01	.748	1.00	0.99, 1.00	.566
School Size	School Enrolment Size ('00s)				1.00	0.96, 1.04	.922	1.01	0.96, 1.06	.722
Grade	9 (ref)									
	10							2.04	1.83, 2.27	<.001*
	11							3.33	2.98, 3.72	<.001*
	12							4.68	4.17, 5.26	<.001*
Sex	Female (ref)									
	Male							1.24	1.15, 1.33	<.001*
Ethnicity	White (ref)									
	Black							1.06	0.87, 1.29	.577
	Asian							0.42	0.36, 0.49	<.001*
	Hispanic							1.11	0.93, 1.33	.236
	Other/Mixed							0.99	0.91, 1.09	.882

Table L2

Model two: Current binge drinking and the level of public health unit engagement in school-based alcohol and/or cannabis use prevention programming

		Unadjusted			Add school factors			Add student factors		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Level of Public Health Unit Engagement	0: No Engagement (ref)									
	1: Provided Information/Resources	0.92	0.69, 1.23	.585	1.06	0.86, 1.30	.564	0.98	0.78, 1.23	.829
	2: Solved Problems Jointly	1.53	1.12, 2.07	.007*	1.58	1.32, 1.89	<.001*	1.51	1.24, 1.83	<.001*
	3: Developed/Implemented Programs Jointly	1.03	0.64, 1.66	.905	1.15	0.85, 1.56	.368	1.08	0.74, 1.58	.69
	4: Programs run by public health unit	0.84	0.60, 1.16	.29	0.93	0.68, 1.27	.641	0.93	0.66, 1.29	.648
Province	Ontario (ref)									
	Alberta				1.29	0.98, 1.71	.07	1.44	0.97, 2.12	.069
	British Columbia				0.83	0.61, 1.12	.225	1.14	0.88, 1.49	.325
Urbanicity	Large Urban (ref)									
	Medium Urban				1.63	1.24, 2.12	<.001*	1.50	1.12, 2.01	.007*
	Small Urban/Rural				2.21	1.69, 2.88	<.001*	1.91	1.42, 2.57	<.001*
SES	School Median Income ('000s)				1.00	0.99, 1.00	.318	1.00	0.99, 1.00	.272
School Size	School Enrolment Size ('00s)				1.01	0.97, 1.06	.56	1.02	0.97, 1.07	.465
Grade	9 (ref)									
	10							2.05	1.84, 2.28	<.001*
	11							3.34	2.99, 3.73	<.001*
	12							4.71	4.20, 5.29	<.001*
Sex	Female (ref)									
	Male							1.24	1.15, 1.33	<.001*
Ethnicity	White (ref)									
	Black							1.06	0.87, 1.30	.553
	Asian							0.42	0.36, 0.49	<.001*
	Hispanic							1.11	0.93, 1.33	.236
	Other/Mixed							0.99	0.91, 1.08	.886

Table L3

Model three: Current alcohol drinking and any level of public health unit engagement in school-based alcohol and/or cannabis use prevention programming

		Unadjusted			Add school factors			Add student factors		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Public Health Unit Engagement	No (ref)									
	Yes	1.01	0.81, 1.25	.958	1.09	0.93, 1.28	.307	1.09	0.91, 1.30	.331
Province	Ontario (ref)									
	Alberta				1.17	0.9, 1.52	.24	1.14	0.85, 1.52	.397
	British Columbia				0.75	0.58, 0.96	.023*	0.86	0.67, 1.10	.229
Urbanicity	Large Urban (ref)									
	Medium Urban				1.50	1.20, 1.86	<.001*	1.38	1.08, 1.77	.009*
	Small Urban/Rural				1.95	1.56, 2.43	<.001*	1.74	1.37, 2.20	<.001*
SES	School Median Income ('000s)				1.00	0.99, 1.00	.71	1.00	0.99, 1.00	.799
School Size	School Enrolment Size ('00s)				1.00	0.97, 1.04	.88	1.01	0.97, 1.05	.591
Grade	9 (ref)									
	10							1.89	1.75, 2.05	<.001*
	11							2.95	2.70, 3.24	<.001*
	12							4.06	3.71, 4.45	<.001*
Sex	Female (ref)									
	Male							1.09	1.03, 1.14	.002*
Ethnicity	White (ref)									
	Black							0.73	0.6, 0.9	.002*
	Asian							0.36	0.31, 0.42	<.001*
	Hispanic							0.92	0.78, 1.08	.297
	Other/Mixed							0.88	0.80, 0.95	.003*

Table L4

Model four: Current alcohol drinking and the level of public health unit engagement in school-based alcohol and/or cannabis use prevention programming

		Unadjusted			Add school factors			Add student factors		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Level of Public Health Unit Engagement	0: No Engagement (ref)									
	1: Provided Information/Resources	0.92	0.70, 1.21	.566	1.01	0.83, 1.22	.932	0.98	0.79, 1.21	.866
	2: Solved Problems Jointly	1.44	1.11, 1.87	.007*	1.44	1.20, 1.74	<.001*	1.46	1.22, 1.74	<.001*
	3: Developed/Implemented Programs Jointly	1.05	0.70, 1.59	.802	1.09	0.83, 1.45	.529	1.09	0.80, 1.49	.577
	4: Programs run by public health unit	0.92	0.71, 1.20	.545	0.96	0.77, 1.19	.689	1.00	0.77, 1.29	.988
Province	Ontario (ref)									
	Alberta				1.14	0.89, 1.47	.285	1.10	0.82, 1.46	.537
	British Columbia				0.73	0.58, 0.93	.012*	0.85	0.67, 1.07	.176
Urbanicity	Large Urban (ref)									
	Medium Urban				1.52	1.22, 1.90	<.001*	1.41	1.10, 1.79	.006*
	Small Urban/Rural				1.98	1.59, 2.47	<.001*	1.78	1.41, 2.25	<.001*
SES	School Median Income ('000s)				1.00	0.99, 1.00	.31	1.00	0.99, 1.00	.397
School Size	School Enrolment Size ('00s)				1.01	0.98, 1.05	.552	1.02	0.98, 1.06	.386
Grade	9 (ref)									
	10							1.90	1.75, 2.06	<.001*
	11							2.96	2.70, 3.25	<.001*
	12							4.08	3.72, 4.47	<.001*
Sex	Female (ref)									
	Male							1.09	1.03, 1.14	.002*
Ethnicity	White (ref)									
	Black							0.73	0.6, 0.9	.003*
	Asian							0.36	0.31, 0.42	<.001*
	Hispanic							0.92	0.78, 1.08	.295
	Other/Mixed							0.87	0.80, 0.95	.003*

