A multilevel analysis examining the association between school-based smoking policies, prevention programs and youth smoking behavior: evaluating a provincial tobacco control strategy

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Abstract

This paper examined how smoking policies and programs are associated with smoking behavior among Grade 10 students \( (n = 4709) \) between 1999 and 2001. Data from the Tobacco Module from the School Health Action Planning and Evaluation System were examined using multilevel logistic regression analyses. We identified that (i) attending a school with smoking prevention programs only was associated with a substantial risk of occasional smoking among students with two or more close smoking friends and (ii) attending a school with both smoking prevention programs and policies was associated with substantial risk of occasional smoking among students who did not believe there were clear smoking rules present. Students attending schools where year of enrolment in high school starts in Grade 9 were more likely to be regular and occasional smokers. Each 1% increase in Grade 12 smoking rates increased the odds that a Grade 10 student was an occasional smoker. It appears that grade of enrolment, senior student smoking behavior, close friend’s smoking behavior and clear rules about smoking at school can impact school-based tobacco control programming. These preliminary study findings suggest the need for further research targeting occasional smoking behavior and the transition stage into high school.

Introduction

Tobacco use is widely acknowledged as the single leading cause of preventable death in Canada and the United States [1, 2]. Estimates suggest that in 2007, smoking would have caused 37 000 deaths in Canada where tobacco use is the major modifiable cause of preventable morbidity and mortality [3]. Despite the health risks associated with tobacco use, a substantial number of Canadian youth continue to smoke. In 2006, \( \sim 12.8\% \) of Canadian youth aged 15–17 were current smokers [4].

Comprehensive reviews have identified numerous individual-based motivational theories that address correlates of smoking among youth, including the health belief model [5], protection motivation theory [6], social cognitive theory [7], theory of reasoned action [8, 9] and theory of planned behavior [10, 11]. However, the theory of triadic influence (TTI), a tobacco-specific behavioral theory, suggests that youth smoking behavior is not only influenced by individual correlates such as intrapersonal factors (e.g. personality traits or self-esteem) and socioenvironmental
factors (e.g. friends and family members) but also by broader contextual factors (e.g. the school environment) [12]. A large body of research has examined the intrapersonal and socioenvironmental domains outlined in the TTI [13, 14], whereas less research has examined factors from the broader contextual domain [15]. Contextual interactions are important because they may show us how a school-level characteristic does not always have the same effect on all students. Understanding these differences will be important to more accurately learn how to tailor and target future programs to the needs of different student populations.

Despite limited evidence, it appears that the school environment represents a broader contextual factor that is associated with youth smoking [12, 14–17], yet it is not clear how these school characteristics directly or indirectly influence smoking behavior. For example, a Cochrane review of school-based smoking interventions [18] suggests that programs and policies are not effective at sustaining smoking reduction, whereas other research suggests that school-based smoking programs and policies can have a positive impact on reducing youth smoking uptake [19–28], especially when targeted to subpopulations of high-risk youth [18, 19, 29], or when tailored to the needs of smoking youth [30, 31]. These conflicting results provide the impetus to explore and evaluate further the impact of school-based prevention programs and policies.

We do know that primary prevention programs that are offered at the elementary school level have had short duration of effect over time. In our previous work [19], we identified that senior students have an effect on the likelihood that younger students will smoke. Further, the increase in occasional smoking rates of 15- to 19-year olds from 1999 to 2006 (17–24%) [4] suggests a need for prevention initiatives that address high school youth. Such shifts in the profile of the smoking population suggest that future research should also consider the influence of programs and policies on youth who exhibit non-daily or occasional smoking behavior patterns. Such insight may be beneficial to inform future prevention initiatives, which will be required for this emerging population [16].

Between 1999 and 2001, Prince Edward Island (PEI) began a province-wide initiative to implement school-based smoking prevention programs and policies banning smoking on all school properties over a 3-year period. This provided a unique natural environment to explore the individual and combined effects of school characteristics such as policies and programs on youth smoking behavior. In our previous paper [19], we examined the impact of policies and programs on senior (Grade 12; age 16–18) students in these same schools. This present study also considers the impact of senior smoking rates, but is unique in that it examines those characteristics among younger students. Therefore, in this paper, we examine how school smoking policies and prevention programs are associated with occasional and regular smoking among Grade 10 (age 15–16) students and compare these findings to existing research with an older student population.

