

Evaluating the Impact of Changes in School-Based Tobacco Interventions Among Never Smokers Between Year 2 and Year 3 of the COMPASS Study

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Abstract

Objective: To examine how changes in school-based tobacco programming within a school influenced smoking susceptibility and smoking initiation outcomes among a sample of grade 9 to 12 students over time.

Methods: This study used longitudinal data from Year 2 and Year 3 of the COMPASS study. The study used school-level data from 79 schools within Ontario using the School Policies and Practices (SPP) questionnaire as well as student-level data on 14965 grade 9 to 12 students who were never smoker individuals at baseline (Year 2) using the COMPASS questionnaire (Cq). This study did not examine individuals who were tried smokers at baseline. Binary logistic regression models were used to examine the impact of changes in tobacco programming within a school had on the relative risk of students' reverting in smoking susceptibility status, becoming susceptible to smoking or initiating smoking behaviour in Year 3.

Results: Between Year 2 and Year 3 of the study, 22 schools (out of 79) Ontario schools reported implementing a new tobacco intervention in their school. Out of 22 schools, one school intervention had the desired impact of significantly increasing the likelihood of a susceptible never smoker individual at baseline reverting in smoking susceptibility that corresponded with a reduced risk of smoking initiation. One intervention significantly decreased the likelihood of individuals trying smoking, however these promising effects were only observed among the sample of non-susceptible never smoker individuals at baseline. In contrast, two interventions had the undesirable impact of significantly increasing the likelihood of a student initiating smoking behaviour among non-susceptible never smokers at baseline.

Conclusion: The evidence presented here indicates that the majority of school-based tobacco prevention programming do not show promise in reducing adolescent smoking susceptibility and initiation among never smokers. Progress in preventing smoking initiation among never smoker youth will require coordinated and comprehensive efforts from various stakeholders. In addition, there is a need for innovative methods to be used in determining which interventions work, for which target audience, and in what context to guide the formulation of tailored and effective programming.

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Dedication

I dedicate my thesis to the loving memory of my father who will always remain my source of inspiration and strength.



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Chapter 1

Introduction and Overview

Despite recent reductions in current smoking within Ontario through the implementation of the Smoke-Free Act in 2006, prevention efforts among youth remain a critical public health priority in order to prevent and reduce smoking experimentation among youth. Considering the majority of Ontario youth attend secondary school, the school environment signifies a unique context for modifying youths' intentions to smoke and smoking behaviour. Furthermore, the school environment has been seen to influence youth health behaviours including smoking susceptibility and behaviour (Leatherdale & Cole, 2015). Despite these findings, research up to date has failed to identify key constituents of effective school-based tobacco programming, thus our understanding of how to intervene within the school context is limited (Galanti et al., 2014; Wiehe et al., 2005). The lack of guidance for school based tobacco programming within Ontario leaves schools with the task of either implementing previously identified evidence-based programs (which may not account for school-specific contextual factors) or the duty of developing novel programs and policies that are usually not evidence based (Leatherdale, 2012). Future research focused on evaluating whether schools are implementing any potentially promising tobacco-related interventions can help in formulating practice-based evidence through the assessment of such natural experiments. This work may be used in guiding the tobacco prevention agenda.

Chapter 2

Literature Review

2.1 Burden/health effects of smoking

Non-communicable chronic diseases, such as cancer and cardiovascular disease, have been recognized as a threat not solely to human health, but also to development and economic growth. Sixty-three percent of deaths globally are attributable to chronic disease and a cumulative output loss of over 40 million dollars is projected over the next two decades (Bloom et al, 2011). One of the four key modifiable risk factors that the World Health Organization (WHO) has identified to chronic disease incidence is tobacco use (Bloom et al., 2011). On a global scale, tobacco use is responsible for nearly 6 million deaths annually and is projected to result in the loss of more than 8 million lives by 2030 (World Health Organization, 2011). In response to the surge of global tobacco use, the WHO Framework Convention on Tobacco Control (WHO FCTC) was developed and aimed at tackling the root causes and complex factors associated with tobacco use. In addition, several reduction demand measures were targeted towards protecting youth (World Health Organization, 2013).

Within the province of Ontario, tobacco use remains the principal cause of preventable death and disease, resulting in a loss of over 13,000 lives within Ontario annually (Ministry of Health and Long Term Care, 2011). Smoking causes numerous types of malignancies including cancers of the lung, throat, mouth, nasal cavity, stomach, pancreas, bladder, acute myeloid leukemia (U.S. Department of Health and Human Services, 2014). In addition, it has been seen to be causally linked to age-related macular degeneration, rheumatoid arthritis, diabetes mellitus, hypertension, cardiovascular diseases and ectopic pregnancy (U.S. Department of Health and

Human Services, 2014). The health consequences causally linked to exposure to second hand tobacco smoke (SHS) include respiratory and cardiovascular diseases (USDHHS, 2014). Within children, adverse effects of SHS also include middle ear disease and sudden infant death syndrome (USDHHS, 2004; USDHHS, 2006, USDHHS, 2014). Given the health consequences associated with tobacco use and exposure, it remains an important public health concern.

2.2 Prevalence of Smoking among Canadian Youth

In recent data examining a nationally representative sample of gr.9 to 12 students, the results indicated that approximately 14 % of Canadian students reported being current cigarette smokers (Minaker et al., 2014). Within the province of Ontario, 11 % of students between grades 9-12 reported being current cigarette smokers (Minaker et al., 2014). Despite the substantial reduction in current smokers seen among youth over the past decade, smoking still remains one of leading public health concerns pertaining to the future health of Canadian youth.

Recent data from the 2010-2011 Youth Smoking Survey (YSS) indicated that 37 % of Canadian high-students have ever tried smoking a cigarette (Minaker et al., 2014). The YSS dataset also indicated that 30 % students within Ontario have reported ever trying smoking cigarettes (Minaker et al., 2014). Prior research has indicated that the first step towards smoking initiation involves entertaining/contemplating the idea of trying a cigarette (Pierce et al., 1996). According to recent national data examining youth smoking by distinct smoking stages, 29 % of youth between grades 9 to 12 were classified as susceptible never-smokers (i.e. youth that have the intention or have contemplated the idea of trying a cigarette but who have never tried smoking) (Kaai et al., 2014). Given that smoking patterns established at adolescence tend to propagate into adulthood (Griffin, Botvin, Doyle, Diaz & Epstein, 1999), youth-based prevention initiatives focused on tobacco control remain a national health priority.

2.3 Stages of Smoking Behaviour

Many scholars have conceptualized smoking uptake behaviour among adolescents as progressing through a sequence of stages (Chassin et al., 2000; Maggi et al., 2007; Colder et al. 2001, Lessov- Shlaggar et al., 2008). There is a considerable amount of literature depicting how youth progress through various stages during the process of becoming a smoker. A review by Mayhew and colleagues (2000) proposed a comprehensive smoking trajectory categorizing adolescent smoking behaviour into six distinct stages. Within the pre-contemplation phase, adolescents who have never smoked are either resisting or ignoring pressures to smoke, simply have no desire to start smoking in the near future or have never thought about smoking. These individuals are classified as “non-susceptible” never-smokers (Pierce et al., 1996). Adolescents may then transition from being non-susceptible never-smokers to susceptible never-smokers (i.e. non-smokers who do not hold a firm intention not to smoke). This step is considered the contemplation /preparatory stage in which adolescents begin creating and altering their pre-smoking beliefs and attitudes about cigarettes. This stage also entails the formulation of perceptions and images of what smoking involves before they try smoking. The terms “non-susceptible”/ “susceptible” never-smokers were coined by Pierce and colleagues who showed that smoking susceptibility among never-smokers could be reliably detected, even among individuals with no apparent social influences to smoke and who established smoking susceptibility as a validated measure predicting future smoking initiation (Pierce et al., 1996; Pierce et al., 1998). Smoking susceptibility has been shown to be a strong predictor of smoking initiation, even after controlling for well-established predictors of smoking initiation (Forrester et al., 2007; Pierce et al., 1996; Tyas & Pederson, 1998). As such, these individuals (i.e. susceptible never-smokers) represent the target population for primary prevention efforts.

Among youth who are “susceptible” never-smokers, adolescents may then proceed to becoming “tried smokers” (Mayhew et al., 2000). This stage is characterized by the point in time in which adolescents who have contemplated the thought of trying cigarettes initiate cigarette use and try having a few cigarettes. This may also be seen as the “smoking initiation” stage. The fourth transitional phase involves tried smokers becoming experimental smokers, depicted by a gradual increase in the frequency of smoking. In the fifth stage, adolescents are characterized as “regular smokers”, where adolescents progress from smoking on a sporadic basis to a more regular, but still infrequent basis. Finally in the last stage, adolescents are classified as “established” or “daily smokers”, characterized by adolescents now smoking either daily or on almost a daily basis.

Smoking susceptibility is the outcome used in determining if primary prevention efforts are effective in deterring smoking initiation. Furthermore, the characterization of distinct smoking stages (i.e. “non-susceptible” never-smoker, “susceptible” never smoker, tried smoker) is important in guiding tailored prevention programs based on the distinct risk and protective factors that adolescents experience when they transition to trying smoking.

2.4 Factors Associated with Smoking Onset

Previous literature has outlined individual and psychosocial factors associated with the increased likelihood of an adolescent becoming susceptible to smoking uptake or an adolescent initiating smoking behaviour. As my proposed study will involve assessing the impact of school-based tobacco interventions on smoking intentions/ tried smoking, these characteristics will be critical to my understanding of other potential sources of influence involved in adolescent smoking intentions/ initiation.

2.4.1 Factors Associated with Smoking Susceptibility among Never-Smokers

Studies have reported a number of student-level factors associated with smoking susceptibility among never smokers. Youth that were in a lower grade were seen to be at an increased risk of being susceptible to smoking (Yang et al., 2011; Okoli et al., 2009). In addition, gender was seen to be another significant factor, with females more likely to be susceptible never-smokers (Leatherdale et al., 2005). Furthermore, students using alcohol or illicit drugs or those who have increased access to pocket money were also seen to be at an increased likelihood of being susceptible never-smokers (Yang et al., 2011). Another characteristic seen to place adolescents at an increased risk of smoking susceptibility included low levels of perceived enforcement of tobacco- related policies (Leatherdale et al., 2005). In addition, holding positive attitudes towards tobacco use also increased an individual's risk of being susceptible to smoking in the future (Kaai et al., 2014). Studies also showed that youth were more likely to be susceptible to smoking if they had smoking friends or a parent who smoked (Leatherdale et al. 2006; Kaai et al., 2014). However, it is important to note that all of the aforementioned studies are cross-sectional in nature. As such, causal inferences cannot be made regarding the relationship between student-level factors and smoking susceptibility. For example, though cross sectional studies have found males to be less likely to be susceptible to smoking (Leatherdale et al., 2005), longitudinal studies are needed in order to determine whether males may, in reality, be more susceptible (i.e. transitioned past the point of susceptibility to trying smoking).

It is also important to note the role of tobacco marketing and advertising in impacting the psychosocial factors mentioned above that, in turn, influence smoking susceptibility. It has been shown that exposure to pro-tobacco advertising and marketing among adolescents has been found to be significantly associated with more positive beliefs about smoking as well as more

positive intentions to smoke in comparison to those that were not exposed to such advertisements (USDHHS, 2012). Furthermore, the Surgeon General Report concluded that “the evidence available is sufficient to conclude that there is a causal relationship between tobacco industries’ advertising and promotional activities and the initiation of tobacco use among young people” (USDHHS, 2012). However, though the impact of tobacco advertising activities is a noteworthy point of consideration, my study will not be examining this source of influence, as I will be focusing solely on the context of the school environment.

2.4.2 Factors associated with Smoking Initiation

Previous work has noted a variety of student-level influences that have been associated with a student’s likelihood of initiating smoking. Smoking initiation was seen to increase among youth who were older and in a higher grade (Tyas & Pederson, 1998). In addition, youth who lived with parents who smoked were seen to be at an increased risk for smoking initiation (Melchior et al., 2010; Vuolo & Staff, 2013; Mayhew et al., 2000; Tyas & Pederson, 1998). Furthermore, those who had friends who smoked were at an increased risk of initiating smoking behaviour (Golade et al., 2012, Mayhew et al., 2000; Tyas & Pederson, 1998; Conrad et al., 1992; Hoffman et al., 2006; Kobus, 2003). Other factors seen to be associated with smoking initiation included poor academic performance (Tyas & Pederson, 1998) low self-esteem (Richardson, Kwon & Ratner, 2012), substance use (alcohol or marijuana) (Ramo et al., 2012; Leatherdale, Hammond & Ahmed, 2008) and being exposed to smoking in movies (World Health Organization, 2011; Charlesworth & Glantz, 2005). Furthermore, research also seemed to indicate that individuals with more weekly spending money per were more likely to initiate smoking (Leatherdale et al., 2008; Tyas & Pederson, 1998).

Understanding the role of various factors in impacting an individual student's probability of being a susceptible-never smoker or initiating smoking over time is critical to the formulation of tailored tobacco-related prevention programming that may inhibit these transitions in smoking behaviour. However, most of the available evidence up-to-date examining smoking susceptibility stem from cross-sectional studies that do not allow for causal inferences to be formulated and for temporal trends to be elucidated. As such, future work focused on exploring the impact of school-based tobacco programming on these outcomes longitudinally within prospective cohort studies is warranted in order to address this gap.

2.5 Theoretical Framework

Researchers have used a multitude of theories to gain an understanding of the complex web of factors that influencesmoking intentions and initiation among adolescents. This study was guided by the Theory of Planned Behaviour (Ajzen, 1991), the Ecological Systems Theory (Bronfenbrenner, 1979) and the Theory of Triadic Influence (Flay & Petraitis, 1994). The following section will provide an overview of these three theories.

2.5.1 Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) was proposed by Icek Ajzen and emerged as a theory for understanding and predicting human social behaviour that is not under an individual's volitional control (Ajzen, 1991). According to TPB (Refer to Figure 1), intention is the immediate precursor of an individual's behaviours and are shaped by an individual's attitude towards the behaviour (i.e. the degree to which an individual has either favorable/unfavorable evaluations of smoking behaviour), the subjective norms (i.e. the belief that people would approve or disapprove of smoking behaviour) and perceived behavioural control (i.e. the

perception of the presence of factors that may assist or impede the ability to partake in smoking behaviour). In addition to indirectly influencing behaviour through behavioural intentions, perceived behavioural control can also directly influence an individual's behavior. TPB posits that the strongest predictor of an individual initiating smoking behaviour is their smoking intentions (i.e. smoking susceptibility).