Table L5

Model five: Current cannabis use and any level of public health unit engagement in school-based alcohol and/or cannabis use prevention programming

		Unadjusted			Add school factors			Add student factors		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Public Health Unit Engagement	No (ref)									
	Yes	1.01	0.84, 1.21	.949	1.01	0.86,1.18	.928	1.02	0.88, 1.18	.79
Province	Ontario (ref)									
	Alberta				0.87	0.69, 1.09	.225	0.90	0.69, 1.16	.404
	British Columbia				0.80	0.59, 1.10	.165	0.96	0.74, 1.26	.781
Urbanicity	Large Urban (ref)									
	Medium Urban				1.48	1.24, 1.78	<.001*	1.50	1.23, 1.82	<.001*
	Small Urban/Rural				1.58	1.26, 1.97	<.001*	1.53	1.25, 1.89	<.001*
School Median Income ('000s)					1.00	0.99, 1.01	.989	1.00	0.99, 1.00	.387
School Enrolment Size ('00s)					1.00	0.96, 1.03	.837	1.00	0.96, 1.04	.971
Grade	9 (ref)									
	10							1.94	1.74, 2.15	<.001*
	11							2.82	2.54, 3.14	<.001*
	12							3.75	3.33, 4.22	<.001*
Sex	Female (ref)									
	Male							1.40	1.31, 1.51	<.001*
Ethnicity	White (ref)									
	Black							1.59	1.32, 1.92	<.001*
	Asian							0.38	0.31, 0.48	<.001*
	Hispanic							0.99	0.85, 1.14	.862
	Other/Mixed							1.47	1.34, 1.62	<.001*

Table L6

Model six: Current cannabis use and the level of public health unit engagement in school-based alcohol and/or cannabis use prevention programming

		Unadjusted			Add school factors			Add student factors		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Level of Public Health Unit Engagement	0: No Engagement (ref)									
	1: Provided Information/Resources	0.92	0.72, 1.17	.494	0.91	0.76, 1.09	.297	0.88	0.74, 1.04	.13
	2: Solved Problems Jointly	1.42	1.03, 1.95	.032*	1.38	1.02, 1.86	.034*	1.37	1.07, 1.74	.012*
	3: Developed/Implemented Programs Jointly	0.92	0.77, 1.10	.352	0.90	0.73, 1.10	.289	0.96	0.80, 1.16	.689
	4: Programs run by public health unit	0.99	0.81, 1.21	.926	0.95	0.78, 1.15	.577	1.04	0.83, 1.30	.755
Province	Ontario (ref)									
	Alberta				0.84	0.66, 1.08	.172	0.87	0.66, 1.13	.292
	British Columbia				0.79	0.58, 1.06	.112	0.96	0.75, 1.23	.746
Urbanicity	Large Urban (ref)									
	Medium Urban				1.48	1.23, 1.80	<.001*	1.51	1.24, 1.83	<.001*
	Small Urban/Rural				1.59	1.27, 1.99	<.001*	1.56	1.27, 1.90	<.001*
SES	School Median Income ('000s)				1.00	0.99, 1.00	.45	1.00	0.99, 1.00	.097
School Size	School Enrolment Size ('00s)				1.00	0.97, 1.04	.853	1.01	0.97, 1.05	.699
Grade	9 (ref)									
	10							1.94	1.74, 2.16	<.001*
	11							2.83	2.54, 3.14	<.001*
	12							3.76	3.34, 4.24	<.001*
Sex	Female (ref)									
	Male							1.40	1.31, 1.51	<.001*
Ethnicity	White (ref)									
	Black							1.60	1.33, 1.93	<.001*
	Asian							0.38	0.31, 0.47	<.001*
	Hispanic							0.99	0.85, 1.14	.847
	Other/Mixed							1.48	1.34, 1.62	<.001*

Table L7

Model seven: Current e-cigarette use and any level of public health unit engagement in school-based alcohol and/or cannabis use prevention programming

		Unadjusted			Add school factors			Add student factors		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Public Health Unit Engagement	No (ref)									
	Yes	1.04	0.86, 1.26	.674	1.00	0.84, 1.19	.98	1.00	0.86, 1.16	.983
Province	Ontario (ref)									
	Alberta				1.00	0.77, 1.31	.997	1.06	0.82, 1.36	.66
	British Columbia				0.80	0.60, 1.07	.127	1.15	0.93, 1.42	.194
Urbanicity	Large Urban (ref)									
	Medium Urban				1.58	1.29, 1.94	<.001*	1.49	1.24, 1.81	<.001*
	Small Urban/Rural				1.77	1.38, 2.27	<.001*	1.62	1.30, 2.01	<.001*
SES	School Median Income ('000s)				1.00	0.99, 1.00	.619	1.00	0.99, 1.00	.363
School Size	School Enrolment Size ('00s)				1.03	0.99, 1.07	.221	1.03	0.99, 1.07	.103
Grade	9 (ref)									
	10							1.55	1.43, 1.68	<.001*
	11							1.91	1.76, 2.07	<.001*
	12							2.17	1.98, 2.39	<.001*
Sex	Female (ref)									
	Male							1.29	1.22, 1.38	<.001*
Ethnicity	White (ref)									
	Black							0.85	0.70, 1.04	.123
	Asian							0.41	0.36, 0.46	<.001*
	Hispanic							1.00	0.87, 1.14	.968
	Other/Mixed							1.04	0.95, 1.13	.415