### Methods

#### Design

The cross-sectional analysis used three waves of data (1999–2001) collected from a provincial census sample of 13,131 students (Grades 10–12; age 15–18) attending all 10 English-speaking secondary schools in the province of PEI, Canada. In Year 1 (1999), none of the schools (i) had policies banning smoking on school property or (ii) were participating in provincially directed school-based smoking prevention programs (e.g. Students Working in Tobacco Can Help–SWITCH and Kick the Nic) (Table I). In Year 2 (2000), (i) four of the schools had introduced a policy banning smoking on school property and (ii) the remaining six schools had implemented provincially directed school-based smoking prevention programs (SWITCH and Kick the Nic). In Year 3 (2001), all 10 schools had (i) introduced a policy banning smoking on school property and (ii) implemented the provincially directed school-based smoking prevention programs (SWITCH and Kick the Nic).

Although there is no pure control or experimental group, our study design allows us to develop some
new insights by examining how the presence or absence of a school smoking policy and prevention program at different points in time were associated with the smoking behavior of a particular group of students, in each school, during each wave of data collection. All data were collected using the Tobacco Module of the School Health Action, Planning and Evaluation System (SHAPES); additional details about SHAPES (http://www.shapes.uwaterloo.ca) and the Tobacco Module measures and their psychometric properties are available [32].

### Data collection

To recruit student participants, each school board or principal agreed to generate address labels for the information letters that were mailed directly to parents requesting students’ participation in the study. Parents were asked to either return a signed copy of the postage-paid refusal letter or call a toll-free number (accessible 24 h a day) if they refused their child’s participation. Teachers participated in a short training session and distributed the surveys to the students during class time. Participants were not provided compensation and could decline participation at any time, including during survey administration. Active information with passive consent was used to reduce demands on schools and to increase student participation rates. In accordance with requirements stipulated by ethics, anonymous data collection was required on all surveys so that individual student smoking behavior could not be tracked over time. All procedures, including passive consent, were approved by the University of PEI Research Ethics Board.

### Participants

Among the 13,131 students in Grades 10–12 who participated in the three waves of data collection \((n = 4114\) in 1999, \(n = 4427\) in 2000 and \(n = 4590\) in 2001), only data from the 4,732 students in Grade 10 during each data collection will be used in the present paper \((n = 1534\) in 1999, \(n = 1537\) in 2000 and \(n = 1661\) in 2001). Since the student-level data were not longitudinal, only using data from students in Grade 10 from each wave of data collection helps to ensure that we are not predicting the behavior of the same student at different points in time. Moreover, since the group of Grade 10 students entering the school each year would be new, we are limiting the potential confounding effect of students already being acculturated to the smoking behavior norms within their school context. We recognize that this approach is not ideal and severely limits our ability to infer certain relationships, but it does allow us to examine how programs and/or policies within a school at a given time were associated with smoking onset among the junior students. A similar approach was used previously to examine the impact of school programs and policies on smoking progression among senior students [19].

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**Table I. Prevention programs offered in PEI high schools**

<table>
<thead>
<tr>
<th></th>
<th>Kick the Nic</th>
<th>SWITCH club</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal</strong></td>
<td>Teens learn reasons behind and consequences of their tobacco use, strategies to avoid tobacco, withdrawal coping strategies and ongoing support strategies</td>
<td>Students working in tobacco control for health where programs are designed and delivered by students</td>
</tr>
<tr>
<td><strong>Program content</strong></td>
<td>10 facilitated sessions</td>
<td>Variable by school</td>
</tr>
<tr>
<td></td>
<td>Trained health and education facilitators</td>
<td>Student designed and delivered</td>
</tr>
<tr>
<td><strong>General topics and activities</strong></td>
<td>Program in and outside class about quitting tobacco; games to play with quit programs; tobacco truth sessions; second-hand smoke; tobacco control initiatives and parent and teacher resources</td>
<td>Programs in and outside classes; information sessions; posters; skits; trivia questions; no smokers week; no smoking day events and student participation on community events</td>
</tr>
</tbody>
</table>

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Measures

Outcome variables

Consistent with existing research [19], smokers were defined as current non-smokers—students who had never smoked or had only tried smoking once, occasional smokers—students who smoked less than weekly and regular smokers—students who smoked every week or most days of the week.