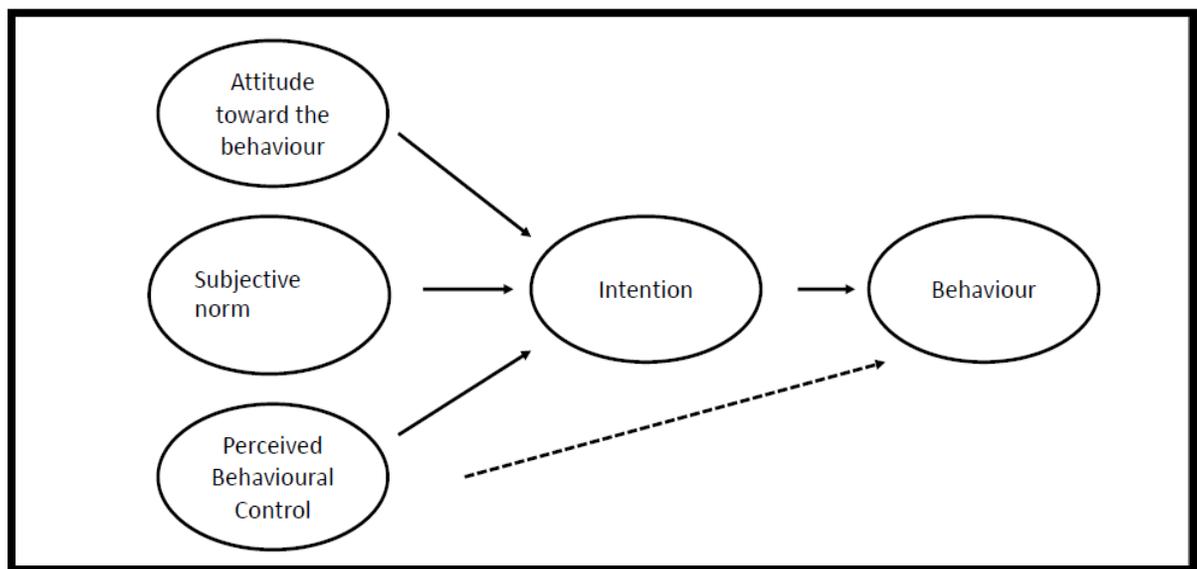


Figure 1: Visual Diagram depicting the Theory of Planned Behaviour.

Empirical support for this theory stemmed from interventions showing changes in behavioural, normative and control beliefs created changes in intentions, which, in turn, resulted in changes in behaviour. TPB has been utilized successfully in order to predict and explain smoking intentions and behaviours. In addition, TPB is a prominent theory utilized to predict substance use behaviours. This theory guided my research questions, which entailed exploring the transitions in smoking susceptibility (intentions) and smoking behaviour (specifically, initiation of smoking) among adolescent never-smokers. However, though TPB addresses the proximal and direct predictors of smoking intentions/ behaviours and may aid in establishing a better understanding

of individual (i.e. student-level) factors, it does not expand upon distal factors (e.g. school policy environment) that may indirectly influence a person's intentions/ behaviour. As such, researchers have used various ecologic theories, including the Ecological Systems Theory and the Theory of Triadic Influence, to address this shortcoming in order to allow for a more integrated approach to be utilized when seeking to examine the various factors associated with changes in smoking intentions and smoking initiation among youth.

2.5.2 The Ecologic Theory

The Ecological Systems Theory posits that an individual's behaviour (such as smoking) is influenced by distinct environmental systems surrounding the individual (the microsystem, mesosystem, exosystem, macrosystem and the chronosystem) that can influence and interact with one another (Bronfenbrenner, 1992). When examining smoking susceptibility/ smoking initiation behaviour among adolescents, there is a need to take a broader ecological approach that not only considers the individual-level characteristics, but also the influential contexts (e.g. school environment) in which the individual is situated. According to the ecological theory (Refer to Figure 2), due to the dynamic nature of interactions between factors at distinct levels, it is not exclusively individual or school-level characteristics that influence smoking intentions/smoking initiation, but rather the combination and interaction of these factors that produce adolescent smoking behaviours (Bronfenbrenner, 1992). As such, when seeking to evaluate potentially promising tobacco control interventions, an ecologic approach is necessary to ensure that school-level factors (e.g. school smoking policies) that influence adolescent smoking susceptibility/ initiation are accounted for.

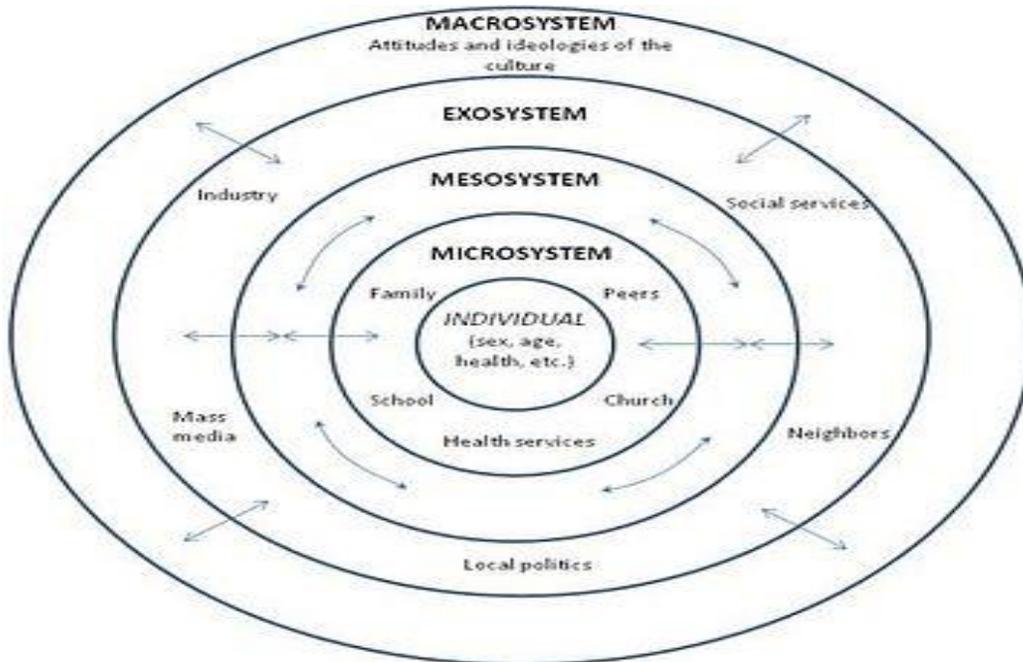


Figure 2: Diagram depicting Bronfenbrenner's Ecological Systems Theory. Adapted from Google Images.

Another tobacco-specific theory that mirrors the Ecological Systems Theory and is widely utilized within the tobacco literature is the Theory of Triadic Influence (TTI) (Flay, Petraitis, 1994). Similar to the Ecological Systems Theory, TTI (Refer to Figure 3) acknowledges the various levels of influence (proximal, distal and ultimate) that determine adolescent smoking behaviour and provides a more comprehensive depiction of the etiology of smoking behaviour (Flay & Petraitis, 1994). In accordance with these ecologic theories, the school setting may provide a unique context for altering adolescents' smoking intentions and behaviours through changes in the school environment (i.e. school policies and practices) relating to tobacco use. However, despite evidence suggesting that the school environment is a significant context that may influence adolescent health behaviours (Bonell et al., 2013) and that school-level factors have been independently associated with both susceptibility to smoking and initiation (Leatherdale & Cole, 2015; Leatherdale & Manske, 2005; Leatherdale et al., 2005), our

understanding of how to effectively intervene within the school context is limited (Galanti et al., 2014; Wiehe et al., 2005).

2.6 The School Environment

As noted in previous sections (Refer to Section 2.4.1 and 2.4.2), an abundance of literature has noted prominent individual and psychosocial characteristics associated with smoking susceptibility among never-smokers and smoking behaviour. Less research has focused on the school-level characteristics associated with youth smoking outcomes. However, prior work has noted significant between-school variability among Canadian youth in smoking outcomes and intentions (Leatherdale & Manske, 2005; Leatherdale & Cole, 2015; Leatherdale et al., 2005). In previous work examining the association between students' smoking within the school environment and smoking initiation among students, attending a school with a high smoking prevalence among older students was seen to increase the risk of smoking onset among younger students (Leatherdale & Manske, 2005; Leatherdale et al., 2005). In addition, prior research has also noted that the number of tobacco retailers surrounding a school was found to be associated with the likelihood of a never smoker being susceptible to future smoking (Chan & Leatherdale, 2011). In a most recent study examining the impact of smoking policies and programs on the school-level prevalence of susceptible never-smokers and current smokers, changes in practices involving enforcement of anti-tobacco policies (e.g. administering progressive punishment to students violating smoking policies) was seen to produce desirable effects on the school-level prevalence of smoking susceptibility and current smoking (Leatherdale & Cole, 2015). The findings by Leatherdale and Cole (2015) mirrored previous results indicating that a population-based intervention approach that alters the environment surrounding youth may have a greater impact on population-level reductions in youth smoking

behaviour, in comparison to individualized approaches (Green & Kreuter, 2004; Rose, 1992) and yield changes that have a larger long-term impact on smoking outcomes (USDHHS, 2000). Considering that a substantial number of youth spend large portions of their week at school, the school environment represents an important context for population-based interventions to reduce and prevent smoking among adolescent populations (Manske, Brown & Cameron, 1997).

2.6.1 Natural Experiments

Though schools are increasingly tasked to provide tobacco control prevention interventions (Botvin, 2004), there is a large gap between the current state of research and the type of research required to inform the school-based tobacco control prevention agenda (Cameron et al., 2009). The majority of current evidence that is available to aid school-based programming is derived from artificially controlled research (i.e. RCTs) that does not coincide with the realities of “real world” practice within the school environment (Dusenbury & Hansen, 2004; Green, 2006) or provide insight that is appropriately suited to schools when interventions are implemented in alternate settings (Hawe et al., 2004). For instance, a school intervention that was shown to be effective may be ineffective in another school setting, as a function of varying school contexts. In addition, as most tobacco control interventions are not suitable for randomization (e.g. school policies prohibiting smoking on school property), quasi-experimental designs may serve a critical purpose in allowing researchers to evaluate such natural experiments while policy-makers /programmers develop these interventions (Petticrew et al., 2005). Moreover, it may allow researchers to assess what interventions works for whom, in what context and under what circumstances. Although evidence from natural experiments may be considered “imperfect”, it may assist in pinpointing effective interventions in real-world settings

(Petticrew et al., 2005) and represent the realities of intervention implementation (Ramanathan et al., 2008). The evaluation of changes in school-based tobacco interventions in relation to adolescent smoking outcomes may provide a greater understanding of how healthy environments can be created to prevent smoking onset. Despite research indicating the significance of the school environment, research identifying effective school-based tobacco policies and practices has yet to be established (Galanti et al., 2014; Coppo et al., 2014).

2.7 Review of School-Based Tobacco Interventions

The following sections will provide a review of the literature pertinent to the impact of existing school-based tobacco policies and programs.

2.7.1 School-based Policy Interventions involving Smoking Bans

Studies have reported that school policies involving strongly enforced smoking bans were associated with a reduced likelihood of being a susceptible never smoker versus a non-susceptible never smoker in comparison to schools implementing weakly enforced bans (Wakefield et al., 2000). These studies also indicated that strong smoking bans were associated with a reduced likelihood of being an early experimenter versus a susceptible never-smoker (Wakefield et al., 2000). Prior work also noted that schools reporting a strong smoking prohibition element (i.e. prohibiting smoking by all people at all times) were associated with a reduced likelihood of students smoking in comparison to schools with weaker/no smoking prohibition policies (Lovato et al., 2007; Moore et al., 2001). In contrast, other studies indicated that school-based policies involving smoking bans were ineffective in reducing students' smoking behaviour (Murnaghan et al., 2009).

A review by Aveyard and colleagues (2004) examining what school-level characteristics accounted for the variability in smoking prevalence across schools indicated that elements of tobacco control policies involving smoking bans appeared to dissuade smoking behaviour. However, a review by Coppo and colleagues (2014) examining the role of school tobacco policies in preventing smoking uptake found no significant differences in smoking prevalence within schools that did and did not have school policies involving smoking bans. Given that the majority of studies examining school smoking bans stem from cross-sectional studies, the need for longitudinal studies to assess the impact of school smoking bans is warranted (Galanti et al., 2013; Coppo et al., 2014; Aveyard et al., 2004).

2.7.2 School-based Policy Interventions involving Enforcement

Various definitions of policy enforcement have been used within the tobacco literature including the implementation of systems used to track students' smoking behaviours, the creation of sanctions for those who violate school smoking policies and students' perceptions of strong compliance with school smoking rules/policy enforcement. In prior research exploring whether tobacco policies were associated with smoking behaviour, numerous studies seemed to indicate associations between strictly enforced policies involving smoking bans and lower overall smoking rates and tobacco use along with higher likelihoods of being at an earlier stage of smoking uptake (Wakefield et al., 2000; Moore, Roberts, Tudor-Smith, 2001; Kumar et al., 2005; Adams et al., 2009; Lipperman-Kreda et al., 2009; Leatherdale & Cole, 2015). These studies were further supported by research examining the association between students' non-compliance to school smoking rules and student smoking behaviour (which was measured through students' exposure to staff and students smoking and smoking outcomes). This data seemed to show that decreased compliance to school smoking rules increased an individual's

probability of smoking (Murnaghan et al., 2009). In contrast, other researchers exploring the association between aspects of policy enforcement (including harsh penalties, remedial penalties) and students' smoking did not provide any clear evidence for an impact of school tobacco policies on smoking outcomes (Evans-Whipp et al., 2010). Other studies seemed to show differential smoking outcomes as a function of strictly enforced smoking policies among distinct age groups (Reitsma & Manske, 2004). For the purposes of this study, "enforced policies" will be defined as any policies/practices that enforce school rules through the implementation of sanctions to those who violate school smoking rules (e.g. suspensions, fines, progressive punishment, warnings), the establishment of school monitoring systems to track tobacco use (e.g. the involvement of a Tobacco Enforcement Officer to those who violate school rules) and compliance with school smoking rules (e.g. if the school administration now consistently enforces the penalties imposed to those violating school rules).

2.7.3 School-based Interventions involving Educational (Curriculum) Components

In studies measuring ever use of cigarettes and regular smoking rates among students as their outcome of interest, the data showed lower rates in schools that provided education and counselling as well as policies entailing disciplinary measures for students caught smoking in school, in comparison to school who only implemented disciplinary measures (Hamilton et al., 2001). In conjunction with these findings, other researchers showed that students attending schools with a focus on tobacco prevention and strong policy prohibition/ smoking bans (i.e. staff and students) were less likely to smoke in comparison to those attending schools without these characteristics (Lovato et al., 2010). In addition, schools involving prevention activities along with prohibition policies were found to be negatively associated with the school smoking

prevalence in comparison to schools that did not possess these features (Piontek et al., 2008). In contrast, studies examining the effects of school policies that mandated an educational component on tobacco use was not seen to be significantly associated with student smoking outcomes (Sabiston et al., 2009). Other research examining whether schools providing a combination of education components in addition to school based policies banning smoking on school property had an impact on smoking outcomes also found no association between this combination in relation to occasional or regular smoking outcomes among students (Murnaghan et al., 2007).

2.7.3.1 School-based Interventions involving Staff Training

In addition to the implementation of tobacco control policies, another significant component of tobacco prevention programming that has been noted by the Centers for Disease Control and Prevention includes the provision of appropriate teacher training (CDC, 1994). Prior research in drug abuse prevention has also noted poor implementation as a factor that may result in the loss of program effectiveness (Dusenbury et al., 2003). One of the key elements of high program fidelity that has been noted in prior literature include the provision of teacher training (Dusenbury et al., 2003). Irrespective of how effective a prevention program may be, researchers have noted the decreased likelihood of a program producing the desired effects unless it is implemented with sufficient fidelity. In conjunction with these findings, a review examining the impact of program implementation offered strong empirical evidence that the level of program implementation affects the outcomes attained in prevention programs (Durlak & DuPre, 2008). For instance, in a recent paper by Leatherdale & Cole (2015), changes in practices involving the provision of staff training were seen to produce desirable changes in the school-level prevalence of smoking susceptibility among secondary school students in contrast to those that did not.

Though the provision of staff training has been noted as a critical element in prevention programming to ensure high quality implementation of interventions (Greenberg et al. 2003; Tobler et al., 2000), a limited body of literature exists assessing the impact of the provision of training opportunities to school staff on smoking outcomes, specifically on distinct stages of smoking onset (i.e. smoking susceptibility, smoking initiation).