Table L8

Model eight: Current e-cigarette use and the level of public health unit engagement in school-based alcohol and/or cannabis use prevention programming

		Unadjusted			Add school factors			Add student factors		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Level of Public Health Unit Engagement	0: No Engagement (ref)									
	1: Provided Information/Resources	1.04	0.81, 1.33	.773	0.98	0.80, 1.21	.88	0.96	0.81, 1.14	.62
	2: Solved Problems Jointly	1.22	0.93, 1.62	.155	1.10	0.85, 1.43	.465	1.08	0.85, 1.36	.529
	3: Developed/Implemented Programs Jointly	0.93	0.70, 1.25	.645	0.92	0.74, 1.13	.404	0.96	0.78, 1.18	.689
	4: Programs run by public health unit	1.03	0.83, 1.28	.788	1.01	0.80, 1.28	.908	1.04	0.83, 1.30	.72
Province	Ontario (ref)									
	Alberta				0.98	0.75, 1.28	.873	1.01	0.77, 1.33	.931
	British Columbia				0.79	0.60, 1.05	.103	0.94	0.76, 1.17	.583
Urbanicity	Large Urban (ref)									
	Medium Urban				1.54	1.24, 1.91	<.001*	1.48	1.22, 1.79	<.001*
	Small Urban/Rural				1.76	1.37, 2.26	<.001*	1.63	1.31, 2.02	<.001*
SES	School Median Income ('000s)				1.00	0.99, 1.00	.645	1.00	0.99, 1.00	.417
School Size	School Enrolment Size ('00s)				1.03	0.98, 1.07	.234	1.03	0.99, 1.07	.095
Grade	9 (ref)									
	10							1.55	1.43, 1.68	<.001*
	11							1.91	1.76, 2.07	<.001*
	12							2.17	1.98, 2.39	<.001*
Sex	Female (ref)									
	Male							1.29	1.22, 1.38	<.001*
Ethnicity	White (ref)									
	Black							0.85	0.70, 1.04	.125
	Asian							0.41	0.36, 0.46	<.001*
	Hispanic							1.00	0.87, 1.14	.956
	Other/Mixed							1.04	0.95, 1.13	.411

Table L9

Model nine: Current cigarette use and any level of public health unit engagement in school-based alcohol and/or cannabis use prevention programming

		Unadjusted			Add school factors			Add student factors		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Public Health Unit Engagement	No (ref)									
	Yes	0.84	0.63, 1.12	.245	0.88	0.68, 1.14	.34	0.90	0.68, 1.18	.431
Province	Ontario (ref)									
	Alberta				1.01	0.64, 1.58	.978	0.93	0.59, 1.49	.777
	British Columbia				1.00	0.78, 1.27	.984	1.17	0.85, 1.63	.338
Urbanicity	Large Urban (ref)									
	Medium Urban				1.49	1.13, 1.97	.005*	1.66	1.22, 2.25	.001*
	Small Urban/Rural				2.27	1.69, 3.05	<.001*	2.42	1.76, 3.34	<.001*
SES	School Median Income ('000s)				1.00	0.99, 1.01	.738	1.00	0.99, 1.01	.473
School Size	School Enrolment Size ('00s)				0.96	0.90, 1.02	.166	0.98	0.92, 1.04	.483
Grade	9 (ref)									
	10							1.55	1.34, 1.79	<.001*
	11							2.14	1.86, 2.47	<.001*
	12							3.06	2.62, 3.57	<.001*
Sex	Female (ref)									
	Male							1.27	1.16, 1.39	<.001*
Ethnicity	White (ref)									
	Black							1.96	1.57, 2.43	<.001*
	Asian							0.58	0.45, 0.75	<.001*
	Hispanic							1.33	1.04, 1.69	.022*
	Other/Mixed							1.76	1.56, 1.98	<.001*

Table L10

Model ten: Current cigarette use and any level of public health unit engagement in school-based alcohol and/or cannabis use prevention programming

		Unadjusted			Add school factors			Add student factors		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Level of Public Health Unit Engagement	0: No Engagement (ref)									
	1: Provided Information/Resources	0.77	0.57, 1.05	.10	0.81	0.62, 1.05	.118	0.82	0.61, 1.10	.182
	2: Solved Problems Jointly	1.29	0.71, 2.33	.407	1.23	0.78, 1.94	.368	1.13	0.75, 1.71	.554
	3: Developed/Implemented Programs Jointly	0.90	0.54, 1.50	.679	0.83	0.60, 1.16	.278	0.89	0.63, 1.27	.53
	4: Programs run by public health unit	0.69	0.49, 0.99	.044*	0.74	0.53, 1.02	.064	0.84	0.57, 1.23	.362
Province	Ontario (ref)									
	Alberta				0.98	0.63, 1.53	.920	0.91	0.57, 1.47	.71
	British Columbia				0.96	0.76, 1.22	.739	1.15	0.83, 1.61	.402
Urbanicity	Large Urban (ref)									
	Medium Urban				1.39	1.01, 1.90	.04*	1.61	1.15, 2.25	.005*
	Small Urban/Rural				2.28	1.72, 3.03	<.001*	2.46	1.79, 3.38	<.001*
SES	School Median Income ('000s)				1.00	0.99, 1.01	.497	1.00	0.99, 1.00	.357
School Size	School Enrolment Size ('00s)				0.96	0.91, 1.02	.202	0.99	0.93, 1.04	.630
Grade	9 (ref)									
	10							1.55	1.34, 1.79	<.001*
	11							2.14	1.86, 2.47	<.001*
	12							3.06	2.63, 3.57	<.001*
Sex	Female (ref)									
	Male							1.27	1.16, 1.39	<.001*
Ethnicity	White (ref)									
	Black							1.96	1.57, 2.44	<.001*
	Asian							0.58	0.45, 0.75	<.001*
	Hispanic							1.32	1.04, 1.68	.023*
	Other/Mixed							1.76	1.56, 1.98	<.001*