School characteristics

School characteristics were operationally defined to be consistent with existing research [19, 24] and were reported at the time of data collection each year. School smoking program and policy were based on whether or not the school was participating in the school-based prevention programming and/or if the school had implemented the school smoking policy. Senior student smoking rate is the prevalence of occasional or regular smoking among the Grade 12 students at a school. The enrolment grade (9 or 10) represents the grade when students first enter the school as new students. School location was measured as urban or rural.

Student characteristics

Student beliefs about school smoking policies were measured by asking: (i) in your school there is a clear set of rules about smoking for students to follow (true/false) and (ii) if a student is caught breaking the smoking rules at your school they get into trouble (true/false). Friend’s smoking behavior was measured by asking students if they have one or more friends who smoke (none/one/two or more smoking friends). Gender was measured as either male or female.

Analyses

Since Grade 10 students were located within schools [creating a two-level nested structure in that individual students (Level 1) were nested within schools (Level 2)], multilevel logistic regression analyses were used to examine how both school and student characteristics were associated with student smoking behavior. The first model examined how school and student characteristics were able to differentiate occasional smokers (1) from current non-smokers (0). The second model examined how school and student characteristics were able to differentiate regular smokers (1) from occasional smokers (0).

Consistent with previous research [19], all analyses controlled for the wave of data collection to adjust for potential differences in between-school variability of the 30 different groups of Grade 10 students over the three waves of data collection (i.e. 10 schools with three different groups of students coming from each school over the three different waves of data collection). Intraclass correlation coefficients were calculated to measure the proportion of the total variance in smoking behavior that were due to school-level differences across each of the 30 groups of students (i.e. school program and/or policy environment during data collection). Contextual interactions between the student and school characteristics were examined; however, only significant interactions are presented in the final models. Statistical analyses were conducted using MLwiN version 1.1 [33].

Results

Significant between-school random variation in occasional smoking \[ \sigma^2_p = 0.118(0.05), P < 0.05 \] was found. The school a Grade 10 student attended was significantly related to his/her likelihood of being an occasional versus a current non-smoker. Between-school random variation in regular smoking \[ \sigma^2_p = 0.007(0.01), P = 0.70 \] was not found. The school a Grade 10 student attended was not significantly related to his/her likelihood of being a regular versus an occasional smoker.

Sample characteristics

Descriptive characteristics of the students’ smoking behaviors are presented in Table II. Complete data were available from 4709 Grade 10 students,
among which there were 3118 (66.2%) current non-smokers, 730 (15.5%) occasional and 861 (18.3%) regular smokers. The sample was 49.2% male and 50.8% female. Although the prevalence of occasional smoking was higher among females than males, 16.9 and 14.0%, respectively, slightly more males (18.7%) were daily smokers compared with females (18%). Overall, regular smokers had more close friends who smoked compared with occasional and current non-smokers. During this same time period, the Canadian Tobacco Use Monitoring Survey reported similar decreased rates of smoking, 28% in 1999 [34], 21% in 2000 [35] and 20.4% in 2001 [36], among PEI youth aged 15–19, an 8% decrease. Further, this data showed that PEI shifted from having the fifth to third lowest provincial smoking rates among this age group [34, 36].

**School characteristics**

The relationships between school smoking policies and programs, student beliefs about school smoking policies and smoking status are presented in Table III. The average senior student smoking rate across the 10 schools at the three different time points was 47.1% (range 33.3–73.1%). Four schools enroll students in Grade 9 and six schools enroll students in Grade 10. Students who started high school in Grade 9 were more likely to be regular and occasional smokers than students who started high school in Grade 10 ($\chi^2 = 31.26$, df = 2, $P < 0.001$).