2.7.4 School-based Interventions involving Cessation Support

In a systematic review examining randomized controlled trials of youth-based smoking cessation interventions, Gervais et al. (2007) found that three out of four interventions conducted within school-based settings involving behavioural components were seen produce positive effects in increasing abstinence among smokers for up to 2 years after the interventions were administered. Currently, there is strong evidence that youth-based cessation programs involving a motivation-enhancement component, cognitive-behavioural techniques and social influence approaches are promising in significantly increasing quit rates among smokers (Sussman et al. 2006; Ontario Tobacco Research Unit, 2015; Gervais et al. 2007). Recent literature surrounding cessation programming within Ontario has also highlighted the need to take a comprehensive approach to counter the distinct levels of influence impacting tobacco use and cessation among youth (Ontario Tobacco Research Unit, 2015).

In contrast, when examining cessation strategies involving health-care professional delivered interventions, limited evidence currently exists supporting the effectiveness of such strategies among youth (Ontario Tobacco Research Unit, 2015; Grimshaw & Standon, 2006). The literature to date presents mixed findings about the effectiveness about such interventions (Gervais et al.; 2007; Sussman & Sun, 2006). Overall, though some evidence exists that cessation programming in general show promise in increasing quit rates among youth (Sussman et al.,

2006), other reviews have indicated that additional research is warranted to establish their effectiveness (Grimshaw & Standon, 2006).

2.7.5 Interventions involving Multicomponent Programming

There is some evidence to support the effectiveness of multimodal programming that involved comprehensive efforts as a means to prevent smoking uptake (Biglan et al., 2000; Carson et al., 2011; Backinger et al., 2003; Pierce et al., 2012; USDHHS, 2012). Previous research evaluating the impact of a combined approach entailing school-based and community-based programming have noted significant effects on adolescent tobacco use in comparison to interventions involving solely school-based prevention efforts (Biglan et al., 2000; Backinger et al., 2003). Similarly, mass media interventions that were designed to deter tobacco use have been seen to be significantly associated with a reduced risk of smoking behaviour when combined with school and community-based programming in comparison to only school-based programming (Pierce et al., 2012; National Cancer Institute, 2008). A recent example providing evidence within the Ontario context was the *expose* Smoke-Free Youth Project, a multicomponent prevention program delivered within high schools that combined mass media, youth leadership development, curriculum components, school and community action, smoking cessation support and the enforcement of legislation. This program was seen to be associated with significant reductions in smoking behaviour along with changes in students' attitudes towards smoking (Zimmerman & Hairnes, 2007). In contrast, other evaluations of multicomponent school-based programming within Ontario have not shown promising results in reducing smoking behaviour. Murnaghan and colleagues (2008) found that a comprehensive tobacco control initiative, the Prince Edward Island Tobacco Reduction Alliance (PETRA), that involved the implementation of school-based policies and programs and enhancing tobacco

control initiatives across the province was not seen to be effective in reducing smoking rates among adolescents.

2.7.6 Targeted School-based Interventions

There are a wide range of factors that contribute towards the elevated risk of smoking susceptibility and smoking behaviours among adolescents including the social and physical environment present within schools. There is some evidence to suggest that school-based programming that are implemented in “high-risk” contexts (i.e. in schools with a high smoking prevalence) can be more effective in deterring smoking behaviour in comparison to those implemented in “low-risk” schools (Cameron et al., 1999; Brown et al., 2002). In a systematic review seeking to explore the characteristics of programs deemed to be successful among adolescent smoking prevention initiatives, the authors concluded that targeting programming towards certain high-risk groups may improve the chances of an intervention yielding promising effects (Sherman et al., 2009). Recent recommendations for youth tobacco control programming within Ontario included targeting high-risk contexts (i.e. high-risk individuals) in order for intervention efforts to be directed where they are most likely to have the greatest impact (Ontario Agency for Health Protection and Promotion, 2010).

2.7.7 Summary

A review of the current literature base indicates that school-based tobacco control program does have the potential to dissuade tobacco use initiation and progression among youth. Some aspects of tobacco programming, including strict enforcement, smoking bans and multimodal approaches were seen to be promising avenues worthy of further exploration (Galanti et al., 2014; Coppo et al., 2014; Carson et al., 2011; Backinger et al., 2003; Pierce et al., 2012). However, the data available up to date provides limited evidence on what constitutes

effective school-based tobacco programming, as the majority of research examining the effects of school-based tobacco interventions stemmed from cross-sectional studies that do not allow for causal inferences to be made and make them susceptible to distinct biases. In addition, some studies did not adjust for potential confounding variables when seeking to examine the effects of school-based interventions on student outcomes and were thus subject to the risk of bias (Wiiium, Wold, 2011; Galanti et al., 2014; Coppo et al., 2014). These biases may obstruct the formulation of a concrete evidence-base regarding the effectiveness of a specific tobacco intervention. In addition, the majority of studies I examined investigated the effects of school-based programming on smoking outcomes, but few considered the effects of school-based programming on distinct stages of smoking onset (e.g. smoking susceptibility). Researchers have noted the need for smoking prevention policies and programs to be tailored to cater for students in distinct smoking stages (Cameron et al., 1999; Mayhew et al., 2000). As such, future studies investigating the effects of school-based interventions while accounting for distinct populations of youth by various smoking stages is a key point of consideration. Research examining the impact of staff training on adolescent smoking outcomes appears to indicate that it may be an underutilized tool that may aid in improving the effectiveness of adolescent tobacco programming (Leatherdale & Cole, 2015; Dusenbury et al., 2003). A need for prospective longitudinal and quasi-experimental studies has been noted as a future crucial area to explore within future research when seeking to examine the effects of school-based tobacco interventions (Galanti et al., 2014; Coppo et al., 2014; Weihe et al., 2005).

Chapter 3

Study Rationale and Research Questions

3.1 Study Rationale

Given that most work up to date stems from cross-sectional studies (Galanti et al., 2014; Coppo et al., 2014), a limited evidence base on school-based tobacco interventions to prevent smoking onset currently exists. As such, evidence from natural experiments may serve as a useful, timely and robust tool to aid in the identification of effective tobacco-control interventions (Green, 2006). Within Ontario, the COMPASS study, a 4-year longitudinal quasi-experimental study, was formulated to address this need (Leatherdale et al., 2014). In a recent COMPASS study that sought to examine the impact of changes in school-based tobacco interventions within Ontario secondary schools, 17 schools were identified where changes had been made between Year 1 and Year 2 of the study (Leatherdale & Cole, 2015). Among these 17 schools, the results showed that schools that implemented changes involving the enforcement of school smoking policies or the provision of staff training on tobacco education/prevention saw desirable changes in the school-level prevalence of smoking susceptibility (Leatherdale & Cole, 2015). However, as these data generalized outcomes at the school-level, they did not factor individual changes in smoking behaviour at the student-level (Leatherdale & Cole, 2015). Future research utilizing longitudinal hierarchical designs to assess how these potentially promising interventions that were identified are related to changes in student-level smoking susceptibility/initiation over time is warranted. Previous research has highlighted smoking susceptibility as a prominent predictor of smoking initiation (Forrester et al., 2007; Pierce et al., 1996). Furthermore, exploring how these promising interventions may be associated with

changes in smoking susceptibility and initiation may serve as a vital tool in guiding future prevention efforts. This data may also provide valuable insight in targeting school-based prevention initiatives where they are most likely to have an impact.

The purpose of this study is to evaluate the impact of changes in school-based tobacco interventions on student-level smoking susceptibility and initiation outcomes between Year 2 and Year 3 of the COMPASS study among Ontario schools. These outcomes will be evaluated among a longitudinal sample of never-smoker grade 9-12 Ontario students over 1-year time period (i.e. between Year 2 and Year 3 of the study), using a longitudinal quasi-experimental design. The ultimate goal of this proposed study is to offer practice-based evidence to school stakeholders/administrators through the evaluation of interventions that may aid in deterring transitions in smoking uptake among adolescents.

3.2 Research Questions

RQ 1: Is there a significant difference in the prevalence of susceptible never-smokers between Year 2 and Year 3 within the linked longitudinal sample?

RQ 2: Between Year 2 and Year 3, do changes in school-based tobacco interventions have an impact on the likelihood of a **Year 2 non-susceptible never-smoker** being a *susceptible never-smoker* in Year 3, when controlling for relevant sociodemographic and behavioural correlates?

RQ 3: Between Year 2 and Year 3, do changes in school-based tobacco interventions have an impact on the likelihood of a **Year 2 non-susceptible never-smoker** being a *tried smoker in Year 3*, when controlling for relevant sociodemographic and behavioural correlates?

RQ 4: Between Year 2 and Year 3, do changes in school-based tobacco interventions have an impact on the likelihood of a **Year 2 susceptible never-smoker** being a *non-susceptible never-smoker in Year 3*, when controlling for relevant sociodemographic and behavioural correlates?

RQ 5: Between Year 2 and Year 3, do changes in school-based tobacco interventions have an impact on the likelihood of a **Year 2 susceptible never-smoker** being a *tried smoker in Year 3*, when controlling for relevant sociodemographic and behavioural correlates?

3.3 Hypotheses

RQ1: Based on previous work (Pierce et al., 1996; Yang et al., 2011; Okoli et al., 2009; Tyas & Perderon, 1998), I expect a decrease in the overall prevalence of susceptible never-smokers between Year 2 and Year 3 within the linked longitudinal sample.

RQ2: Yes, I expect that changes involving a comprehensive and multicomponent approach will reduce the risk of a non-susceptible never-smoker being a tried smoker in Year 3.

RQ3: Yes, I expect that changes involving a comprehensive and multicomponent approach will reduce the risk of a susceptible never-smoker being a tried smoker in Year 3.

RQ4: Yes, I expect that some changes involving a comprehensive and multicomponent approach will reduce the risk of a non-susceptible never smoker becoming a tried smoker.

RQ5: Yes, I expect that some changes involving a comprehensive and multicomponent approach will reduce the risk of a susceptible never-smoker becoming a tried smoker.

Chapter 4

Methods

4.1 Data sources

The current study analyzed data from Ontario students in grades 9 to 12 collected during the Year 2 (Year 2: 2013-2014) and Year 3 (Year 3: 2014-2015) COMPASS Study (Cohort Study Obesity Marijuana use Physical Activity Alcohol Use Smoking Sedentary behaviour). Student level data was obtained from the COMPASS student questionnaire (Cq), that collected individual student data pertinent to all health behaviours being examined (physical activity, tobacco use, marijuana use etc.) School level data was obtained through the COMPASS School Programs and Policies Questionnaire (SPP), a survey completed by the school administrators most familiar with school programs and the policy environment.

4.1.1 The COMPASS Study

The COMPASS study is a prospective cohort study designed to gather hierarchical longitudinal data from a convenience sample of 89 secondary schools and grades 9 to 12 students over the span of 4 years (Leatherdale et al., 2014). This survey provides invaluable health behaviour data that assess tobacco use, marijuana use, obesity, healthy eating, physical activity, sedentary behaviour, school connectedness, bullying and academic achievement. In addition, this survey gathers information pertaining to the social and demographic factors that are associated with tobacco use and perceptions regarding tobacco accessibility. A longitudinal quasi-experimental design was purposefully selected within this study as it provides robust internal validity, as a function of the examination of student and school-level changes over time and external validity as a function of the quasi-experimental design implemented. COMPASS allows

for the evaluation of the natural experiments throughout the duration of this study in order to assess the “real-world” effectiveness of promising interventions, thus allowing for the generation of practice-based evidence. Through the examination of these natural experiments, this study aimed to evaluate and pinpoint promising school-based tobacco interventions that may aid in interrupting the onset of smoking among secondary school students within Canada. The current study used longitudinal student-level and school-level data from Ontario and Alberta schools in Year 2 (2013-2014) and Year 3 (2014-2015).

4.1.1.1 School board and school recruitment

Ontario and Alberta schools were purposefully sampled and schools that were deemed eligible for participation were approached after the board approval was granted. Given the COMPASS study was not created to represent a specific geographical population outside of the schools selected within the study, hence purposeful sampling was appropriate. Board-level inclusion criteria included being an English-speaking secondary school that allows the use of active-information passive-consent parental permission protocols. At the school level, additional criteria included being a secondary school with students between grades 9 to 12 with a student population of at least 100 students or greater in each grade that permitted the use of the active information-passive consent parental permission protocols. Prior research has documented the problematic nature of active consent in introducing a certain degree of selection bias that may result in non-representative samples, thus compromising the external validity of a study (White et al.,2004). Furthermore, the suitability of passive-consent protocols for youth surveys examining self-reported health behaviours has been outlined in previous literature (Flicker & Guta, 2008; Rojas et al., 2008; White et al., 2004).

4.1.1.2 Student level recruitment

In schools that participated within the study, eligible students were recruited using active-information passive-consent permission protocols. Parent(s)/guardian(s) were mailed an information letter providing details of the COMPASS study and asked to either call the COMPASS recruitment coordinator using a toll free number provided or email the COMPASS recruitment coordinator using the COMPASS email address provided in the information letter if they opted not to have their child participate within the study. Students were allowed to decline to participate or withdraw from the study at any point during the consent or data collection process. The University of Waterloo Office of Research Ethics and appropriate School Board committees approved of all procedures, including passive consent. All grade 9 to 12 students from all participating schools whose parent(s) did not withdraw their child from the study were deemed eligible for participation.

4.1.1.3 Survey Protocols

The COMPASS questionnaire was administered by teachers during a designated class period. Teachers were provided with instructions (Teacher Instruction Questionnaire Letter) for implementing the survey to ensure consistency across various schools and in order to ensure that student confidentiality is maintained. A trained COMPASS data collector is also present on site in the central location of the school in order to manage the data collection. Though participants were not provided with any compensation; schools were given an honorarium in addition to a customized School Health Profile provided after the data collection.

4.1.1.4 COMPASS Student Questionnaire (Cq)

The student questionnaire was designed to collect individual student data relating to obesity, sedentary behaviours, physical activity, tobacco, marijuana and alcohol use, bullying, academic outcomes, amount of sleep and demographic characteristics. The Cq facilitates multiple large-scale school-based data collections and uses in-class data collection methods, consistent with previous research (Leatherdale & Burkhalter, 2012; Leatherdale et al., 2010; Leatherdale & Papadakis, 2011). Due to the in-class data collection methods, it was purposefully made short. The Cq is a machine-readable 12 pages long survey which takes approximately 30-40 minutes to complete. All the items present on the student questionnaire (Cq) has demonstrated both reliability and validity (Leatherdale & Laxer, 2013; Wong et al., 2006) and is consistent with measures used within current national surveillance tools and public health guidelines (Elton-Marshall et al., 2011). Consistent with previous research (Kearney et al., 1984), the cover page of the Cq contains measures required in order to produce a unique self-generated code for each participant in a school to ensure the anonymity of the students, while still enabling the COMPASS team researchers to link each student's unique anonymous identifier data over several years. Through these self-generated codes, longitudinal changes among respondents can be explored through linking student-level data within schools from year to year.

4.1.1.5 COMPASS Schools Programs and Policies Questionnaire

The COMPASS School Programs and Policies Questionnaire (SPP) is a paper-based survey completed by the administrators within each school that are most attuned with the school program and policy environment. The SPP is based on a previously validated tool, the Healthy School Planner (Pan Canadian Joint Consortium for School Health, 2014), but was altered to be shorter in length and to contain further content domains. The SPP was utilized in order to

measure the presence or absence of relevant programs and/or policies and changes in school policies, practices or resources that pertain to student health in each of the behavioural domains measured in the Cq. The completed SPP was collected by COMPASS staff from each school during the time of their school's student-level (COMPASS student questionnaire) data collection along with copies of relevant policy handbook(s) or rules for additional document review if needed.