Appendix M

Table M1

Model one: Current binge drinking in low and high use schools and any level of public health unit engagement in alcohol and/or cannabis use prevention programming

		All Schools			Low-Use Schools			High-Use Schools		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Public Health Unit Engagement	No (ref)									
	Yes	1.07	0.88, 1.31	.487	0.85	0.69, 1.05	.14	1.04	0.86, 1.26	.692
Province	Ontario (ref)									
	Alberta	1.31	0.93, 1.85	.125				0.83	0.57, 1.2	.322
	British Columbia	0.89	0.68, 1.16	.39	0.84	0.65, 1.1	.213	0.85	0.62, 1.18	.327
Urbanicity	Large Urban (ref)									
	Medium Urban	1.47	1.1, 1.98	.01*	1.27	1.03, 1.57	.028*	1.27	0.98, 1.65	.067
	Small Urban/Rural	1.86	1.37, 2.52	<.001*	1.02	0.75, 1.4	.877	1.21	0.87, 1.68	.247
SES	School Median Income ('000s)	1	0.99, 1.00	.566	1	0.99, 1.01	.783	1.01	1.00, 1.02	.113
School Size	School Enrolment Size ('00s)	1.01	0.96, 1.06	.722	1.05	1.00, 1.11	.032*	0.95	0.89, 1.02	.188
Grade	9 (ref)									
	10	2.04	1.83, 2.27	<.001*	2.1	1.74, 2.53	<.001*	2.04	1.78, 2.33	<.001*
	11	3.33	2.98, 3.72	<.001*	3.51	2.94, 4.18	<.001*	3.29	2.84, 3.82	<.001*
	12	4.68	4.17, 5.26	<.001*	4.92	4.04, 6.00	<.001*	4.68	4.07, 5.37	<.001*
Sex	Female (ref)									
	Male	1.24	1.15, 1.33	<.001*	1.15	1.05, 1.26	.003*	1.32	1.19, 1.47	<.001*
Ethnicity	White (ref)									
	Black	1.06	0.87, 1.29	.577	0.97	0.73, 1.29	.838	1.24	0.9, 1.7	.184
	Asian	0.42	0.36, 0.49	<.001*	0.4	0.33, 0.49	<.001*	0.41	0.32, 0.53	<.001*
	Hispanic	1.11	0.93, 1.33	.236	1.16	0.9, 1.5	.246	1.05	0.83, 1.31	.698
	Other/Mixed	0.99	0.91, 1.09	.882	0.95	0.81, 1.11	.518	1.02	0.93, 1.13	.618

Table M2

Model two: Current binge drinking in low and high use schools and the level of public health unit engagement in alcohol and/or cannabis use prevention programs

		All Schools			Low-Use Schools			High-Use Schools		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Level of Public Health Unit Engagement	0: No Engagement (ref)									
	1: Provided Information/Resources	0.98	0.78, 1.23	.829	0.78	0.61, 1.00	.047*	1.02	0.84, 1.23	.871
	2: Solved Problems Jointly	1.51	1.24, 1.83	<.001*	1.61	1.26, 2.05	<.001*	1.11	0.87, 1.41	.408
	3: Developed/Implemented Programs Jointly	1.08	0.74, 1.58	.69	0.87	0.53, 1.42	.571	1.07	0.79, 1.45	.639
	4: Programs run by public health unit	0.93	0.66, 1.29	.648	0.92	0.73, 1.16	.482	0.97	0.69, 1.38	.876
Province	Ontario (ref)									
	Alberta	1.44	0.97, 2.12	.069				1.00	0.67, 1.49	.994
	British Columbia	1.14	0.88, 1.49	.325	1.14	0.88, 1.49	.323	1.17	0.85, 1.62	.342
Urbanicity	Large Urban (ref)									
	Medium Urban	1.50	1.12, 2.01	.007*	1.37	1.09, 1.72	.006*	1.30	1.03, 1.64	.025*
	Small Urban/Rural	1.91	1.42, 2.57	<.001*	1.04	0.75, 1.44	.806	1.22	0.87, 1.69	.247
SES	School Median Income ('000s)	1.00	0.99, 1.00	.272	1.00	0.99, 1.00	.766	1.01	1.00, 1.02	.21
School Size	School Enrolment Size ('00s)	1.02	0.97, 1.07	.465	1.06	1.01, 1.12	.0254*	0.95	0.89, 1.02	.165
Grade	9 (ref)									
	10	2.05	1.84, 2.28	<.001*	2.10	1.74, 2.53	<.001*	2.04	1.78, 2.33	<.001*
	11	3.34	2.99, 3.73	<.001*	3.51	2.95, 4.18	<.001*	3.30	2.84, 3.82	<.001*
	12	4.71	4.20, 5.29	<.001*	4.93	4.05, 6.02	<.001*	4.68	4.08, 5.38	<.001*
Sex	Female (ref)									
	Male	1.24	1.15, 1.33	<.001*	1.15	1.05, 1.26	.003*	1.32	1.19, 1.46	<.001*
Ethnicity	White (ref)									
	Black	1.06	0.87, 1.30	.553	0.97	0.73 1.29	.841	1.24	0.90, 1.70	.182
	Asian	0.42	0.36, 0.49	<.001*	0.40	0.33 0.49	<.001*	0.41	0.32, 0.53	<.001*
	Hispanic	1.11	0.93, 1.33	.236	1.17	0.90 1.50	.239	1.05	0.83, 1.31	.695
	Other/Mixed	0.99	0.91, 1.08	.886	0.95	0.81 1.11	.528	1.02	0.93, 1.13	.634