### Table II. Descriptive statistics for Grade 10 students who are current non-smokers (n = 3118), occasional smokers (n = 730) and regular smokers (n = 861) from 10 high schools in PEI, Canada (1999–2001)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Current non-smokers % (n)</th>
<th>Occasional smokers % (n)</th>
<th>Regular smokers % (n)</th>
<th>Chi square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>67.3 (1561)</td>
<td>14.0 (325)</td>
<td>18.7 (432)</td>
<td>$\chi^2 = 7.65$, df = 2, $P &lt; 0.05$</td>
</tr>
<tr>
<td>Female</td>
<td>65.1 (1557)</td>
<td>16.9 (405)</td>
<td>18.0 (429)</td>
<td></td>
</tr>
<tr>
<td>Clear smoking rules at school</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>False</td>
<td>68.3 (338)</td>
<td>16.1 (80)</td>
<td>15.6 (77)</td>
<td>$\chi^2 = 2.91$, df = 2, $P = 0.234$</td>
</tr>
<tr>
<td>True</td>
<td>65.8 (2728)</td>
<td>15.5 (643)</td>
<td>18.7 (775)</td>
<td></td>
</tr>
<tr>
<td>Students get into trouble for breaking smoking rules</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>False</td>
<td>66.6 (599)</td>
<td>18.3 (165)</td>
<td>15.1 (136)</td>
<td>$\chi^2 = 12.16$, df = 2, $P &lt; 0.01$</td>
</tr>
<tr>
<td>True</td>
<td>66.0 (2452)</td>
<td>14.8 (551)</td>
<td>19.1 (711)</td>
<td></td>
</tr>
<tr>
<td>Number of close friends who smoke</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>76.2 (1763)</td>
<td>15.2 (352)</td>
<td>8.6 (198)</td>
<td>$\chi^2 = 551.44$, df = 10, $P &lt; 0.001$</td>
</tr>
<tr>
<td>1</td>
<td>62.9 (769)</td>
<td>17.1 (209)</td>
<td>20.0 (244)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>54.6 (361)</td>
<td>16.5 (109)</td>
<td>28.9 (191)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>41.9 (88)</td>
<td>13.3 (28)</td>
<td>44.8 (94)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>22.1 (19)</td>
<td>4.7 (4)</td>
<td>73.2 (63)</td>
<td></td>
</tr>
<tr>
<td>5+</td>
<td>35.2 (25)</td>
<td>11.3 (8)</td>
<td>53.5 (38)</td>
<td></td>
</tr>
<tr>
<td>Wave of data collection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>60.8 (932)</td>
<td>19.2 (295)</td>
<td>20.0 (307)</td>
<td>$\chi^2 = 40.25$, df = 4, $P &lt; 0.001$</td>
</tr>
<tr>
<td>2</td>
<td>67.4 (1036)</td>
<td>13.2 (203)</td>
<td>19.4 (298)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>69.9 (262)</td>
<td>14.3 (238)</td>
<td>15.8 (262)</td>
<td></td>
</tr>
</tbody>
</table>
Differentiating occasional smokers from current non-smokers (Model 1)

School characteristics

When compared with a student attending a school without the smoking prevention programs, a student attending a school with the smoking prevention programs was less likely to be an occasional smoker [odds ratio (OR) 0.57, 95% confidence interval (CI) 0.44–0.75]. A student attending a school where first year students were enrolled in Grade 10 was also less likely to be an occasional smoker (OR 0.60, 95% CI 0.42–0.88) when compared with a student attending a school where first year students were enrolled in Grade 9. Each 1% increase in the smoking rate among Grade 12 students at a particular school increased the odds that a Grade 10 student at that particular school was an occasional smoker (Fig. 1).