Data from the SPP collected in Year 3 were used in order to pinpoint any changes to school-based tobacco programs and policies between Year 2 and Year 3. The Year 3 SPP asked administrators to comment on whether there have been any changes to their school tobacco control policies since the previous school year. They were asked to comment particularly on: a) whether Year 2 policies, practices, environment and relationships were still in place b) whether any new policies, practices, relationships and environment changes were administered in Year 3. To further corroborate that any of the identified changes actually took place or to verify that no changes had occurred, a COMPASS knowledge broker (a staff member who had continuous contact with each participating school administrator) verified all of tobacco control program and policy amendments identified within the Year 3 SPP.

4.1.1.6 Participants

A total of 41,709 students completed the Cq in the Year 2 (2013-2014). A total of 39,011 students completed the Cq in Year 3 (2014-2015). A total of 14,965 students (N= 77 Ontario schools) that completed the Cq in both Year 2 and Year 3 of the study will form the linked longitudinal sample. Individuals who did not report their smoking behaviour and intentions in either Year 2 and Year 3 of the study were excluded (N= 285). Students that were entering grade

9 in Year 3(N= 10612) and students that graduated gr. 12 in Year 2(N= 9370) were also not included within the longitudinal sample as they were not present at both time points.

4.2 Measures

The following sections describe the response (dependent) variables, student-level explanatory and school-level explanatory variables. In addition, the coding of these variables were described in detail. Operational definitions for the measures used within this paper were consistent with prior research using national standards and current national public health guidelines.

4.2.1 Response (outcome) variables

Tried Smoking: Cigarette use was measured on the COMPASS student questionnaire using four items on the COMPASS questionnaire. The first question measured ever use of cigarettes among respondents: “Have you ever tried a cigarette, even just a few puffs?” Respondents who select “No” were classified as *never-smokers* and will be coded as “0” and will act as the reference group. Respondents who select “Yes” were classified as *tried smokers* and will be coded as “1”.

Smoking susceptibility: Consistent with previously validated and reliable measures (Pierce, 1996), smoking susceptibility among never smokers (respondents who reported that they have never smoked a cigarette, not even a puff) was derived from three validated measures which asked respondents: “Do you think in the future you might try smoking cigarettes?”; “If one of your best friends were to offer you a cigarette, would you smoke it?;and, “At any time during the next year do you think you will smoke a cigarette?” Students responded to these questions on a 4-point Likert scale and students who answered “definitely not” to all three

questions were classified as *non-susceptible never smokers* and will be coded as “0”. Respondents who responded positively to at least one item were classified as *susceptible never-smokers* and will be coded as “1”. It is important to note that smoking susceptibility was only examined among never-smokers, in concordance with Pierce’s (1996) susceptibility construct.

4.2.2 Student-level Predictor Variables

The COMPASS student questionnaire was used in order to collect relevant student-level measures (e.g. socio-demographic characteristics, health behaviours etc.) that may influence smoking susceptibility and smoking initiation. The variables included below have been shown to have an influence on smoking susceptibility. As such, they were included as covariates within our model, in order to control for the effects of confounding variables. Detailed information about each characteristic is outlined below.

4.2.2.1 Socio-demographic characteristics

Gender: One question on the COMPASS questionnaire asked about gender: “Are you..” followed by two response options: female and male. Respondents who picked “female” were coded as “0” and acted as the reference group, while those who picked “male” were coded as “1”.

Grade: One question on the COMPASS questionnaire asked about grade: “What grade are you in?” Respondents who selected “*Grade 9*” were coded as “0” and acted as the reference group. Those who select “*Grade 10*” were coded as “1”, “*Grade 11*” were coded as “2” and “*Grade 12*” were be coded as 3.

Ethnicity: One question on the COMPASS questionnaire asked about ethnicity: “How would you describe yourself? (*Mark all that apply*)” Respondents who selected “*White*” were

coded as “0” and will act as the reference group. Respondents who selected “Black” were coded as “1”, those who selected “Asian” as “2”, those who selected “Aboriginal (First Nations, Metis, Inuit)” were coded as “3”, those who selected “Latin American/Hispanic” were coded as “4” and those who selected “Other” were coded as “5”.

Social sources of tobacco: One question on the COMPASS questionnaire asked about friends’ smoking behaviour: “Your closest friends are the friends you like to spend the most time with. How many of your closest friends’ smoke cigarettes?” Respondents that selected “None” were coded as “0” and will act as the reference group. Respondents who select “1 friend” will be coded as “1”, those who select “2 friends” will be coded as “2”, those who select “3 friends” will be coded as “3”, those who select “4 friends” will be coded as “4” and those who select “5 or more friends” will be coded as 5.

4.2.2.2 Behavioural Characteristics

Current use of Marijuana (past month): One question on the COMPASS questionnaire asked “In the last 12 months, how often did you use marijuana or cannabis? (a joint, pot, weed, hash)” Respondents that selected “I have never used marijuana” were classified as *non-marijuana users* and will be coded as “0” and act as the reference group. Respondents who selected “I have used marijuana but not in the last 12 months”/“Less than once a month” were classified as “*non-current marijuana users*” and will be coded as “1”. Respondents who selected “Once a month”/ “2 or 3 times a month”/ “Once a week”/ “2 or 3 times a week”/ “4 to 6 times a week”/ “Every day” were classified as *current marijuana users* and will be coded as “2”.

Current use of Alcohol (past month): One question on the COMPASS questionnaire measured binge drinking among those who indicated they have ever had a drink of alcohol: “In

the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?” Responses were collapsed across categories to identify those who have had 5 or more drinks on one occasion within the last month. Respondents who selected “I have never done this” were identified as *non-binge drinkers*, were coded as “0”, and acted as the reference group. Respondents who selected “I did not have 5 or more drinks on one occasion in the last 12 months” or “less than once a month” were identified as *non-current binge drinkers* and will be coded as “1”. Respondents who selected “once a month”, “2 to 3 times a month”, “once a week”, “2 to 5 times a week”, or “daily or almost daily” were identified as *current binge drinkers* and were coded as “2”.

4.2.3 School-level Predictor Variables:

School level data pertinent to the tobacco policies and programs being examined within our study was collected from the SPP completed by COMPASS school administrators and served as our primary predictor variables.

4.2.3.1 School Policies and Programs:

Policies/Programs: As described in Section 4.1.1.5, changes in tobacco-related policies/practices (Refer to Table 1) were noted within the SPP and completed by administrators most knowledgeable about the school policy/program environment. To verify that changes took place within the schools (or verify that no changes were made), notes from knowledge broker communication were be used. The 55 schools where no changes in tobacco policies/practices were noted between Year 2 and Year 3 will be collapsed and serve as the reference/ “Control” group. These schools will be coded as “0”. The 22 schools where changes in school-based tobacco interventions were made will serve as the “Intervention groups”. Below are the school-

based tobacco interventions that were made between Year 2 and Year 3 that will be explored within Intervention schools.

Table 1: Table describing changes made in school-based tobacco policy/practice changes between Year 2 and Year 3 of COMPASS study listed within the SPP.

Schools where changes in policies/practices were made	Type of Policy/Practice Change
<u>Effective & Enforced Policies</u>	
School 1	<p>-The school now has consistent/ongoing monitoring of tobacco use (The school did not provide details of the monitoring systems being used).</p> <p>-Health classes and health care classes are now used to educate students</p>
School 2	Students observed smoking on schools grounds are issued a warning
School 3	Students caught smoking used to be issued a warning, but the substance was not confiscated. The school now confiscates substances until parent comes and picks it up.
School 4	Contact has been established between school administration and tobacco control officers for information regarding fines/penalties and enforcement.
School 5	Repeat offenders violating school policies regarding smoking on school property or providing tobacco to those <19 yo are

	reported to the TEO (School did not disclose details of repercussions/TEO's actions after student is reported).
School 6	Violations of school smoking policies are now enforced with suspensions.
<u>Aligned and Coordinated Support (Training)</u>	
School 7	No information on tobacco prevention and cessation is provided anymore through conferences for staff. Also, equipment related to e-cig, hookah and other forms of tobacco are banned on campus, although off campus/weekend use is growing.
School 8	-A teacher has had training with a select group of students to create awareness and opportunities to help eliminate smoking. -This school has a strong smoking cessation program in effect this year.
<u>Multicomponent Programming</u>	
School 9	-School now offers a provincially funded comprehensive tobacco control program implemented in partnership with OPHEA and other community partners that includes youth leadership and engagement opportunities - they created a tobacco denormalization plan called "how will you grow old?"
<u>Cessation Programming</u>	

School 10	Students are encouraged but not required to participate in assistance/education or cessation program.
School 11	-The school is now offering a smoking cessation program -Tobacco and substance abuse is now part of the health program for students in phys-ed and healthy active living classes
School 12	The Health Unit now comes in to help a small group of students quit smoking.
School 13	The school is now offering a new smoking cessation program.
School 14	The school added smoking cessation/support group
School 15	- Choices for Change is in the school twice a week and offers tobacco cessation program. - Health Nurse also offers tobacco prevention and cessation
School 16	Smoking cessation program formed at the school.
<u>Policies involving Prohibition of E-cigarettes</u>	
School 17	The school now prohibits e-cigarettes on campus.
School 18	E-cigarettes are not allowed on campus
School 19	The school is now explicit about the prohibition of e-cigarette use.
<u>Targeted Intervention (CHEW)</u>	
School 20	Smokeless Tobacco Campaign – The school staff identified a

	<p>problem with 'CHEW' at the school so a campaign has been developed to target staff, students, and parents with messages about the dangers of CHEW and also where to go for help. A presentation was made by Public Health Nurse to school staff. The school put up posters about CHEW tobacco and resources were left in strategic areas of the school such as the boys' change room. 4 classroom presentations for students were made by the PHN at the request of individual teachers who identified this as a problem in their classrooms. Information was posted on the Holy Cross website and in the newsletter for parents to access as well. Information on E-cigarettes was also provided.</p>
<p><u>Interventions involving Educational Components</u></p>	
School 21	Health unit provides education via a website
<p><u>Industry Marketing and Promotion Intervention</u></p>	
School 22	- Any tobacco/ company logos/apparel has to be removed.

Chapter 5

Statistical Analyses

5.1 Analysis for Research Question 1

Descriptive statistics are reported for all response variables and explanatory variables mentioned in the sections above. McNemar tests were run in order to test whether there were significant differences in the prevalence of susceptible never-smokers between Year 2 and Year 3 within the linked longitudinal sample (described below). McNemar tests resemble Chi-squared tests but are used for repeated measures present within longitudinal datasets. Similar tests were conducted in order to test for significant differences in response variables by gender and grade. This step was completed based on prior research indicating that risky health behaviours (including smoking behaviour) tend to differ by both grade and gender. The following section will detail how the linked longitudinal sample was created.

Data Linkage:

In order to explore the longitudinal changes among students in COMPASS Year 2 and Year 3, student-level data was linked within schools. The cover page of the Cq contains measures that produced self-generated unique codes for every student that participated within the survey. This allowed for the creation of identifiers that were unique to each individual. This process also ensured that the anonymity of each student was sustained while allowing for the COMPASS team to link student-data over time. Non-linkage of participants occurred due to various reasons including students transferring to other schools and students being absent while the data collection within their school is being administered. For the longitudinal analyses being completed, COMPASS Year 2 students in grade 12 that graduated were not included within our

sample, as they were not present at follow-up (i.e. Year 3). In addition, COMPASS Year 3 students in grade 9 were not included within our sample as they were not present within the Year 2 data collection. The datasets that were used for the completion of this research, that included the student questionnaire and the SPP from Year 2 and Year 3 was linked by SchoolID. 77 schools present within both Year 2 and Year 3 of the study were included within the longitudinal sample. Over all, the 10 Alberta schools that were recruited in Year 2 of the study were excluded from my sample. Given the current interest of one of our provincial stakeholders, Public Health Ontario, only Ontario schools were considered within my study. The data gathered from this evaluation will help inform the Smoke Free Ontario strategy.

5.2 Longitudinal Analyses

Longitudinal analyses are necessary when repeated measurements are acquired from an individual or a group on a specific outcome. Furthermore, when a researcher's interest lies in examining a specific trend over time (e.g. changes in smoking susceptibility over time), longitudinal analyses are needed. They also allow for the separation of both age and cohort effects. Longitudinal analyses will allow me to examine how each of the interventions identified as changes in tobacco interventions between Year 2 and Year 3 (Refer to Section 4.2.3.1), are related to changes in the outcome of interest (e.g. smoking susceptibility), while accounting for relevant sociodemographic and behavioural covariates.

There are two distinct methods that can be used when dealing with correlated (i.e. dependent) outcomes within longitudinal studies: random-effects or generalized estimating equations. The choice of model is contingent upon both the research question and nature of the covariates. Random effects models used for longitudinal data can be utilized in order to describe

a trend over time (i.e. smoking susceptibility trajectories), in addition to factoring in the correlation that exists between successive measurements. This method allows for differences between subjects to be accounted for within the model and is appropriate when the focus of research is on examining individual differences. This method allows for variations in the intercepts and slopes between subjects to be accounted for and inferences on between-subject effects to be made. Another approach to assessing longitudinal data is through of the utilization of generalized estimating equations (GEE). Generalized Estimating Equation is an extension of GLM (Generalized Linear Models) that accounts for clustered data and is considered a marginal or population-average estimate. For longitudinal data, the marginal model separately models the mean response and within-subject association among the repeated measures. Generalized estimating equations (GEE) are used in order to allow for the correlation between observations (i.e. within-school variation) that occurs within longitudinal multilevel studies to be accounted for. In contrast to random effect models, GEE serves as an appropriate method when the focus of the research is on producing population average (or group differences) estimates as opposed to accounting for individual differences.

In order to answer Research Question 2 through 5, four distinct models were developed (that will be outlined within the following sections) where the GEE method was utilized to account for within-school associations. This study followed a quasi-experimental design with longitudinal data present at the school-level. This method allowed us to simultaneously examine the impact of the school-level tobacco-related interventions between Year 2 and Year 3 on each of the four outcome of interests. The following sections details the modelling approach for each specific outcome of interest.

5.2.1 Analysis for Research Question 2

The first model was used to evaluate whether changes in school-based tobacco interventions had an impact on a Year 2 non-susceptible never-smoker's likelihood of being susceptible in Year 3. The target population that was used within this analysis included the sample of non-susceptible never-smokers in Year 2 present within the linked longitudinal sample. The independent variables within this analysis were the interventions being explored and the outcome variable (i.e. dependent variable) was smoking susceptibility. The covariates that were used within this model included gender, grade, ethnicity, having a friend who smokes, amount of pocket money, current binge drinking and current marijuana use. In our modelling approach, the 22 schools where changes in school-based tobacco interventions were made between Year 2 and Year 3 served as our Intervention schools. The grouping of schools based on intervention type was based off the coding described in Methods (Refer to Section 4.2.3.1). The schools where no changes to school-based tobacco interventions were made between Year 2 and Year 3 were collapsed into one category and serve as the Control schools. A Relative Risk (RR) increase was used to measure the pattern in change in a student's probability of being susceptible at follow-up (i.e. Year 3).