Table M3

Model three: Current alcohol use in low and high use schools and any level of public health unit engagement in alcohol and/or cannabis use prevention programs

		All Schools			Low-Use Schools			High-Use Schools		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Public Health Unit Engagement	No (ref)									
	Yes	1.09	0.91, 1.30	.331	0.96	0.80, 1.17	.701	1.00	0.86, 1.17	.952
Province	Ontario (ref)									
	Alberta	1.14	0.85, 1.52	.397	1.21	1.03, 1.41	.020*	0.84	0.58, 1.22	.356
	British Columbia	0.86	0.67, 1.10	.229	0.84	0.66, 1.07	.149	0.82	0.66, 1.01	.066
Urbanicity	Large Urban (ref)									
	Medium Urban	1.38	1.08, 1.77	.009*	1.07	0.88, 1.29	.511	1.05	0.84, 1.30	.681
	Small Urban/Rural	1.74	1.37, 2.20	<.001*	1.19	0.98, 1.43	.073	1.09	0.78, 1.51	.628
SES	School Median Income ('000s)	1.00	0.99, 1.00	.799	1.00	1.00, 1.00	.94	1.01	1.00, 1.02	.172
School Size	School Enrolment Size ('00s)	1.01	0.97, 1.05	.591	1.03	0.99, 1.07	.114	0.97	0.90, 1.04	.333
Grade	9 (ref)									
	10	1.89	1.75, 2.05	<.001*	1.92	1.70, 2.16	<.001*	1.90	1.70, 2.13	<.001*
	11	2.95	2.70, 3.24	<.001*	2.99	2.67, 3.36	<.001*	2.99	2.58, 3.46	<.001*
	12	4.06	3.71, 4.45	<.001*	4.14	3.62, 4.74	<.001*	4.11	3.63, 4.65	<.001*
Sex	Female (ref)									
	Male	1.09	1.03, 1.14	.002*	1.07	1.00, 1.14	.055	1.11	1.02, 1.20	.014*
Ethnicity	White (ref)									
	Black	0.73	0.60, 0.90	.002*	0.66	0.50, 0.86	.002*	0.91	0.67, 1.23	.529
	Asian	0.36	0.31, 0.42	<.001*	0.36	0.29, 0.44	<.001*	0.33	0.26, 0.42	<.001*
	Hispanic	0.92	0.78, 1.08	.297	0.98	0.78, 1.22	.842	0.79	0.64, 0.98	.031*
	Other/Mixed	0.88	0.80, 0.95	.003*	0.83	0.72, 0.95	.006*	0.93	0.83, 1.03	.158

Table M4

Model four: Current alcohol use in low and high use schools and the level of public health unit engagement in alcohol and/or cannabis use prevention programs

		All Schools			Low-Use Schools			High-Use Schools		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Level of Public Health Unit Engagement	0: No Engagement (ref)									
	1: Provided Information/Resources	0.98	0.79, 1.21	.866	0.85	0.69, 1.04	.121	1.00	0.85, 1.18	.992
	2: Solved Problems Jointly	1.46	1.22, 1.74	<.001*	1.59	1.30, 1.94	<.001*	1.07	0.88, 1.29	.515
	3: Developed/Implemented Programs Jointly	1.09	0.80, 1.49	.577	1.05	0.72, 1.55	.793	0.98	0.73, 1.31	.877
	4: Programs run by public health unit	1.00	0.77, 1.29	.988	1.08	0.88, 1.33	.45	0.95	0.74, 1.23	.698
Province	Ontario (ref)									
	Alberta	1.10	0.82, 1.46	.537	1.31	1.08, 1.58	.005*	0.85	0.60, 1.21	.368
	British Columbia	0.85	0.67, 1.07	.176	0.89	0.71, 1.11	.295	0.81	0.65, 1.00	.055
Urbanicity	Large Urban (ref)									
	Medium Urban	1.41	1.10, 1.79	.006*	1.23	0.99, 1.52	.067	1.08	0.87, 1.33	.502
	Small Urban/Rural	1.78	1.41, 2.25	<.001*	1.19	0.98, 1.45	.077	1.12	0.80, 1.56	.523
SES	School Median Income ('000s)	1.00	0.99, 1.00	.397	1.00	1.00, 1.00	.943	1.01	1.00, 1.01	.244
School Size	School Median Income ('000s)	1.02	0.98, 1.06	.386	1.04	1.00, 1.09	.065	0.97	0.91, 1.04	.35
Grade	9 (ref)									
	10	1.90	1.75, 2.06	<.001*	1.92	1.71, 2.16	<.001*	1.90	1.70, 2.13	<.001*
	11	2.96	2.70, 3.25	<.001*	3.00	2.67, 3.37	<.001*	2.99	2.58, 3.46	<.001*
	12	4.08	3.72, 4.47	<.001*	4.16	3.64, 4.76	<.001*	4.11	3.63, 4.65	<.001*
Sex	Female (ref)									
	Male	1.09	1.03, 1.14	.002*	1.07	1.00, 1.14	.054	1.11	1.02, 1.20	.015*
Ethnicity	White (ref)									
	Black	0.73	0.60, 0.90	.003*	0.66	0.50, 0.85	.002*	0.91	0.67, 1.23	.528
	Asian	0.36	0.31, 0.42	<.001*	0.36	0.29, 0.44	<.001*	0.33	0.26, 0.42	<.001*
	Hispanic	0.92	0.78, 1.08	.295	0.98	0.78, 1.22	.853	0.79	0.64, 0.98	.03*
	Other/Mixed	0.87	0.80, 0.95	.003*	0.83	0.72, 0.95	.006*	0.93	0.83, 1.03	.154