Table III. Multilevel logistic regression of school-level smoking programs, policies and student-level beliefs associated with student smoking behavior in 4709 high school students in PEI, Canada (1999–2001)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Adjusted ORa (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1b</td>
</tr>
<tr>
<td></td>
<td>Occasional smoker</td>
</tr>
<tr>
<td></td>
<td>versus current non-smoker</td>
</tr>
<tr>
<td>School characteristics</td>
<td></td>
</tr>
<tr>
<td>School smoking programs and policies</td>
<td>1.00</td>
</tr>
<tr>
<td>No smoking programs or policies</td>
<td></td>
</tr>
<tr>
<td>Smoking program only</td>
<td>0.57 (0.44, 0.75)***</td>
</tr>
<tr>
<td>Smoking policy only</td>
<td>0.72 (0.50, 1.03)</td>
</tr>
<tr>
<td>Smoking programs and policies</td>
<td>1.54 (0.79, 3.01)</td>
</tr>
<tr>
<td>Senior student smoking rate</td>
<td>1.00</td>
</tr>
<tr>
<td>Each 1% increase in Grade 12 smoking rate at a school</td>
<td>1.02 (1.00, 1.04)*</td>
</tr>
<tr>
<td>Grade when students first enter the school</td>
<td></td>
</tr>
<tr>
<td>Grade 9</td>
<td>1.00</td>
</tr>
<tr>
<td>Grade 10</td>
<td>0.60 (0.42, 0.88)**</td>
</tr>
<tr>
<td>Student characteristics</td>
<td></td>
</tr>
<tr>
<td>Clear smoking rules at school</td>
<td>1.00</td>
</tr>
<tr>
<td>False</td>
<td></td>
</tr>
<tr>
<td>True</td>
<td>1.30 (0.94, 1.80)</td>
</tr>
<tr>
<td>Students get into trouble for breaking smoking rules</td>
<td>1.00</td>
</tr>
<tr>
<td>False</td>
<td>1.00</td>
</tr>
<tr>
<td>True</td>
<td>0.73 (0.58, 0.91)**</td>
</tr>
<tr>
<td>Number of close friends who smoke</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>1.00</td>
</tr>
<tr>
<td>1</td>
<td>1.40 (1.14, 1.70)*</td>
</tr>
<tr>
<td>2 or more</td>
<td>1.24 (0.96, 1.61)</td>
</tr>
<tr>
<td>Contextual interactions</td>
<td></td>
</tr>
<tr>
<td>Smoking program only by having two or more close friends who smoke (refer to Fig. 2)</td>
<td></td>
</tr>
<tr>
<td>Smoking programs and policies by clear smoking rules at school (refer to Fig. 3)</td>
<td></td>
</tr>
</tbody>
</table>

Model 1: 1, occasional smoker (n = 730); 0, never smoker (n = 3118) and Model 2: 1, regular smoker (n = 861); 0, occasional smoker (n = 730).

aORs are adjusted for all other variables in the table.
bControlling for gender, school location and wave of data collection.

*P < 0.05, **P < 0.01, ***P < 0.001.
Student characteristics

A student who believed that students get into trouble for breaking the school smoking rules was at a decreased risk for being an occasional smoker (OR 0.73, 95% CI 0.58–0.91) compared with a student who did not believe students get into trouble. Conversely, if a student had one close friend who smoked, he/she was at increased risk for occasional smoking (OR 1.40, 95% CI 1.14–1.70) compared with a student with no smoking friends.

Contextual interactions

The first significant contextual interaction was between the presence of smoking programs at a school and a student having two or more close friends who smoke (Fig. 2). Attending a school with smoking programs only was associated with a decreased risk of occasional smoking among students with no smoking friends. However, students who had two or more smoking friends were at a substantially increased risk for occasional smoking if they attended a school with smoking programs only.

Fig. 1. Model-based estimated OR for being an occasional smoker versus a current non-smoker as a function of the senior student smoking rate at a school. The model-based ORs of a student being an occasional smoker relative to a student at a hypothetical school with a 30% senior student smoking rate are presented.

Fig. 2. Model-based estimated OR for being an occasional smoker versus a current non-smoker as a function of school smoking programs and the number of close friends who smoke. Using the model estimates, the odds of a student being an occasional smoker can be estimated as a function of whether or not the school has smoking programs and the number of close friends a student has who smoke. In Fig. 2, the model-based ORs of a student being an occasional smoker relative to a hypothetical student who has no smoking friends at a hypothetical school without school smoking programs are presented.
The second significant contextual interaction was between the presence of both smoking programs and policies at a school and beliefs about smoking rules at school (Fig. 3). Attending a school with both smoking programs and policies was associated with a decreased risk of occasional smoking among students who believed that there were clear smoking rules for students to follow at the school. However, students who did not believe there were clear smoking rules were at a substantially increased risk for occasional smoking if they attended a school with smoking programs and policies.

Differentiating regular smokers from occasional smokers (Model 2)

School characteristics
When compared with a student attending a school without the smoking policy, a student attending a school with the smoking policy was more likely to be a regular smoker (OR 1.54, 95% CI 1.04–2.29).

Student characteristics
A student who believed that students get into trouble for breaking the school smoking rules was at an increased risk for being a regular smoker (OR 1.53, 95% CI 1.13–2.08) compared with a student who did not believe students get into trouble. Similarly, if a student had one close friend who smoked (OR 1.99, 95% CI 1.53–2.59) or two or more close friends who smoked (OR 4.76, 95% CI 3.64–6.23), he/she was at an increased risk for regular smoking compared with a student with no smoking friends.