Log binomial models were used in estimating the relative risk (Note that logistic binomial models were used since the outcome of interest is categorical and dichotomous). Outlined below is the model:

$$\text{Model 1 } \log(\pi_{it}) = \beta_0 + \beta_1 X_{it} + \beta_2 G_{ik}$$

where X_{it} was the set of covariates that was used in order to account for external influences that must be accounted for in order to minimize confounding effects and β_1 were the effects of

covariates, $G_i=(G_{i1}\dots G_{ik})$ was a vector of indicators where $G_{ik}=1$ if student i was in the k th School Intervention (i.e. school where changes in tobacco policies/practices was made between Year 2 and Year 3) and $G_{ik}=0$ otherwise. I set the control schools (i.e. schools with no changes in policies/practices were made in Year 3) as the reference groups. Since I was interested in the difference in RR between control and intervention schools at follow-up (i.e. Year 3), β_2 was my parameter of interest. For the purposes of answering my research question, I was focused on examining the effect of each “School Intervention”, as this parameter denoted the effects of school-specific changes in each of the intervention schools on the relative increase or decrease in the likelihood of a non-susceptible never smoker student at baseline (i.e. Year 2) being susceptible to smoking in Year 3 relative to a similar student in the control schools.

A 2-level logistic regression model was used to account for the hierarchical nature of COMPASS data that includes (1) students and (2) schools in addition to the within-school associations present within the model. The GEE method (described in detail in section 5.2.2.1) was used in order to account for within-school associations, due to the clustered and correlated nature of the data. The PROC GENMOD procedure was used in order to perform the statistical analysis.

5.2.2 Analysis for Research Question 3

The second model was used to evaluate whether changes in school-based tobacco interventions had an impact on a Year 2 non-susceptible never-smoker’s likelihood of being a tried smoker in Year 3. The target population that was used within this analysis included the sample of non-susceptible never-smokers in Year 2 present within the linked longitudinal sample. The independent variables within this analysis were the interventions being explored and

the outcome variable (i.e. dependent variable) was tried smoking. The covariates that were used within this model included gender, grade, ethnicity, having a friend who smokes, amount of pocket money, current binge drinking and current marijuana use. In our modelling approach, the schools where changes in school-based tobacco interventions were made between Year 2 and Year 3 served as our Intervention schools. The grouping of schools based on intervention type was based off the coding described in Methods (Refer to Section 4.2.3.1). The schools where no changes to school-based tobacco interventions were made between Year 2 and Year 3 were collapsed into one category and served as the Control schools. A Relative Risk (RR) increase was used to measure the pattern in change in a student's probability of being a tried smoker at follow-up (i.e. Year 3). This model was used to answer RQ 2.

Log binomial models were used in estimating the relative risk (Note that logistic binomial models will be used since the outcome of interest is categorical and dichotomous). Outlined below is the model:

$$\text{Model 2 } \log(\pi_i) = \beta_0 + \beta_1 X_i + \beta_2 G_{ik}$$

where X_i was the set of covariates that was used in order to account for external influences that must be accounted for in order to minimize confounding effects and β_1 was the effects of covariates, $G_i = (G_{i1} \dots G_{ik})$ was a vector of indicators where $G_{ik} = 1$ if student i is in the k th School Intervention (i.e. school where changes in tobacco policies/practices were made between Year 2 and Year 3) and $G_{ik} = 0$ otherwise. I set the control schools (i.e. schools with no changes in policies/practices were made in Year 3) as the reference groups. Since I was interested in the difference in RR between control and intervention schools at follow-up (i.e. Year 3), β_2 was my parameter of interest. For the purposes of answering my research question, I was focused on examining the effect of each "School Intervention", as this parameter denoted

the effects of school-specific changes in each of the intervention schools on the relative increase or decrease in the likelihood of a non-susceptible never smoker student at baseline (i.e. Year 2) being a tried smoker in Year 3 relative to a similar student in the control schools.

A 2-level logistic regression model was used to account for the hierarchical nature of COMPASS data that included (1) students and (2) in addition to the within-school associations present within the model. The GEE method (described in detail in section 5.2.2.1) was used in order to account for within-school associations, due to the clustered and correlated nature of the data. The PROC GENMOD procedure was used in order to perform the statistical analysis.

5.2.3 Analysis for Research Question 4

The third model was used to evaluate whether changes in school-based tobacco interventions had an impact on a Year 2 susceptible never-smoker's likelihood of being non-susceptible in Year 3. The target population that was used within this analysis included the sample of susceptible never-smokers in Year 2 present within the linked longitudinal sample. The independent variables within this analysis were the interventions being explored and the outcome variable (i.e. dependent variable) was non-susceptibility. The covariates that were used within this model included gender, grade, ethnicity, having a friend who smokes, amount of pocket money, current binge drinking and current marijuana use. In our modelling approach, the 22 schools where changes in school-based tobacco interventions were made between Year 2 and Year 3 served as our Intervention schools. The grouping of schools based on intervention type was based off the coding described in Methods (Refer to Section 4.2.3.1). The schools where no changes to school-based tobacco interventions were made between Year 2 and Year 3 were collapsed into one category and serve as the Control schools. A Relative Risk (RR) increase was

used to measure the pattern in change in a student's probability of being susceptible at follow-up (i.e. Year 3).

Log binomial models were used in estimating the relative risk (Note that logistic binomial models were used since the outcome of interest was categorical and dichotomous). Outlined below is the model:

$$\text{Model 3 } \log(\pi_i) = \beta_0 + \beta_1 X_i + \beta_2 G_{ik}$$

where X_i was the set of covariates that were used in order to account for external influences that must be accounted for in order to minimize confounding effects and β_1 were the effects of covariates, $G_i=(G_{i1} \dots G_{ik})$ was a vector of indicators where $G_{ik}=1$ if student i was in the k th School Intervention (i.e. school where changes in tobacco policies/practices were made between Year 2 and Year 3) and $G_{ik}=0$ otherwise. I set the control schools (i.e. schools with no changes in policies/practices were made in Year 3) as the reference group. Since I am interested in the difference in RR between control and intervention schools at follow-up (i.e. Year 3), β_2 was my parameter of interest. For the purposes of answering my research question, I was focused on examining the effect of each "School Intervention", as this parameter denoted the effects of school-specific changes in each of the intervention schools on the relative increase or decrease in the likelihood of a susceptible never smoker student at baseline (i.e. Year 2) being non-susceptible in Year 3 (i.e. reverting in susceptibility) relative to a similar student in the control schools.

A 2-level logistic regression model was used to account for the hierarchical nature of COMPASS data that included (1) students and (2) in addition to the within-school associations present within the model. The GEE method (described in detail in section 5.2.2.1) was used in

order to account for within-school associations, due to the clustered and correlated nature of the data. The PROC GENMOD procedure was used in order to perform the statistical analysis.

5.2.4 Analysis for Research Question 5

The fourth model was used to evaluate whether changes in school-based tobacco interventions had an impact on a Year 2 susceptible never-smoker's likelihood of being a tried smoker in Year 3. The target population that was used within this analysis included the sample of susceptible never-smokers in Year 2 present within the linked longitudinal sample. The independent variables within this analysis were the interventions being explored and the outcome variable (i.e. dependent variable) was tried smoking. The covariates that were used within this model included gender, grade, ethnicity, having a friend who smokes, amount of pocket money, current binge drinking and current marijuana use. In our modelling approach, the 22 schools where changes in school-based tobacco interventions were made between Year 2 and Year 3 served as our Intervention schools. The grouping of schools based on intervention type were based off the coding described in Methods (Refer to Section 4.2.3.1). The schools where no changes to school-based tobacco interventions were made between Year 2 and Year 3 were collapsed into one category and serve as the Control schools. A Relative Risk (RR) increase was used to measure the pattern in change in a student's probability of being susceptible at follow-up (i.e. Year 3). This model was used to answer RQ 2.

Log binomial models were used in estimating the relative risk (Note that logistic binomial models were used since the outcome of interest is categorical and dichotomous). Outlined below is the model:

$$\text{Model 4 } \log(\pi_i) = \beta_0 + \beta_1 X_i + + \beta_2 G_{ik}$$

where X_i was the set of covariates that were used in order to account for external influences that must be accounted for in order to minimize confounding effects and β_1 were the effects of covariates, $G_i=(G_{i1} \dots G_{ik})$ was a vector of indicators where $G_{ik}=1$ if student i was in the k th School Intervention (i.e. school where changes in tobacco policies/practices were made between Year 2 and Year 3) and $G_{ik}=0$ otherwise. I set the control schools (i.e. schools with no changes in policies/practices were made in Year 3) as the reference group. Since I was interested in the difference in RR between control and intervention schools at follow-up (i.e. Year 3), β_2 was my parameter of interest. For the purposes of answering my research question, I was focused on examining the effect of each “School Intervention”, as this parameter denoted the effects of school-specific changes in each of the intervention schools on the relative increase or decrease in the likelihood of a susceptible never smoker at baseline (i.e. Year 2) student being a tried smoker in Year 3 relative to a similar student in the control schools.

A 2-level logistic regression model was used to account for the hierarchical nature of COMPASS data that includes (1) students and (2) in addition to the within-school associations present within the model. The GEE method (described in detail in section 5.2.2.1) was used in order to account for within-school associations, due to the clustered and correlated nature of the data. The PROC GENMOD procedure was used in order to perform the statistical analysis.

5.2.5 Interpretation of Transitions in Smoking Behaviour

All four models above were used in evaluating the impact of changes in tobacco programming on smoking susceptibility and initiation outcomes. When evaluating the impact of school-based tobacco programming, transitions in smoking behaviour were interpreted as either “undesirable” or “desirable” transitions in smoking behaviour. An individual transitioning from

being a non-susceptible never smoker in Year 2 to a susceptible never smoker/ tried smoker in Year 3 was considered an “undesirable” outcome. Similarly, an individual transitioning from being a susceptible never smoker in Year 2 to a tried smoker in Year 3 was considered an “undesirable” outcome. Conversely, an individual reverting in smoking susceptibility status (i.e. transitioning from being a susceptible never smoker to non-susceptible) from Year 2 to Year 3 was considered a “desirable outcome”. Similarly, an individual remaining a non-susceptible never smoker in Year 3 was considered a “desirable outcome”.

5.3 Software

All analyses were performed using SAS (9.4).

Chapter 6

Results

6.1 Descriptive statistics

The following section provides an overview of the descriptive results for student-level and school level characteristics associated with transitions in smoking behavior.

6.1.1 Descriptive results for student level characteristics

Of the 14965 individuals from 77 Ontario secondary schools included within the linked longitudinal sample of never smokers in Year 2, 53.3 % identified as females and 46.7 % as males. Furthermore, 42.4 % of individuals were from grade 9, 32.4 % from grade 10, 23.3 % from grade 11 and 0.02 % from grade 12 (i.e. these represented individuals who did not graduate in Year 3 and thus were present in the longitudinal sample). Overall, 10542 individuals (70.4 %) were classified as non-susceptible never smokers and 4423 individuals (29.6 %) were classified as susceptible to smoking in Year 2. Among non-susceptible never-smokers in Year 2, 78.2 % remained non-susceptible, 13.8% became susceptible never smokers and 8.0 % became tried smokers within the following year (i.e. Year 3). Among susceptible never-smokers in Year 2, 28.7 % became non-susceptible (i.e. exhibited a reversion in susceptibility; a “desirable” outcome). In contrast, among susceptible never smokers in Year 2, 46.6 % remained susceptible never-smokers (an “undesirable” outcome) and 24.7 % became tried smokers (an “undesirable” outcome) within Year 3. Table 2 below provides the descriptive statistics for the transitions in phases of smoking susceptibility and tried smoking between Year 2 and Year 3 within the linked longitudinal sample.

Table 2: The Distribution of Year 2 non-susceptible never-smokers by Year 3 smoking status within the linked longitudinal sample

YEAR 2		YEAR 3			
		Non-susceptible never smokers ^a	Susceptible never smokers ^a	Tried Smokers ^a	Total
		n (%)	n (%)	n (%)	
Non-susceptible never smokers ^a	n (%)	8243 (78.2)	1454 (13.8)	845 (8.0)	10542 (70.4)
Susceptible never-smokers ^a	n (%)	1271 (28.7)	2060 (46.6)	1092 (24.7)	4423 (29.6)

^a Non-susceptible never smokers includes those who answered “definitely not” to all three questions in Pierce’s validated construct; Susceptible never smokers includes those who responded positively to at least one of the items; Tried smokers includes all individuals who have ever tried smoking a cigarette (i.e. all levels of smokers).

6.1.1.1 Descriptive results for students by gender

Table 3 below shows the descriptive statistics by gender within the linked sample of never smokers. Chi-squared results indicates that males were more likely to report having one or more friends who smoked ($\chi^2 = 24.6$, $df = 3$, $p < 0.0001$), being current marijuana users ($\chi^2 = 11.7$, $df = 2$, $p = 0.0029$), being current binge drinkers ($\chi^2 = 22.6$, $df = 2$, $p < 0.0001$) and having more than \$100 of weekly disposable income ($\chi^2 = 57.2$, $df = 4$, $p < 0.0001$), when compared to females. Conversely, males were less likely to identify as “White” or “Asian” ($\chi^2 = 19.6$, $df = 5$, $p < 0.0015$) and were less likely to report being susceptible to smoking in the future, in comparison to females ($\chi^2 = 4.57$, $df = 1$, $p = 0.032$).

Table 3: Descriptive statistics for the sample of never smoker youth in the COMPASS Year 2 sample by gender (2013-2014), Ontario, Canada

	Females		Males		Total	
	(n=7916) ^a		(n=6922) ^a			
	n	%	n	%	N (%)	
Grade	9	3227	51.3	3068	48.7	6295(42.5)
	10	2634	54.9	2168	45.1	4802(32.4)
	11	1928	55.8	1525	44.2	3453(23.3)
	12	105	40.5	154	59.5	259(1.80)
Ethnicity^b	White	6182	53.7	5335	46.3	11517(77.9)
	Black	284	45.4	342	54.6	626(4.2)
	Asian	560	55.4	451	44.6	1011(6.8)
	Aboriginal	236	54.4	198	45.6	434(3.0)
	Latin American/Hispanic	195	52.1	179	47.9	374(2.5)
	Other	423	51.8	393	48.2	816(5.5)
Disposable income	\$0	1506	50.5	1475	49.5	2981(20.3)
	\$1 to \$20	2831	52.9	2524	47.1	5355(36.4)
	\$20 to 100	1873	56.4	1446	43.6	3319(22.5)
	More than \$100	535	46.6	612	53.4	1147(7.8)
	I do not know how much money I get each week	1111	57.6	818	42.4	1929(13.0)
Number of friends who smoke	None	6400	54.4	5360	45.6	11760(79.7)
	1 friend	883	50.1	878	49.9	1761(12.0)
	2 friends	348	49.4	357	50.6	705(4.8)

	3+ friends	242	46.9	274	53.1	516(3.5)
Current (past month) binge drinking^c	Non-binge drinker	5454	52.3	4982	47.7	10436(70.8)
	Non-current binge drinker	1770	57.2	1326	42.8	3096(21.0)
	Current binge drinker	642	53.1	568	46.9	1210(8.2)
Current (past month) marijuana use^d	Non-marijuana user	7133	53.7	6146	46.3	13279(90.6)
	Non-current marijuana user	510	54.3	429	45.7	939(6.4)
	Current marijuana user	202	45.5	242	54.5	444(3.0)
Susceptible to smoking^e	No ^e	5507	52.7	4934	47.3	10441(70.5)
	Yes ^e	2388	54.7	1981	45.3	4369(29.5)

^a Estimates based on linked longitudinal sample, as described in the methods sections. Numbers may not add to total due to missing values.