Table M5

Model five: Current cannabis use in low and high use schools and any level of public health unit engagement in alcohol and/or cannabis use prevention programs

		All Schools			Low-Use Schools			High-Use Schools		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Public Health Unit Engagement	No (ref)									
	Yes	1.02	0.88, 1.18	.79	1.04	0.83, 1.31	.713	0.99	0.84, 1.17	.907
Province	Ontario (ref)									
	Alberta	0.90	0.69, 1.16	.404	0.92	0.76, 1.12	.409	0.87	0.63, 1.22	.424
	British Columbia	0.96	0.74, 1.26	.781	0.99	0.71, 1.37	.937	1.09	0.95, 1.26	.232
Urbanicity	Large Urban (ref)									
	Medium Urban	1.50	1.23, 1.82	<.001*	1.31	0.99, 1.73	.0572	1.04	0.87, 1.24	.652
	Small Urban/Rural	1.53	1.25, 1.89	<.001*	1.36	1.15, 1.61	<.001*	1.06	0.90, 1.25	.501
SES	School Median Income ('000s)	1.00	0.99, 1.00	.387	1.00	0.99, 1.00	.610	1.00	0.99, 1.01	.781
School Size	School Enrolment Size ('00s)	1.00	0.96, 1.04	.971	1.03	0.99, 1.07	.107	0.99	0.95, 1.03	.702
Grade	9 (ref)									
	10	1.94	1.74, 2.15	<.001*	2.01	1.68, 2.41	<.001*	1.90	1.67, 2.17	<.001*
	11	2.82	2.54, 3.14	<.001*	2.99	2.53, 3.54	<.001*	2.75	2.40, 3.15	<.001*
	12	3.75	3.33, 4.22	<.001*	4.19	3.46, 5.06	<.001*	3.46	2.99, 4.01	<.001*
Sex	Female (ref)									
	Male	1.40	1.31, 1.51	<.001*	1.47	1.35, 1.61	<.001*	1.34	1.20, 1.50	<.001*
Ethnicity	White (ref)									
	Black	1.59	1.32, 1.92	<.001*	1.56	1.23, 1.97	<.001*	1.58	1.18, 2.13	.002*
	Asian	0.38	0.31, 0.48	<.001*	0.32	0.24, 0.42	<.001*	0.51	0.37, 0.69	<.001*
	Hispanic	0.99	0.85, 1.14	.862	0.96	0.81, 1.14	.653	0.97	0.74, 1.29	.858
	Other/Mixed	1.47	1.34, 1.62	<.001*	1.31	1.15, 1.50	<.001*	1.64	1.43, 1.88	<.001*

Table M6

Model six: Current cannabis use in low and high use schools and the level of public health unit engagement in alcohol and/or cannabis use prevention programs

		All Schools			Low-Use Schools			High-Use Schools		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Level of Public Health Unit Engagement	0: No Engagement (ref)									
	1: Provided Information/Resources	0.88	0.74, 1.04	.13	0.89	0.71, 1.12	.315	0.97	0.84, 1.11	.622
	2: Solved Problems Jointly	1.37	1.07, 1.74	.012*	1.12	0.81, 1.54	.502	1.07	0.79, 1.45	.647
	3: Developed/Implemented Programs Jointly	0.96	0.80, 1.16	.689	1.26	1.00, 1.59	.049*	0.82	0.69, 0.98	.026*
	4: Programs run by public health unit	1.04	0.83, 1.30	.755	1.23	0.90, 1.67	.202	0.98	0.85, 1.13	.812
Province	Ontario (ref)									
	Alberta	0.87	0.66, 1.13	.292	0.95	0.74, 1.22	.697	0.90	0.67, 1.21	.473
	British Columbia	0.96	0.75, 1.23	.746	1.01	0.77, 1.33	.941	1.07	0.91, 1.26	.425
Urbanicity	Large Urban (ref)									
	Medium Urban	1.51	1.24, 1.83	<.001*	1.26	1.06, 1.51	.009*	1.05	0.86, 1.28	.633
	Small Urban/Rural	1.56	1.27, 1.90	<.001*	1.29	1.05, 1.57	.014*	1.08	0.88, 1.33	.440
SES	School Median Income ('000s)	1.00	0.99, 1.00	.097	1.00	0.99, 1.00	.607	1.00	0.99, 1.00	.495
School Size	School Enrolment Size ('00s)	1.01	0.97, 1.05	.699	1.04	1.00, 1.09	.050*	1.00	0.96, 1.04	.954
Grade	9 (ref)									
	10	1.94	1.74, 2.16	<.001*	2.01	1.68, 2.41	<.001*	1.90	1.67, 2.17	<.001*
	11	2.83	2.54, 3.14	<.001*	3.00	2.54, 3.55	<.001*	2.75	2.40, 3.15	<.001*
	12	3.76	3.34, 4.24	<.001*	4.20	3.48, 5.08	<.001*	3.46	2.99, 4.01	<.001*
Sex	Female (ref)									
	Male	1.40	1.31, 1.51	<.001*	1.47	1.35, 1.61	<.001*	1.34	1.20, 1.50	<.001*
Ethnicity	White (ref)									
	Black	1.60	1.33, 1.93	<.001*	1.56	1.23, 1.97	.000*	1.59	1.18, 2.14	.002*
	Asian	0.38	0.31, 0.47	<.001*	0.32	0.25, 0.42	<.001*	0.51	0.37, 0.70	<.001*
	Hispanic	0.99	0.85, 1.14	.847	0.96	0.81, 1.14	.663	0.97	0.74, 1.29	.851
	Other/Mixed	1.48	1.34, 1.62	<.001*	1.32	1.15, 1.51	<.001*	1.65	1.44, 1.88	<.001*