Contextual interactions

There were no significant contextual interactions identified that were associated with the likelihood of a Grade 10 student being a regular smoker.

Discussion

Even though comprehensive approaches to youth tobacco control prevention programming are recommended [13], our results suggest that the school tobacco control prevention program implemented in PEI was not associated with a decreased risk of occasional or regular smoking among Grade 10 students who attended the schools with the most increased risk for being a regular smoker.

![Fig. 3. Model-based estimated OR for being an occasional smoker versus a current non-smoker as a function of school smoking programs and policies and beliefs about smoking rules at school. Using the model estimates, the odds of a student being an occasional smoker can be estimated as a function of whether or not the school has smoking programs, policies and beliefs about whether or not the school has clear rules about smoking for students to follow. In Fig. 3, the model-based ORs of a student being an occasional smoker relative to a hypothetical student who does not believe his/her school has clear rules about smoking at a hypothetical school without both school smoking programs and policies are presented.](chart.png)
comprehensive programming (i.e. programs and policies). However, consistent with previous research, we did identify that the characteristics of the school a student attends are associated with his/her likelihood of smoking [15, 19, 28, 37].

Specifically, we found that the presence of school tobacco control programs and policies were both independently associated with the risk of smoking among students [19] and that the prevalence of smoking among older students at a school was associated with the risk for occasional smoking among students at a school [24, 37]. These empirical findings, when coupled with the theoretical literature (e.g. the TTI), provide additional evidence that characteristics of the school environment can play an important role in the smoking behavior of student populations [12]. As such, there is a need to better understand the factors within schools that are related to student smoking behavior.

The present study was also the first to identify that the grade when students are first enrolled into secondary school may be associated with their likelihood of occasional smoking. Specifically, a student who first enrolled in his/her high school in Grade 9 rather than Grade 10 was at an increased risk of occasional smoking. This new finding suggests that not only do the characteristics of the school a student attends place them at risk for smoking onset but also the timing of when students transition into different school environments. Although several studies have investigated the reasons why students begin to smoke during transition periods [17, 38, 39], the timing of the transition to high school has generally been ignored. Additional research is required to duplicate this finding and to explore the causal mechanisms so that the appropriate preventative measures may be developed.

Our finding, that the smoking behavior of older students at a school was associated with younger student smoking behavior, is consistent with previous research [16, 24]. It has been suggested that the smoking behavior of senior students (role models) may be a catalyst for the uptake of smoking among the junior students due to a misperception by younger students that smoking is acceptable behavior for that school [40–42], that cigarettes will be available to them [43] and that they can infiltrate friendship circles of senior student smokers by initiating smoking [44, 45]. Interestingly, it has previously been suggested that a senior student smoking rate >30% creates a school environment that places students at noticeably greater risk for smoking onset [24, 29]. In this study, the average senior smoking rate was 48%, which is cause for concern. This insight may suggest that practitioners consider using senior smoking rates as a method for identifying high-risk schools (i.e. the schools with the highest rates of senior student smoking) that may benefit the most from additional prevention activities. Additional research is required to replicate and evaluate the benefits of such a targeted approach to prevention programming.

Students who attended schools with prevention programming only were at reduced risk for occasional smoking. This finding is supported by our previous study with Grade 12 students [19], but contrary to some of the existing empirical evidence that suggests such programs have had mixed success in preventing or reducing youth smoking [46–48]. However, our finding is consistent with previous research [30, 31], which identified programs that are tailored to the needs of smoking youth are effective at reducing smoking uptake. It may be that the programs being examined in the present study were not targeted to specific schools for any particular reason, which may explain why they were not effective. If they had been targeted to where they were needed most, the findings may have been different.

We also identified that students attending schools with smoking policies were more likely to be regular smokers than students attending schools without the policy. Although this appears contrary to empirical evidence suggesting that school smoke-free policies have a positive impact on reducing smoking uptake [14, 23, 26, 49], our finding is consistent with research suggesting that policies on their own are not effective [13, 19] and that prevention initiatives need to be tailored to the specific needs of schools [30–32].