^b Respondents were able to select more than one answer

^c Non-binge drinkers includes those who have never had 5 drinks of alcohol or more on one occasion; Non-current binge drinkers include those who have not had 5 or more drinks on one occasion in the last 12 months, and those who had 5 or more drinks on one occasion less than once a month; Current binge drinkers includes those who had 5 or more drinks on one occasion once a month, 2 to 3 times a month, once a week, 2 to 5 times a week, and daily or almost daily.

^d Non-marijuana users includes those who have never used marijuana; Non-current marijuana users include those who have not used it within the last 12 months, and those who used it less than once a month; Current marijuana users includes those who have used it once a month, and 2 or 3 times a month, once a week, 2 or 3 times a week, 4 to 6 times a week, and every day.

^e Non-susceptible never smokers includes those who answered “definitely not” to all three questions in Pierce’s validated construct; Susceptible never smokers includes those who responded positively to at least one of the items

6.1.1.2 Descriptive results for the sample of never smokers by susceptibility status

Table 4 below shows the descriptive statistics for non-susceptible never smokers and susceptible never smokers within the linked sample of never smokers in Year 2. Overall, 29.6 % of individuals were classified as susceptible never-smokers. Chi-squared tests indicated females were more likely to be susceptible to smoking than males ($\chi^2=4.58$, $df =1$, $p= 0.032$).

Furthermore, students in higher grades were less likely to be susceptible to smoking than students in lower grades ($\chi^2=35.48$, $df =3$, $p<0.0001$). Youth with a higher disposable income were more likely to be susceptible to smoking than youth with a lower disposable income ($\chi^2=38.2$, $df =4$, $p<0.0001$). Students who were current marijuana users ($\chi^2=240.4$, $df =2$, $p<0.0001$) or current binge drinkers ($\chi^2=591.6$, $df=2$, $p<0.0001$) were more likely to be susceptible to smoking in comparison to non-marijuana users or non-binge drinkers. Youth with no close friends who smoke were less likely to be susceptible to smoking than youth with smoking friends ($\chi^2=372.7$, $df=3$, $p<0.0001$).

Table 4: Descriptive statistics for non-susceptible never smokers and susceptible never smoker youth in the COMPASS Year 2 sample (2013-2014), Ontario, Canada

		Non-susceptible never smokers ^a (n=10542) ^b		Susceptible never smokers ^a (n=4423) ^b		Total
		n	%	n	%	N (%)
Gender	Females	5507	69.8	2388	30.2	7895(53.3)
	Males	4934	71.3	1981	28.7	6915(46.7)
Grade	9	4317	68.2	2013	31.8	6330(42.4)
	10	3443	71.1	1403	28.9	4842(32.5)
	11	2565	73.6	918	26.4	3483(23.3)
	12	193	73.1	71	26.9	264(1.80)
Ethnicity^c	White	8188	70.6	3409	29.4	11597(77.9)
	Black	480	75.7	154	24.3	634(4.2)
	Asian	715	70.0	307	30.0	1022(6.9)
	Aboriginal	288	65.6	151	34.4	439(3.0)
	Latin American/Hispanic	234	61.9	144	38.1	378(2.5)
	Other	587	71.3	236	28.7	823(5.5)
Disposable	\$0	2203	73.5	796	26.5	2999(20.2)

income	\$1 to \$20	3702	68.6	1691	31.4	5393(36.4)
	\$20 to 100	2296	68.5	1054	31.5	3350(22.6)
	More than \$100	827	71.4	331	28.6	1158(7.8)
	I do not know how much money I get each week	1433	73.8	508	26.2	1941(13.0)
Number of friends who smoke	None	8783	74.1	3074	25.9	11857(79.7)
	1 friend	1025	57.7	751	42.3	1776(12.0)
	2 friends	410	57.4	304	42.6	714(4.8)
	3+ friends	266	51.0	256	49.0	522(3.5)
Current (past month) drinking^d	Non-binge drinker	8023	76.2	2504	23.8	10547(70.8)
	Non-current binge drinker	1859	59.6	1258	40.4	3121(21.0)
	Current binge drinker	611	49.9	613	50.1	1227(8.3)
Current (past month) marijuana use^e	Non-marijuana user	9699	72.5	3688	27.5	13387 (90.5)
	Non-current marijuana user	502	52.8	449	47.2	951(6.4)
	Current marijuana user	236	52.3	215	47.7	451(3.1)

^a Non-susceptible never smokers includes those who answered “definitely not” to all three questions in Pierce’s validated construct; Susceptible never smokers includes those who responded positively to at least one of the items

^b Estimates based on linked longitudinal sample, as described in the methods sections. Numbers may not add to total due to missing values.

^c Respondents were able to select more than one answer

^d Non-binge drinkers includes those who have never had 5 drinks of alcohol or more on one occasion; Non-current binge drinkers include those who have not had 5 or more drinks on one occasion in the last 12 months, and those who had 5 or more drinks on one occasion less than once a month; Current binge drinkers includes those who had 5 or more drinks on one occasion once a month, 2 to 3 times a month, once a week, 2 to 5 times a week, and daily or almost daily.

^e Non-marijuana users includes those who have never used marijuana; Non-current marijuana users include those who have not used it within the last 12 months, and those who used it less than once a month; Current marijuana users includes those who have used it once a month, and 2 or 3 times a month, once a week, 2 or 3 times a week, 4 to 6 times a week, and every day.

6.1.2.1 Research Question 1: McNemar Tests of Proportion for Matched Pairs of Susceptible Never Smokers between Year 2 and Year 3

In Year 2, the prevalence of susceptible never smokers was 29.6 %. In Year 3, the prevalence of susceptible never smokers was 27.0 %. McNemar tests indicated a significant

difference was present in the prevalence of susceptible never-smokers between Year 2 and Year 3 (p-value of 0.0005).

6.1.2 Descriptive Results for school-level characteristics

Table 5 below provides an overview of the number of students in each school that were susceptible never smokers and susceptible never smokers at baseline, the prevalence rates of susceptible never smokers and tried smokers in Year 3 among the sample of non-susceptible never smokers in Year 2 by Intervention and Control schools and the prevalence rates of non-susceptible never smokers and tried smokers in Year 3 among the sample of susceptible never smokers in Year 2 by Intervention and Control schools.

Results of chi-squared tests indicated that among non-susceptible never-smokers, students in Intervention Schools 12 were less likely to report being susceptible never-smokers in comparison to Control schools. In contrast, among non-susceptible never-smokers in Year 2, students in Intervention School 12 and 15 were more likely to report being tried smokers in Year 3 in comparison to Control schools. Furthermore, among non-susceptible never smokers in Year 2, students in Intervention School 6 were less likely to report being tried smokers in Year 3 in comparison to Control schools.

Among susceptible-never smokers, students in Intervention School 1 and 12 were less likely to report being non-susceptible never-smokers at follow-up in comparison to Control schools. Conversely, among susceptible never smokers, students in Intervention School 9 were more likely to report being non-susceptible never smokers at follow up in comparison to Control Schools. Among susceptible never-smokers, students in Intervention School 1 and 12 were more likely to report being tried smokers at follow-up in comparison to Control schools. Furthermore,

among susceptible never smokers, students in Intervention School 9 were less likely to report being tried smokers at follow-up in comparison to Control schools.

Table 5: The prevalence of non-susceptible never smokers, susceptible never smokers and tried smokers in Year 3 among Year 2 never smokers by Intervention and Control schools

YEAR 2	Non-susceptible never smokers ^a (N=10542) ^b			Susceptible never-smokers ^a (N=4423) ^b		
YEAR 3	N	Susceptible (%)	Tried Smokers (%)	N	Non-susceptible (%)	Tried Smokers (%)
Control Schools ^c	7788	13.9	7.8	3339	28.8	24.2
Intervention Schools ^c 1	32	12.5	9.4	22	4.6**	50.0**
2	17	23.5	0	11	18.2	54.6
3	110	18.2	7.3	54	37.0	11.1
4	116	12.1	7.8	41	31.7	36.6
5	52	13.5	5.8	24	37.5	33.3
6	233	12.0	3.0*	76	27.6	25.0
7	67	14.9	11.9	33	42.4	21.2
8	41	17.1	9.8	12	25.0	41.7
9	136	13.2	9.6	43	48.8**	9.30**
10	114	15.8	1.8	54	25.9	16.7
11	150	12.6	7.3	42	23.8	26.2
12	147	8.2**	15.0**	59	20.3*	40.0*
13	118	12.7	12.7	65	21.5	32.3
14	122	16.4	11.5	48	29.2	18.8
15	96	13.5	16.7**	47	19.2	36.2
16	164	11.6	7.9	49	18.4	32.7
17	158	13.9	11.4	68	22.1	30.9
18	107	18.7	6.5	52	36.5	17.3
19	184	12.0	9.8	83	26.5	21.7
20	288	13.2	5.9	84	32.1	15.5
21	119	15.1	12.6	83	34.9	21.7

22	183	14.8	8.2	84	35.2	15.6
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Notes: *: p-value of <0.01 **: p-value <0.05

^a Non-susceptible never smokers includes those who answered “definitely not” to all three questions in Pierce’s validated construct; Susceptible never smokers includes those who responded positively to at least one of the items

^bEstimates based on linked longitudinal sample, as described in the methods sections. ^cControl schools include schools that made no changes in school-based tobacco interventions between Year 2 and Year 3; Intervention Schools 1-6 included schools that made changes involving enforcement of tobacco policies; Schools 7-8 included changes involving aligned and coordinated support (training opportunities); Schools 8 included schools that changes involving multicomponent programming; School 9-16 included schools that made changes involving cessation support; Schools 17-19 included schools that made changes involving prohibition of e-cigarettes; Schools 20 included schools that made changes involving targeted interventions education interventions; School 21 included that made changes involving education; School 22 included a school that made changes involving the industry marketing and promotion interventions.

6.2 Results of Log Binomial Models examining the impact of school-based interventions on smoking behavior

The following section will provide an overview of results obtained using Generalized Estimating Equations models to examine the impact of changes in school-based tobacco interventions on transitions in smoking behaviour among both groups of never smokers within 76 Ontario schools (as described in Section 5.1.3). The first two models (Models 1 and 2) were formulated to explore transitions in smoking behaviour at follow-up (Year 3) among non-susceptible never smokers at baseline (i.e. Year 2). The other two models (Models 3 and 4) were formulated to explore transitions in smoking behaviour at follow up (Year 3) among susceptible never-smokers at baseline (i.e. Year 2).

6.2.1 Research Question 2 and 3: Examining the impact of school-based tobacco interventions on transitions in smoking behaviour among non-susceptible never smokers.

Table 6 below provides the relative risk estimates of each school-specific intervention associated with transitions in smoking behavior (i.e. smoking susceptibility, tried smoking) at follow up (Year 3) among *non-susceptible never smokers at baseline (Year 2)*, controlling for

relevant student-level characteristics. Due to sample size issues, Intervention School 2 could not be included within the models described and were excluded from the following analyses.

Table 6: Logistic Regression Model Analysis of the association between school-based tobacco interventions and transitions in smoking behaviour at follow-up (Year 3), among the sample of non-susceptible never-smokers at baseline (Year 2), while controlling for student-level characteristics

Parameters			
		Susceptible to smoking (Model 1) ^a	Tried smoker (Model 2) ^a
		RR(95% CI)	RR(95 % CI)
Control Schools	School 0 (Ref)	---	---
Interventions involving Enforcement Practices	School 1	0.81 (0.33,1.98)	1.07 (0.40,2.92)
	3	1.32 (0.90,1.95)	0.92 (0.50,1.69)
	4	0.76 (0.48,1.21)	1.00 (0.57,1.79)
	5	0.88 (0.42,1.82)	0.95 (0.35,2.59)
	6	0.89 (0.66,1.21)	0.42* (0.21,0.84)
Interventions involving Training	7	1.13 (0.63,2.04)	1.84 (0.95,3.55)
	8	1.30 (0.66,2.56)	1.13 (0.47,2.68)
Multi-component Interventions	9	0.85 (0.55,1.33)	1.19 (0.73,1.93)
Interventions involving Cessation	10	1.31 (0.87,1.97)	0.56 (0.16,1.89)
	11	0.89 (0.60,1.32)	0.93 (0.56,1.57)
	12	0.52* (0.32,0.85)	1.45 (1.00,2.11)

Support	13	0.82 (0.52,1.28)	1.13 (0.72,1.77)
	14	1.20 (0.82,1.77)	2.03* (1.28,3.23)
	15	0.90 (0.56,1.46)	1.91* (1.21,3.00)
	16	0.82 (0.55,1.21)	1.18 (0.74,1.90)
Interventions involving Prohibition of E-cigarettes	17	0.97 (0.67,1.39)	1.13 (0.74,1.73)
	18	1.28 (0.86,1.92)	0.89 (0.46,1.70)
	19	0.86 (0.60,1.23)	1.22 (0.79,1.85)
Targeted Interventions	20	0.99 (0.77,1.29)	0.86 (0.56,1.30)
Interventions involving Education	21	1.10 (0.73,1.65)	1.53 (0.96,2.44)
Industry Marketing and Promotion Interventions	22	1.02 (0.74,1.41)	1.24 (0.79,1.93)
Gender	Females(Ref)	---	---
	Males	1.03 (0.93,1.13)	1.02 (0.91,1.16)
Grade at Year 2	9 (Ref)	---	---
	10	0.73**(0.65,0.82)	0.93 (0.81,1.08)
	11	0.55**(0.48,0.64)	0.74**(0.63,0.87)
	12	0.63* (0.42,0.93)	0.97 (0.66,1.44)
Ethnicity^c	White (Ref)	---	---
	Black	0.75* (0.57,0.98)	0.85 (0.63,1.14)
	Asian	1.11 (0.92,1.36)	1.00 (0.74,1.34)
	Aboriginal	0.64* (0.44, 0.93)	1.37*(1.03, 1.82)

	Latin American/Hispanic	1.23 (0.91,1.66)	1.34 (0.95,1.88)
	Other	0.99 (0.79,1.22)	0.88 (0.65,1.19)
Weekly Disposable income	\$0 (Ref)	---	---
	\$1 to \$20	1.20* (1.02,1.41)	1.00 (0.80,1.26)
	\$20 to 100	1.21* (1.03,1.42)	0.98 (0.78,1.22)
	More than \$100	1.12 (0.94,1.34)	1.18 (0.94,1.47)
	I do not know how much money I get each week	1.03 (0.85,1.27)	0.86 (0.65,1.14)
Number of friends who smoke	None (Ref)	---	---
	1 friend	1.46** (1.27,1.67)	2.02** (1.71,2.38)
	2 friends	1.70** (1.43,2.02)	2.65** (2.20,3.18)
	3+ friends	1.27* (1.03,1.57)	2.86** (2.40,3.43)
Current (past month) binge drinking^d	Non-binge drinker (Ref)	---	---
	Non-current binge drinker	1.71** (1.53,1.93)	2.38** (1.97,2.87)
	Current binge drinker	1.72** (1.47,2.00)	3.53** (2.89,4.30)
Current (past month) marijuana use^e	Non-marijuana user (Ref)	---	---
	Non-current marijuana user	1.02 (0.87,1.19)	3.05** (2.58,3.61)
	Current marijuana user	0.75* (0.60,0.92)	4.50** (3.78,5.35)

Note: *: p<0.05, **: p<0.001

^a Model estimates are adjusted to control for student level characteristics. School 2 was not included in the analysis due to sample size.