Table M7

Model seven: Current e-cigarette use in low and high use schools with any level of public health unit engagement in e-cigarette and/or tobacco use prevention programs

		All Schools			Low-Use Schools			High-Use Schools		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Public Health Unit Engagement	No (ref)									
	Yes	1.04	0.90, 1.20	.564	0.93	0.77, 1.13	.474	1.04	0.90, 1.20	.564
Province	Ontario (ref)									
	Alberta	1.06	0.82, 1.36	.66	0.76	0.64, 0.90	.001*	1.06	0.82, 1.36	.66
	British Columbia	1.15	0.93, 1.42	.194	0.89	0.70, 1.14	.371	1.15	0.93, 1.42	.194
Urbanicity	Large Urban (ref)									
	Medium Urban	1.15	0.99, 1.34	.065	1.32	1.12, 1.56	.001*	1.15	0.99, 1.34	.065
	Small Urban/Rural	1.12	0.91, 1.39	.28	1.34	1.09, 1.64	.005*	1.12	0.91, 1.39	.28
SES	School Median Income ('000s)	1.00	0.99, 1.00	.387	1.00	0.99, 1.00	.644	1.00	0.99, 1.00	.387
School Size	School Enrolment Size ('00s)	1.00	0.96, 1.05	.86	1.05	1.01, 1.09	.014*	1.00	0.96, 1.05	.86
Grade	9 (ref)									
	10	1.50	1.34, 1.69	<.001*	1.61	1.44, 1.81	<.001*	1.50	1.34, 1.69	<.001*
	11	1.82	1.62, 2.04	<.001*	2.03	1.81, 2.27	<.001*	1.82	1.62, 2.04	<.001*
	12	2.03	1.78, 2.33	<.001*	2.34	2.06, 2.66	<.001*	2.03	1.78, 2.33	<.001*
Sex	Female (ref)									
	Male	1.31	1.21, 1.42	<.001*	1.28	1.17, 1.41	<.001*	1.31	1.21, 1.42	<.001*
Ethnicity	White (ref)									
	Black	1.02	0.82, 1.29	.832	0.77	0.58, 1.03	.075	1.02	0.82, 1.29	.832
	Asian	0.45	0.36, 0.55	<.001*	0.39	0.33, 0.45	<.001*	0.45	0.36, 0.55	<.001*
	Hispanic	0.94	0.75, 1.18	.622	1.02	0.87, 1.20	.803	0.94	0.75, 1.18	.622
	Other/Mixed	1.07	0.93, 1.22	.338	1.02	0.91, 1.13	.759	1.07	0.93, 1.22	.338

Table M8

Model eight: Current e-cigarette use in low and high use schools and the level of public health unit engagement in e-cigarette and/or tobacco use prevention programs

		All Schools			Low-Use Schools			High-Use Schools		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Level of Public Health Unit Engagement	0: No Engagement (ref)									
	1: Provided Information/Resources	0.96	0.81, 1.14	.62	0.90	0.72, 1.11	.31	1.02	0.85, 1.22	.844
	2: Solved Problems Jointly	1.08	0.85, 1.36	.529	0.79	0.61, 1.01	.062	1.05	0.90, 1.23	.545
	3: Developed/Implemented Programs Jointly	0.96	0.78, 1.18	.689	1.01	0.78, 1.30	.957	0.99	0.79, 1.25	.958
	4: Programs run by public health unit	1.04	0.83, 1.30	.72	0.99	0.78, 1.25	.936	1.09	0.90, 1.31	.375
Province	Ontario (ref)									
	Alberta	1.01	0.77, 1.33	.931	0.77	0.64, 0.93	.006*	1.04	0.81, 1.33	.762
	British Columbia	0.94	0.76, 1.17	.583	0.90	0.71, 1.15	.417	1.15	0.93, 1.42	.194
Urbanicity	Large Urban (ref)									
	Medium Urban	1.48	1.22, 1.79	<.001*	1.33	1.11, 1.60	.002*	1.17	1.01, 1.36	.039*
	Small Urban/Rural	1.63	1.31, 2.02	<.001*	1.31	1.08, 1.58	.006*	1.16	0.90, 1.49	.243
SES	School Median Income ('000s)	1.00	0.99, 1.00	.417	1.00	0.99, 1.00	.66	1.00	0.99, 1.00	.44
School Size	School Enrolment Size ('00s)	1.03	0.99, 1.07	.095	1.05	1.01, 1.09	.027*	1.01	0.96, 1.06	.821
Grade	9 (ref)									
	10	1.55	1.43, 1.68	<.001*	1.61	1.44, 1.81	<.001*	1.50	1.34, 1.68	<.001*
	11	1.91	1.76, 2.07	<.001*	2.03	1.81, 2.27	<.001*	1.82	1.61, 2.04	<.001*
	12	2.17	1.98, 2.39	<.001*	2.34	2.07, 2.66	<.001*	2.03	1.77, 2.33	<.001*
Sex	Female (ref)									
	Male	1.29	1.22, 1.38	<.001*	1.28	1.17, 1.41	<.001*	1.31	1.21, 1.42	<.001*
Ethnicity	White (ref)									
	Black	0.85	0.70, 1.04	.125	0.77	0.58, 1.03	.074	1.02	0.82, 1.29	.834
	Asian	0.41	0.36, 0.46	<.001*	0.39	0.33, 0.45	<.001*	0.45	0.36, 0.55	<.001*
	Hispanic	1.00	0.87, 1.14	.956	1.02	0.87, 1.20	.812	0.94	0.75, 1.18	.618
	Other/Mixed	1.04	0.95, 1.13	.411	1.02	0.92, 1.13	.73	1.07	0.94, 1.22	.33