These new findings, coupled with our previously reported results [19], suggest that practitioners need to reevaluate how school-based prevention programs
and policies are implemented. For instance, targeting prevention efforts that address the school environment, particularly in high-risk schools (i.e. where high percentages of senior students smoke and in schools that only have smoking policies without accompanying prevention programs), may provide more effective prevention initiatives for decreasing smoking. However, the preliminary nature of these findings warrants further research.

**Contextual interaction**

Consistent with previous research [17, 19, 24, 38], our findings illustrate that students were at a substantial risk for occasional smoking if they reported having close friends who smoke and if they attended schools with smoking prevention programs. For instance, if a Grade 10 student had no smoking friends, prevention programs on their own did decrease the risk of being an occasional smoker (Fig. 2). However, if a student had two or more smoking friends, prevention programs were a risk factor for smoking. How a program puts students at risk might be explained by the complex interplay of developmental, physical, social and environmental factors that are linked to youth smoking behavior.

Smoking uptake may be associated with developmental changes that adolescents experience, including increased curiosity about tobacco use or defiance of new policies and programs. Further, the social situations that students are experiencing with close friends may provide social access to cigarettes [50]. However, because high school is a time of changing friendships, caution must be used in our interpretation of the role of friendships on smoking behavior. For example, more refined studies [51, 52] have shown that the relationship between smoking behavior and close friendships is strongly linked to social selection of friends as well as social influence particularly between non-reciprocal and reciprocal friends.

Moreover, developmental changes in friendship patterns may create the social context where youth embrace new social roles and experience higher need for emotional and social connectedness to peers, while modeling the behaviors of initially peers and later adult role models [53]. Similar to our findings with Grade 12 students [19], these findings may suggest that further analysis of programs deemed ineffective might include a specific evaluation of outcomes among occasional smoking populations.

Students attending schools where both smoking prevention programs and smoking policies are in place were less likely to be at risk for occasional smoking when they believed there were clear smoking rules. However, students were at substantial risk for occasional smoking when they did not believe that there were clear smoking rules. These findings are contrary to studies that caution about the counter effects of enforcement of smoking rules for secondary schools [20, 22]. However, the findings are consistent with previous work [23, 27, 54, 55] that describe multifaceted approaches of successful comprehensive school programs, including smoking prevention initiatives, policy enforcement, curriculum and smoking restrictions when on school grounds, near and/or leaving school property.

**Limitations**

Despite the promising and novel findings of the current study, there are limitations that need to be considered. It is not possible to generalize the findings because of the small sample of schools and the inability to link students from one wave of data collection to the next. Therefore, we cannot infer causality for whether or not the findings were directly related to the policy or program. The positive changes in smoking behavior may be a reflection of >20 years of health promotion and prevention initiatives that have addressed the burden and harm from cigarette use. Moreover, other environments and experiences that junior students have lived may also be responsible for their smoking behavior. As such, additional study is required on the contextual influence of schools as well as other environments on youth smoking behavior.

There may have been a selection bias in the sample due to the small sample size and the convenience sampling method. It will be important that future studies attempt to randomly select students to
increase the representativeness of the sample and to follow those students over time rather than following schools over time. Further, because of an inconsistency in documentation of the student data by classroom, we were unable to use class as a level of analysis which may have allowed us to link the data sets across the three waves for a more robust analysis.

Data were based on self-reports, so the validity of the responses may be questioned. For instance, students reported on their friends’ smoking status and as a result, the findings may have overestimated close friends’ smoking influence [56]. This overestimation may be a reflection of adolescents’ misperception that they are more similar to their friends than is actually the case [57]. Also, there were only 30 different groups of students clustered within 10 different schools, so it is likely that this study would be underpowered to identify weaker associations if we were testing particular hypotheses rather than performing exploratory analyses between school-level characteristics and individual student behaviors. Finally, we were unable to consider cognitive determinants which are known to influence individual smoking behavior because this type of information was not available from the survey instrument that we used for this study.

**Conclusion**

Characteristics of the school and student beliefs about policies appear to be associated with smoking behavior of youth. Comprehensive programming that included both policies and programs was not associated with decreased risk of smoking for Grade 10 students. However, programming that addresses the influence of senior student smoking behavior, grade of enrolment for high school, the influence of close friends and clear rules surrounding smoking policies may be important to future smoking prevention initiatives for Grade 10 students. Further study is required to determine if similar results will be found with larger population of schools and from other provincial (or state) jurisdictions.

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**Conflict of Interest Statement**

None declared.

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