^bControl schools include schools that made no changes in school-based tobacco interventions between Year 2 and Year 3; Intervention Schools 1-6 included schools that made changes involving enforcement of tobacco policies; Schools 7-8 included changes involving aligned and coordinated support (training opportunities); Schools 9 included schools that changes involving multicomponent programming; School 10-16 included schools that made changes involving cessation support; Schools 17-19 included schools that made changes involving prohibition of e-cigarettes; Schools 20 included schools that made changes involving targeted interventions education interventions; School 21 included that made changes involving education; School 22 included a school that made changes involving the industry marketing and promotion interventions.

^c Respondents were able to select more than one answer

^d Non-binge drinkers includes those who have never had 5 drinks of alcohol or more on one occasion; Non-current binge drinkers includes those who have not had 5 or more drinks on one occasion in the last 12 months, and those who had 5 or more drinks on one occasion less than once a month; Current binge drinkers includes those who had 5 or more drinks on one occasion once a month, 2 to 3 times a month, once a week, 2 to 5 times a week, and daily or almost daily.

^e Non-marijuana users includes those who have never used marijuana; Non-current marijuana users includes those who have not used it within the last 12 months, and those who used it less than once a month; Current marijuana users includes those who have used it once a month, and 2 or 3 times a month, once a week, 2 or 3 times a week, 4 to 6 times a week, and every day.

6.2.1.1 Interventions associated with smoking susceptibility among non-susceptible never smokers (Model 1)

As shown in Table 6, only Intervention School 12 saw significant reductions in RR (RR=0.52, p=0.0087) in the likelihood of a non-susceptible never smoker reporting becoming susceptible relative to the control schools. This intervention used the involvement of a Health Unit coming in to help a small group of students quit smoking (i.e. cessation support). The RR of smoking susceptibility in all other Intervention schools relative to the Control schools were not seen to be significant.

6.2.1.2 Interventions associated with tried smoking among non-susceptible never smokers (Model 2)

As indicated within Table 6, only Intervention School 6 saw significantly lower RR (RR=0.42, p= 0.013) in the likelihood of a non-susceptible never smoker reporting trying smoking relative to control schools. This intervention involved the enforcement of violations of school smoking policies with suspensions. In contrast, students in Intervention School 14 and 15 were at a significantly increased risk of reporting trying cigarettes relative to control schools (RR=2.03, p=0.003; RR= 1.91, p= 0.0052). Both schools implemented interventions involving the provision of cessation support. Furthermore, Intervention School 12 had a borderline significant increase in the risk of reporting trying cigarettes relative to control schools (RR=1.45,

p=0.05). The RR of tried smoking in all other Intervention schools relative to the Control schools were not seen to be significant.

6.2.2 Research Question 4 and 5: exploring the impact of school-based tobacco interventions on transitions in smoking behaviour in Year 3 among susceptible never smokers at baseline (Year 2).

Table 7 below provides the relative risk estimates of each school-specific intervention associated with transitions in smoking behavior (i.e. reversion in smoking susceptibility, tried smoking) at follow up (Year 3) among *susceptible never smokers at baseline (Year 2)*, controlling for relevant student-level characteristics.

Table 7: Logistic Regression Model Analysis of the association between school-based tobacco interventions and transitions in smoking behaviour at follow-up (Year 3), among the sample of non-susceptible never-smokers at baseline (Year 2), while controlling for student-level characteristics

Parameters			
		Non-susceptible (Model 3) ^a	Tried smoker (Model 4) ^a
		RR(95% CI)	RR(95 % CI)
Control Schools	School 0 (Ref)	---	---
Interventions involving Enforcement	School 1	0.17*(0.03,0.91)	1.50 (0.89,2.53)
	3	1.19 (0.81,1.76)	0.56 (0.27,1.17)
	4	1.20 (0.75,1.94)	1.34 (0.85,2.14)

Practices	5	1.31 (0.74,2.29)	1.60 (0.87,2.93)
	6	0.93 (0.63,1.37)	0.99 (0.63,1.55)
Interventions involving Training	7	1.36 (0.86,2.16)	0.98 (0.51,1.90)
	8	0.90 (0.34,2.36)	1.48 (0.69,3.14)
Multi-component Interventions	9	1.56*(1.06,2.30)	0.60 (0.25,1.43)
Interventions involving Cessation Support	10	0.77 (0.48,1.22)	1.05 (0.57,1.91)
	11	0.77 (0.45,1.33)	1.24 (0.73,2.11)
	12	0.89 (0.54,1.48)	1.06 (0.71,1.56)
	13	1.02 (0.64,1.63)	0.80 (0.54,1.21)
	14	0.90 (0.57,1.43)	1.11 (0.59,2.09)
	15	0.57 (0.30,1.09)	1.46 (0.95,2.25)
	16	0.68 (0.38,1.20)	1.15 (0.73,1.82)
Interventions involving the Prohibition of E-cigarettes	17	0.84 (0.53,1.31)	1.04 (0.68,1.58)
	18	1.21 (0.81,1.81)	0.91 (0.48,1.70)
	19	0.83 (0.56,1.23)	1.22 (0.79,1.85)
Targeted Interventions	20	1.02 (0.72,1.44)	0.79 (0.47,1.33)
Interventions involving Education	21	1.15 (0.79,1.68)	1.24 (0.80,1.91)
Industry Marketing and Promotion Interventions	22	1.24 (0.83,1.85)	1.33 (0.86,2.06)
Gender	Females(Ref)	---	---

	Males	1.05 (0.94,1.15)	1.07 (0.97,1.19)
Grade at Year 2	9 (Ref)	---	---
	10	1.00 (0.90,1.12)	0.97 (0.86,1.10)
	11	1.11 (0.98,1.27)	0.93 (0.81,1.07)
	12	1.26 (0.87,1.83)	1.17 (0.84,1.63)
Ethnicity^c	White (Ref)	---	---
	Black	1.06 (0.82,1.37)	0.94 (0.72,1.24)
	Asian	0.76* (0.62,0.93)	1.01 (0.79,1.30)
	Aboriginal	0.99 (0.76, 1.30)	1.09 (0.86, 1.41)
	Latin American/Hispanic	0.91 (0.69,1.07)	1.14 (0.86,1.51)
	Other	0.86 (0.69,1.07)	0.83 (0.64,1.07)
Weekly Disposable income	\$0 (Ref)	---	---
	\$1 to \$20	1.03 (0.89,1.20)	1.05 (0.86,1.28)
	\$20 to 100	1.15 (1.00,1.35)	1.11 (0.91,1.34)
	More than \$100	1.05 (0.88,1.25)	1.13 (0.92,1.38)
	I do not know how much money I get each week	1.02 (0.84,1.24)	1.04 (0.82,1.32)
Number of friends who smoke	None (Ref)	---	---
	1 friend	0.75** (0.65,0.89)	1.74**(1.53,2.00)
	2 friends	0.73* (0.60,0.88)	1.83**(1.57,2.14)
	3+ friends	0.46** (0.36,0.59)	2.36**(2.04,2.72)
Current (past month) binge drinking^d	Non-binge drinker (Ref)	---	---
	Non-current binge drinker	0.70** (0.63,0.78)	1.56**(1.33,1.83)
	Current binge drinker	0.58** (0.50,0.68)	2.10**(1.79,2.48)

Current (past month) marijuana use^e	Non-marijuana user (Ref)	---	---
	Non-current marijuana user	0.76** (0.66,0.87)	2.27**(1.99,2.59)
	Current marijuana user	0.61** (0.50,0.73)	2.70**(2.35,3.11)

Note: *: p<0.05, **: p<0.001;

^a Model estimates are adjusted to control for student level characteristics. School 2 was not included within the analysis due to sample size.

^b Control schools include schools that made no changes in school-based tobacco interventions between Year 2 and Year 3; Intervention Schools 1-6 included schools that made changes involving enforcement of tobacco policies; Schools 7-8 included changes involving aligned and coordinated support (training opportunities); Schools 9 included schools that changes involving multicomponent programming; School 10-16 included schools that made changes involving cessation support; Schools 17-19 included schools that made changes involving prohibition of e-cigarettes; Schools 20 included schools that made changes involving targeted interventions education interventions; School 21 included that made changes involving education; School 22 included a school that made changes involving the industry marketing and promotion interventions. ^c Respondents were able to select more than one answer

^d Non-binge drinkers includes those who have never had 5 drinks of alcohol or more on one occasion; Non-current binge drinkers include those who have not had 5 or more drinks on one occasion in the last 12 months, and those who had 5 or more drinks on one occasion less than once a month; Current binge drinkers includes those who had 5 or more drinks on one occasion once a month, 2 to 3 times a month, once a week, 2 to 5 times a week, and daily or almost daily.

^e Non-marijuana users includes those who have never used marijuana; Non-current marijuana users include those who have not used it within the last 12 months, and those who used it less than once a month; Current marijuana users includes those who have used it once a month, and 2 or 3 times a month, once a week, 2 or 3 times a week, 4 to 6 times a week, and every day.

6.2.2.1 Interventions associated with reversion in smoking susceptibility among susceptible never smokers (Model 3)

As shown within Table 7, only Intervention School 9 saw significant differences on the RR increase (RR=1.56, p=0.04) in the likelihood of a susceptible never smoker reporting becoming non-susceptible in comparison to Control schools. This school implemented changes involving offering a tobacco control program in partnership with OPHEA and the creation of a tobacco de-normalization plan called “how will you grow old?”. In contrast, students in Intervention School 1 were less likely to report being non-susceptible never smokers (i.e. reversion of susceptibility) in comparison to Control schools. This school implemented changes involving consistent/ongoing monitoring of tobacco use in conjunction with the provision of

health classes to educate students. The RR of tried smoking in all other Intervention schools relative to the Control schools were not seen to be significant.

6.2.2.2 Interventions associated with tried smoking among susceptible never smokers (Model 4)

As shown within Table 7, none of the Intervention Schools (i.e. Schools 1,3-21) saw significant differences in the likelihood of a susceptible never smoker trying smoking relative to Control schools.

6.2.3 Student-level characteristics associated with transitions in smoking behaviour (Models 1-4)

Individuals that had friends that smoked were at an increased risk of being susceptible to smoking in comparison to students that had no friends that smoked. Both non-susceptible and susceptible never-smoker students that had friends that smoked were at an increased risk of trying smoking in comparison to students with no friends that smoked. Susceptible never smokers that had friends who smoked were less likely to revert in susceptibility in comparison to those who had no friends who smoked. Furthermore, students that were current substance users (i.e. current binge drinkers, current marijuana users) were also at an increased risk of trying smoking in comparison to students that were not substance users. Current substance users were also less likely to revert in susceptible (i.e. go from being susceptible to non-susceptible) in comparison to those who were not current substance users. Students identifying as “Black” or “Aboriginal” were seen to be at a reduced risk of smoking susceptibility. The results also indicated that Aboriginal students were at an increased risk of trying smoking. In addition, students in higher grades were seen to be at a reduced risk of

smoking susceptibility in comparison to grade 9 students. Interestingly, the results also showed that non-susceptible never-smokers within grade 11 were at a decreased risk of trying smoking in comparison to grade 9 individuals.

Chapter 7

Discussion

7.1 Prevalence of Smoking Susceptibility

The findings indicated that approximately a third of the sample reported being susceptible never smokers. These results were consistent with recent national estimates (Kaai et al., 2014) and with previous research from Year 1 COMPASS data (Leatherdale, Cole, 2015). Consistent with our hypotheses, there was a decreasing prevalence of smoking susceptibility within the linked sample that corresponded with an increasing prevalence of tried smoking between Year 2 and Year 3 of the study. These results were also consistent with previous work indicating that smoking initiation increased with grade and age (Tyas & Pederson, 1998). This data points towards the importance of school-based tobacco control programming in deterring smoking initiation, despite recent reductions in the prevalence of current smoking among youth.

7.2 School-Based Interventions Associated with Transitions in Smoking Behaviour

Over all we identified 22 different school-based interventions that took place in 22 different schools between Year 2 and Year 3. Only one of the schools (School 9) had the desirable impact of significantly increasing the likelihood of a susceptible never smoker reverting in smoking susceptibility status (i.e. going from susceptible to non-susceptible). School 6 had the desirable impact of significantly reducing the risk of smoking initiation among the population of never smokers, though the significance of these results was not maintained when examining individuals who were susceptible at baseline. Two of the schools (Schools 14 and 15)

involving cessation support were seen to have the undesirable impact of increasing smoking initiation among never smokers.

7.2.1 Comprehensive Programming

Only School 9 had the desirable impact of significantly increasing the likelihood of a susceptible never smoker reverting in susceptibility. This intervention involved the implementation of a provincially funded comprehensive tobacco control program that focused on five distinct areas: 1) curriculum, teaching and learning 2) school and classroom leadership 3) student engagement 4) social and physical environments and 5) school and community partnerships in conjunction with a tobacco de-normalization plan. Our findings were consistent with previous work indicating that interventions using comprehensive and coordinated programming that addressed multiple determinants of tobacco use were effective in preventing smoking initiation among adolescents (Backinger et al., 2003; Zimmerman & Hairnes, 2007; Ontario Agency for Health Protection and Promotion, 2010). Our findings also aligned with previous research indicating that programming involving combined school and community efforts were effective in reducing smoking uptake among youth and young adults (Carson et al., 2011). Youth who are susceptible to smoking may be more vulnerable to a wide range of risk factors including personal, social and environmental influences that encourage them to experiment with tobacco (Yang et al., 2011; Chan & Leatherdale, 2011). Multicomponent programs that are comprehensive in scope may hold the potential to address the distinct levels of influence that impact smoking initiation outcomes among this population of youth. Moving forward, we believe the intervention in School 9 may represent a potentially promising practice-based intervention.

7.2.2 Enforced Policies

The majority of interventions involving the enforcement of school smoking policies did not have the desirable impact of significantly reverting smoking susceptibility status or reducing tried smoking outcomes among never smokers. These results were not surprising when examining School 4, which initiated contact with tobacco enforcement officers regarding information about penalties/fines but did not make any mention of whether specific enforcement practices were communicated to students or what the level of involvement of enforcement officers was within this school. Among schools that exercised particular enforcement strategies, similarly insignificant results were seen. For example, one of schools (School 3) that now enforced violations of school smoking policies by confiscating cigarette packs until parents come to pick them up had a reduced risk of smoking susceptibility and tried smoking outcomes that was seen to be insignificant. Our results were inconsistent with previous research indicating that strict policy enforcement is associated with lower smoking rates and a higher likelihood of students being at an earlier stage of smoking uptake (Galanti et al., 2014; Lovato et al., 2010; Pinilla et al., 2002; Moore et al., 2001; Wakefield et al., 2000; Reitsma & Manske, 2004). Conversely, our findings were consistent with previous studies indicating that the enforcement of policies with sanctions and informing parents are not associated with adolescent smoking outcomes (Wiiium et al., 2011). These findings also aligned with previous work suggesting that policies as a stand-alone intervention are not effective (Murnaghan et al., 2007; USDHHS, 1994; Murnaghan et al., 2008). It is important to consider that while enforcing school policies may limit and govern the location and timing of students' smoking, they do not stop students from smoking in general (Lovato et al., 2007). Policies alone may fall short of changing behaviours-

especially during adolescence, a period of time when youth tend to experiment with various risky and deviant behaviours, including tobacco use (Sabiston et al., 2009).

Only one intervention involving the enforcement of school smoking policies with suspensions was associated with a significant reduction in the risk of tried smoking among non-susceptible never smokers. However, these reductions in risks were not observed when examining its impact among susceptible never smokers. The observed results may be attributable to differences in the sub-populations being examined. Prior research has indicated that susceptible never smokers report greater exposure to pro-tobacco advertising in comparison to non-susceptible never smokers (Dube et al., 2013). As such, the enforcement of school smoking policies with suspensions may not be sufficient in counter-acting the broader societal influences that susceptible never smokers are exposed to. Supplementing strongly enforced policies with mass media counter-advertising campaigns that are implemented at the community-level may serve as an appropriate prevention approach to deter smoking initiation among this high-risk population.