Table M9

Model nine: Current cigarette use in low and high use schools and any level of public health unit engagement in e-cigarette and/or tobacco use prevention programs

		All Schools			Low-Use Schools			High-Use Schools		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Public Health Unit Engagement	No (ref)									
	Yes	0.90	0.68, 1.18	.431	0.92	0.72, 1.17	.505	0.79	0.64, 0.99	.04*
Province	Ontario (ref)									
	Alberta	0.93	0.59, 1.49	.777				0.52	0.30, 0.90	.02*
	British Columbia	1.17	0.85, 1.63	.338	1.31	0.92, 1.85	.131	0.71	0.51, 0.98	.038*
Urbanicity	Large Urban (ref)									
	Medium Urban	1.66	1.22, 2.25	.001*	1.36	1.08, 1.71	.01*	1.45	1.09, 1.93	.01*
	Small Urban/Rural	2.42	1.76, 3.34	<.001*	1.27	0.92, 1.76	.142	1.77	1.26, 2.49	<.001*
SES	School Median Income ('000s)	1.00	0.99, 1.01	.473	0.99	0.99, 1.00	.156	1.01	0.99, 1.02	.228
School Size	School Enrolment Size ('00s)	0.98	0.92, 1.04	.483	1.04	1.00, 1.09	.06	0.98	0.92, 1.05	.626
Grade	9 (ref)									
	10	1.55	1.34, 1.79	<.001*	1.56	1.28, 1.90	<.001*	1.56	1.27, 1.92	<.001*
	11	2.14	1.86, 2.47	<.001*	2.15	1.80, 2.56	<.001*	2.21	1.79, 2.71	<.001*
	12	3.06	2.62, 3.57	<.001*	3.48	2.90, 4.19	<.001*	2.85	2.27, 3.58	<.001*
Sex	Female (ref)									
	Male	1.27	1.16, 1.39	<.001*	1.31	1.15, 1.49	<.001*	1.24	1.09, 1.41	.001*
Ethnicity	White (ref)									
	Black	1.96	1.57, 2.43	<.001*	1.78	1.32, 2.39	<.001*	2.32	1.61, 3.34	<.001*
	Asian	0.58	0.45, 0.75	<.001*	0.49	0.35, 0.69	<.001*	0.68	0.46, 0.99	.044*
	Hispanic	1.33	1.04, 1.69	.022*	1.23	0.87, 1.74	.233	1.51	1.03, 2.21	.037*
	Other/Mixed	1.76	1.56, 1.98	<.001*	1.52	1.33, 1.75	<.001*	1.95	1.64, 2.31	<.001*

Table M10

Model ten: Current cigarette use in low and high use schools and the level of public health unit engagement in e-cigarette and/or tobacco use prevention programs

		All Schools			Low-Use Schools			High-Use Schools		
		OR	95% CI	*p*-value	*AOR*	95% CI	*p*-value	*AOR*	95% CI	*p*-value
Level of Public Health Unit Engagement	0: No Engagement (ref)									
	1: Provided Information/Resources	0.82	0.61, 1.10	.182	0.92	0.70, 1.20	.527	0.74	0.58, 0.93	.011*
	2: Solved Problems Jointly	1.13	0.75, 1.71	.554	0.95	0.74, 1.23	.71	0.92	0.67, 1.27	.615
	3: Developed/Implemented Programs Jointly	0.89	0.63, 1.27	.53	0.64	0.41, 1.01	.054	0.77	0.57, 1.03	.083
	4: Programs run by public health unit	0.84	0.57, 1.23	.362	1.03	0.75, 1.41	.846	0.75	0.52, 1.07	.11
Province	Ontario (ref)									
	Alberta	0.91	0.57, 1.47	.71				0.56	0.34, 0.92	.021*
	British Columbia	1.15	0.83, 1.61	.402	1.32	0.95, 1.84	.102	0.72	0.51, 1.02	.068
Urbanicity	Large Urban (ref)									
	Medium Urban	1.61	1.15, 2.25	.005*	1.31	1.05, 1.63	.016*	1.42	1.05, 1.93	.021*
	Small Urban/Rural	2.46	1.79, 3.38	<.001*	1.13	0.81, 1.58	.458	1.74	1.27, 2.39	.001*
SES	School Median Income ('000s)	1.00	0.99, 1.00	.357	1.00	0.99, 1.01	.493	1.01	0.99, 1.02	.406
School Size	School Enrolment Size ('00s)	0.99	0.93, 1.04	.63	1.04	0.99, 1.08	.102	0.98	0.91, 1.05	.528
Grade	9 (ref)									
	10	1.55	1.34, 1.79	<.001*	1.56	1.28, 1.90	<.001*	1.56	1.27, 1.92	<.001*
	11	2.14	1.86, 2.47	<.001*	2.15	1.80, 2.56	<.001*	2.20	1.79, 2.71	<.001*
	12	3.06	2.63, 3.57	<.001*	3.50	2.91, 4.20	<.001*	2.86	2.27, 3.59	<.001*
Sex	Female (ref)									
	Male	1.27	1.16, 1.39	<.001*	1.31	1.15, 1.50	<.001*	1.24	1.09, 1.41	.001*
Ethnicity	White (ref)									
	Black	1.96	1.57, 2.44	<.001*	1.78	1.31, 2.41	<.001*	2.32	1.61, 3.35	<.001*
	Asian	0.58	0.45, 0.75	<.001*	0.50	0.36, 0.69	<.001*	0.67	0.46, 0.99	.045*
	Hispanic	1.32	1.04, 1.68	.023*	1.23	0.87, 1.74	.237	1.50	1.02, 2.21	.038*
	Other/Mixed	1.76	1.56, 1.98	<.001*	1.53	1.33, 1.75	<.001*	1.94	1.64, 2.28	<.001*