7.2.3 Cessation Programming

School interventions that involved the provision of cessation support by school nurses/creation of new cessation program did not appear promising. For example, School 14 that implemented a cessation program involving counsellors and delivered to high risk individuals in addition to cessation/prevention services delivered by a nurse had an undesirable impact of significantly increasing the risk of tried smoking outcomes among never smokers. Similarly, an increased risk of tried smoking was observed within School 15 that now had a new cessation program available. Our findings aligned with a recent review indicating little evidence to support

the effectiveness of interventions delivered by health care professionals on reductions in smoking behaviour among youth (Gabble et al., 2015). Conversely, our results were inconsistent with previous work indicating some evidence of effectiveness of school-based cessation programming involving collaborations between nurses, counsellors, teachers and community members in reducing smoking among adolescents in reducing smoking among adolescents (Fritz et al., 2008; Dino et al., 2008; Horn et al., 2005; Health Canada, 2005). Recent meta-analyses and systematic reviews have pinpointed key constituents of effective cessation programming to include behavioural and motivational interviewing strategies, an appropriate context, relevant content suitable for adolescents along with a multifaceted and comprehensive approach that addresses the multiple levels of influence that impact smoking behaviour (OTRU, 2015; Backinger et al., 2003; Sussman & Sun, 2009). One possible reason for these findings could be that cessation programming that targets solely high-risk individuals (i.e. smokers) may not capture other crucial sub- populations including never-smokers that may be susceptible to smoking in the future. Other plausible reasons may include students being exposed to smoking near school property or in areas where smoking is prohibited on school grounds. This may result in the creation of a high-risk environment that makes smoking appear more normative and accepted and provide greater opportunities for access to social sources of cigarettes. Previous research has shown evidence that low-risk students (that have no family/friends who smoke) were over twice as likely to try smoking if they attended a high-risk school in comparison to a low-risk school (Leatherdale & Manske, 2005).

7.2.4 Media-based/ Industry Marketing and Promotion Interventions

Interventions based solely on the dissemination of knowledge (School 21) did not appear promising in reducing the risk of smoking susceptibility and initiation behaviours. School 21

made changes involving their Health Unit providing education via an online website. These findings were inconsistent with prior work indicating that Internet-facilitated programs may represent a promising avenue for reducing substance use behaviours (Champion et al., 2013). The most common components of Internet-based youth smoking prevention and cessation programs that were seen to be effective included the utilization of multimedia, the provision of personalized feedback, interactive platforms and tailored strategies (Park & Drake, 2015). Given the limited information provided within the SPP, it is difficult to discern whether these components were present on the Health Unit's website, whether the information present on the Health Unit's website was actively communicated to students and how many students actually visited the website.

Other interventions involving preventing youth from wearing tobacco-related apparel (School 22) did not appear to reduce the risk of smoking susceptibility and initiation. These findings were contrary to extensive evidence indicating the significance of interventions involving the restriction of tobacco industry marketing and promotion (Ontario Agency for Health Protection and Promotion, 2010; US Department of Health and Human Services, 1994; Slater et al., 2007). However, these findings were consistent with previous COMPASS data (Leatherdale & Cole, 2015). It is important to note that the Tobacco Act currently prohibits the supply of a tobacco branded products on non-tobacco products that are likely to appeal to young people (Department of Justice, 2016). Obtaining additional details on whether there were a number of students within this school wearing tobacco-branded apparel may provide greater insight into possible reasons for the observed effects (e.g. lack of enforcement).

7.2.5 Interventions involving Training Opportunities

Interventions involving aligned and coordinated support (via the provision of staff/youth training) did not appear promising in significantly reducing smoking susceptibility and tried smoking outcomes. This was not surprising in School 7 where training conferences relating to tobacco prevention and cessation were no longer provided to staff. However, the outcome observed in School 8 where training opportunities were now offered to students by teachers was a cause for concern. These findings are contrary to previous work indicating the importance of training opportunities (Leatherdale & Cole, 2015; Dusenbury et al., 2003) and youth engagement within the tobacco prevention agenda (Dobbins et al., 2008; Fiissel et al., 2008). However, these results align with previous work indicating the limited effectiveness of school based programming alone in preventing smoking initiation (Backinger et al., 2003). Given the small sample of intervention schools involving training opportunities that were evaluated (N=2), future work may benefit from examining the impact of this type of intervention within a more largely powered sample.

7.3 Student-level Characteristics Associated with Transitions in Smoking Behaviour

When examining the results of full models (i.e. Models 1 to 4), a consistent trend was apparent that having more close friends that smoked increased the risk of initiating smoking behaviour among never smoker individuals. These findings aligned with extensive research indicating the role of smoking peers in influencing smoking behaviour (Simons-Morton & Farhat, 2010; Tyas & Pederson, 1998; Kobus, 2003; De Vries et al., 2003). Similarly, substance users (i.e. marijuana user'/ binge drinkers) were seen to be at an elevated risk of smoking

initiation. These results were consistent with prior evidence indicating that youth who reported trying alcohol or binge drinking were substantially more likely to have also tried using tobacco products (Leatherdale & Ahmed, 2010; Leatherdale et al., 2008) and that co-morbid patterns of substance use were common among adolescents (Ramos et al., 2012; White et al., 2015). Consistent with previous work (Gritz et al., 2003; Kaufman et al., 2003; Leatherdale et al., 2005), students in high grades were less likely to be susceptible within the fully fitted model. Furthermore, gender was not seen to act as a significant predictor of smoking susceptibility and initiation within the fully fitted logistic regression models. These results aligned with some prior work (Tyas & Pederson, 1998; Garcia-Rodriguez et al., 2011) but not others (Leatherdale et al., 2005; Kaufman et al., 2003). When evaluating the impact of prevention programs/policies on changes in students' smoking susceptibility and initiation outcomes, these covariates were controlled for in order to minimize potential confounding effects.

7.4 Implications for Research

Interventions involving multicomponent and comprehensive programming appeared to show promise in reducing smoking susceptibility among never smokers. Future follow-up research may benefit from collecting additional substantive details from school administrators on how this program was designed and implemented. Furthermore, given that our evaluation of multicomponent programming focused solely on one school (School 9), future work may benefit from evaluating similar interventions using a larger sample of intervention schools.

There were clear differences present in effect of tobacco programming on distinct populations of never smokers. For example, enforcement of school policies with suspensions produced promising effects among non-susceptible never smokers, but dissimilar results were

seen when examining individuals that were susceptible at baseline. Discerning what these differences were due to presented a challenge due to the heterogeneity of enforcement practices implemented within this study. Future evaluations may benefit from including proximal measures (e.g. students' perceptions of enforcement policies) that may provide greater insight on why these differential effects were observed. This research may provide greater insight on how interventions can be more effectively tailored to school needs and context.

There is evidence that indicates that youth-led comprehensive programming works in reducing smoking behaviour (Zimmerman & Hairnes, 2007). However, there is a general lack of understanding of how best to engage youth and of the mechanisms of change that may lead to improved smoking outcomes (Kirst et al., 2013). Additional research focused on improving student participation and recruitment within tobacco control initiatives is warranted in order to inform program design and implementation.

Future studies should duplicate the work done within this study over an extended period of time. Once COMPASS Year 4 data is ready, future work should also use additional data points when examining the impact of interventions deemed promising so that the long-term effects can be elucidated. Given that our sample was likely underpowered at the school-level, future work should also seek to examine the impact of interventions deemed promising within a more largely powered sample.

Future work should also focus on research aimed at addressing gaps in knowledge about effective interventions to reduce smoking uptake of tobacco among high-risk groups including Aboriginals and on identifying the key factors contributing to the successful implementation of these interventions. This data may provide guidance on how best to tailor programs in a culturally appropriate manner that account for the unique needs of this vulnerable population.

7.5 Implications for Policy and Practice

Extensive research has outlined the effectiveness for multicomponent programming in reducing smoking uptake. Our results provided further evidence, as seen within School 9 where students were less likely to transition from being susceptible to non-susceptible at follow-up (Y₃). Moving forward, there is a need for integrated programming in order to advance the tobacco prevention agenda within schools. Consistent with social-ecological models that indicate the various levels of influence involved in tobacco use, multi-level and synergistic interventions involving a combination of prevention programs, comprehensive policies and mass media interventions are necessary to deter tobacco initiation among adolescents. Given the complex nature of the tobacco epidemic, a complex system of interventions is needed in order to achieve significant reductions in smoking initiation among youth.

Furthermore, most of the interventions implemented within this study did not appear to significantly reduce smoking susceptibility and uptake outcomes. Moving forward, there is a need for additional collaborations to be formed between schools, community partners and provincial stakeholders in order to inform the development, implementation and evaluation of tobacco prevention programs and in order to achieve significant reductions in these outcomes.

Future school-based tobacco prevention initiatives should also focus on obtaining feedback from multiple audiences including school administrators, educators and community partners prior to administering prevention programs. These feedback information loops may play a crucial role in allowing for programs to be tailored to school-specific contexts and needs. This information may be used to inform program design and implementation. This information may also ensure that the available resources are placed where they are most likely to have an impact.

Despite the evidence that student-led programming hold the potential to reduce smoking behaviour among youth, only 2 out of 77 schools (Schools 8 and 9) made changes surrounding youth involvement opportunities. Future prevention initiatives should ensure that youth are involved in the planning and implementation phase of the program. Obtaining feedback from students may increase youth participation and recruitment within tobacco control programs and reinforce the role of youth as empowering members of the community. Incorporating students' opinions and ideas within the program design phase may also help introduce key strategies for meaningful youth engagement, which can be used by program providers when delivering school-based programming.

A clear pattern was apparent in our findings indicating the co-occurrence of smoking initiation with established patterns of binge drinking and marijuana use. Given that clear associations across these co-occurring risk factors emerged across all schools examined within this study, these data suggest that multi-substance prevention programming are required for youth populations. Given that these risky behaviours tend to cluster together, future program design may benefit from focusing on substance use prevention as a whole as opposed to solely on tobacco use (which represents the current model within Ontario).

7.6 Strengths of Study

Though most research has focused on smoking susceptibility as a measure of the effectiveness of primary prevention efforts, most of the work conducted to date examining smoking susceptibility stemmed from cross-sectional studies. Cross-sectional studies do not allow for monitoring the progression of smoking behaviour among individuals that are at the highest risk for smoking initiation. As such, this study adds valuable information in examining

the impact of changes in school-based tobacco interventions on smoking susceptibility outcomes longitudinally. Consequently, temporal trends can be elucidated and changes in smoking susceptibility and initiation outcomes can be monitored over time. Furthermore, the longitudinal design of COMPASS offers robust internal validity when examining the changes over time and robust external validity as a function of the quasi-experimental design.

Though most of the available school-based prevention evidence stems from artificially controlled research that do not align with the realities of prevention practices within the school environment (Green et al., 2006; Ringwalt et al., 2004; Hawe et al., 2004), the quasi-experimental design of COMPASS allows for the evaluation of the “real-world” effectiveness of interventions that are implemented within schools. The lack of guidance for school-based tobacco control programming within Ontario often leaves schools with the task of either identifying and implementing existing evidence-based programs (which may not be appropriate within their school context), or they are forced to develop their own unique programs or policies which are often not evidence-based (Leatherdale, 2012). COMPASS allows for the generation of practice - based evidence through the evaluation of natural experiments occurring within schools (Leatherdale et al., 2014). Promising interventions may also be appropriately recommended to schools that share similar social contexts. Conversely, recommendations may also be made to schools to stop interventions that appear to have a deleterious impact of increasing the risk of smoking susceptibility and initiation among youth.

Lastly, the self-reported tobacco use student-level measures used within this study were consistent with national measures that were found to be both reliable and valid (Bredin et al., 2014; Elton-Marshall et al., 2011).

7.7 Limitations

A limitation of the present study was that no data was available from the SPP pertinent to process or implementation details for each of the 22 interventions identified (e.g. program fidelity, the consistency of policy enforcement). Though these details are well beyond the scope of this thesis, the evidence presented here aids in the identification of promising school-based tobacco prevention interventions that occurred between Year 2 and Year 3 of the COMPASS study that warrant additional investigation. Moving forward, additional data can be collected from school administrators within schools that implemented interventions that had a desired impact on smoking susceptibility and initiation outcomes (e.g. the tobacco control program implemented in School 9) in order to perform additional evaluation research. Additional details on what particular staff were involved in the administration of this intervention, what resources were allocated to this program and what necessary partnerships were formed during the process may also be collected in order to provide a greater understanding of what led to the observed effects.

An additional limitation of this study is that COMPASS relies on self-reported data of smoking behaviour. As such, our findings may reflect some under-reporting bias, which is quite common within youth smoking research. However, the COMPASS study is based on previous validated self-reported measures of youth smoking and honest reporting was encouraged during the data collection process (Wong et al., 2012; Pierce et al., 1996). Furthermore, given the longitudinal design of COMPASS and the passive consent protocols in place, potential bias in self-reported data is partially mitigated as any biases should remain consistent over time (Diggle et al., 2002).

Our sample was likely underpowered at the school-level (N= 77 schools) making it difficult to elucidate the true effects of school-based interventions. For example, when examining the impact of school-based interventions on the likelihood of an individual reverting in susceptibility (Refer to Table 7), it appeared that only a RR (Relative Risk) of 1.5 and above could be detected significantly within this sample of individuals. As such, future work should focus on examining the impact of interventions that appeared promising (e.g. School 9) using more largely powered samples in order to identify potentially effective interventions.

This study did not examine the impact of school-based tobacco prevention interventions on transitions in specific stages of smoking behaviour (e.g. puffers, experimenters, current smokers) or the use of alternative tobacco products (e.g. cigarillos, hookah, e-cigarettes) between Year 2 and Year 3. This study also did not examine the impact of these interventions on the school smoking prevalence rate. However, future research may explore the impact of school-based tobacco interventions on these other tobacco-related outcomes in order to provide additional evidence to inform future tobacco control initiatives.

Lastly, though recent studies have incorporated a new measure of “curiosity to smoke” to the susceptibility index in order to further refine the identification of at-risk adolescents (Strong et al., 2015; Nodora et al., 2014) , this measure could not be examined as it was not present within the COMPASS questionnaire (Cq). However, future work may benefit from exploring this measure of “curiosity” and assessing the utility of an enhanced smoking susceptibility index.

7.8 Conclusions

The evaluation of natural experiments, such as the 22 interventions evaluated within this study, may provide the best available “real-world” public health evidence and allow for the

identification of new potentially promising tobacco control interventions among adolescents (Petticrew et al., 2005). There is a clear need to develop more effective methods of pinpointing promising interventions in youth tobacco control as the current evidence base is weak and inconclusive (Galanti et al., 2014; Weihe et al., 2005; Coppo et al., 2013). Data collection systems such as COMPASS can provide the infrastructure to support the formulation of practice-based evidence and in order to provide a greater understanding of how to intervene within the school context. The evidence presented here indicates that the majority of school-based tobacco prevention programming do not show promise in reducing adolescent smoking susceptibility and initiation among never smokers. Progress in preventing smoking initiation among never smoker youth will require coordinated and comprehensive efforts from various stakeholders. In addition, there is a need for innovative methods to be used in determining which interventions work, for which target audience, and in what context to guide the formulation of tailored and effective programming (Leatherdale, 2012).

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