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# Are experimental smokers different from their never-smoking classmates? A multilevel analysis of Canadian youth in grades 9 to 12

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## Abstract

**Introduction:** Understanding the characteristics of experimental smoking among youth is critical for designing prevention programs. This study examined which student- and school-level factors differentiated experimental smokers from never smokers in a nationally representative sample of Canadian students in grades 9 to 12.

**Methods:** School-level data from the 2006 Canadian Census and one built environment characteristic (tobacco retailer density) were linked with data from secondary school students from the 2008–2009 Canadian Youth Smoking Survey and examined using multilevel logistic regression analyses.

**Results:** Experimental smoking rates varied across schools ( $p < .001$ ). The location (adjusted odds ratio [AOR] = 0.66, 95% CI: 0.49–0.89) of the school (urban vs. rural) was associated with the odds of a student being an experimental smoker versus a never smoker when adjusting for student characteristics. Students were more likely to be experimental smokers if they were in a lower grade, reported low school connectedness, used alcohol or marijuana, believed that smoking can help people relax, received pocket money each week and had a family member or close friend who smoked cigarettes.

**Conclusion:** School-based tobacco prevention programs need to be grade-sensitive and comprehensive in scope; include strategies that can increase students' attachment to their school; and address multi-substance use, tobacco-related beliefs and the use of pocket money. These programs should also reach out to students who have smoking friends and family members. Schools located in rural settings may require additional resources.

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**Keywords:** tobacco smoking, youth, prevention, multilevel analysis, Canada

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## Introduction

Despite the proven harmful outcomes of smoking, youth smoking rates remain high in North America.<sup>1–4</sup> More than 16% and 20% of all annual deaths in Canada and the United States, respectively, result from tobacco-related diseases.<sup>2,5,6</sup> Lifetime smoking often commences as naive experi-

mentation during adolescence and develops into a habit that is difficult to break.<sup>7</sup> Most adult smokers initiated smoking during their teenage years.<sup>3</sup> Evidence also suggests that adolescent smoking behaviour consists of distinct smoking trajectories or stages: susceptible never smokers, experimenters and established (or current) smokers.<sup>8–10</sup> Differentiating between these

smoking stages is important to public health practitioners and educators who need to design prevention and intervention programs to match the risk and protective factors in these different stages.

A majority of studies examine established smoking stages.<sup>10–17</sup> Considering that approximately three-quarters of students will experiment with smoking at least once before completing high school<sup>18,19</sup> and that about one-third will become established smokers,<sup>20</sup> understanding the factors that differentiate experimental smokers from never smokers is critical to informing the development of the tobacco control programs designed to discourage students from experimenting with cigarettes.

Many researchers have used the Theory of Triadic Influence (TTI)<sup>21</sup> to understand the complex factors associated with adolescent smoking behaviour. TTI postulates that youth smoking behaviour is influenced by a combination of and interaction between intrapersonal, social context and broader societal influences. Intrapersonal risk factors associated with experimental smoking include age,<sup>22</sup> male sex,<sup>23</sup> use of alcohol or illicit drugs,<sup>22</sup> access to pocket money,<sup>24</sup> low school connectedness,<sup>25</sup> positive attitudes towards smoking<sup>26</sup> and perceiving clear school rules about smoking.<sup>27</sup> Existing social context influences include smoking family members<sup>22,23</sup> or friends.<sup>22,27</sup> The broader societal (or school-level) factors associated with experimental smoking include attending a school with a relatively high smoking rate in senior grades,<sup>27</sup> high

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density of tobacco retailers around the school<sup>28</sup> and living in a home that does not have a total ban on smoking.<sup>29</sup> Chan and Leatherdale<sup>30</sup> explored the relationship between tobacco retailers and smoking *susceptibility*, *occasional* smoking and *established* smoking. They reported that the number of tobacco retailers located around a school was associated only with smoking susceptibility.<sup>30</sup> Other societal factors associated with *established* (not experimental) smoking include school location<sup>31-33</sup> and neighbourhood socioeconomic status (SES).<sup>31,32,34,35</sup>

Nevertheless, there is a dearth of literature on the influence of school location (urban vs. rural), tobacco retailer density and the SES of the community around a school on students' experimental smoking when adjusting for other student-level factors. Because these school-level factors have previously been found to be associated with established smoking,<sup>31-38</sup> we were interested in finding out whether these factors were also associated with experimental smoking among adolescents. As such, the purpose of this study was to examine which school neighbourhood and student-level characteristics differentiate experimental smokers from never smokers. Understanding these factors will provide new insight for public health practitioners and educators who develop smoking prevention strategies that effectively target youth in different stages of smoking. The authors have also written on the factors associated with current (or established) smoking.<sup>39</sup>

## Methods

### Design

The 2008–2009 Canadian Youth Smoking Survey (2008 YSS) is a nationally representative cross-sectional, school-based survey that is used to measure the determinants of youth smoking behaviour. It is a valid and reliable machine-readable, pencil and paper study.<sup>40</sup> (See Elton-Marshall et al.<sup>41</sup> and [www.yss.uwaterloo.ca](http://www.yss.uwaterloo.ca) for detailed information on the survey development, design, survey weights and data collection protocol.) In

brief, the target population consisted of all young Canadian residents in the appropriate grades attending public or private schools in all 10 provinces in Canada. The sample design was based on a stratified multistage design. The survey took about 20 to 30 minutes, and to ensure confidentiality, students placed completed questionnaires in an envelope that was sealed and placed in a larger classroom envelope. The University of Waterloo Office of Research and Ethics approved the survey methods.

### Participants

The sample for this study was from the secondary school portion of 2008 YSS. This portion was administered to all sampled grade 9 to 12 students ( $n = 29\,296$ ) attending 133 schools from all 10 Canadian provinces. The student response rate was 73.2%.<sup>41</sup> Our study used only the subset of 18 072 students who were experimental or never smokers.

### Data sources and measures

#### Outcome variables

Based on other research,<sup>13,28,42,43</sup> we defined “experimental smokers” as those who had smoked in the last 30 days before the survey but had not smoked 100 cigarettes in their lifetime. This group was compared with “never smokers,” defined as those who reported never having smoked even a puff of a cigarette.<sup>40</sup>

#### Student (intrapersonal and social context) and school-level (broader societal) correlates

Selection of all variables was guided by TTI<sup>21</sup> and our literature review. We coded the intrapersonal factors (sex, grade, alcohol or marijuana use, pocket money, school connectedness, knowledge and attitude towards tobacco, and perception of school smoking rules) and social context measures (parents', siblings' and friends' smoking status) as listed in Table 1. Two school-level neighbourhood characteristics from the 2006 Canadian Census (i.e., location [urban vs. rural] and median household income, which is a proxy measure for school neighbourhood SES) were linked with the 2008 YSS

dataset, as has been done by other researchers.<sup>44,45</sup> Both school location and median household income data were derived from school postal codes using the Postal Code Conversion File that links between the postal code and Statistics Canada's standard 2006 Census geographical areas<sup>46</sup> (see Table 1). The 2008/09 Enhanced Points of Interest (EPOI) data file from Desktop Mapping Technologies Inc.<sup>47</sup> provided numerical data on the number of tobacco retailers located within a 1-kilometre radius of each school (Table 1).

### Statistical data analyses

We used multilevel logistic regression to analyze the two-level nested data because it accounts for the clustering (interdependence) of students within schools by allowing the model intercept to vary across schools.<sup>48</sup> This produces accurate standard errors and reduces the likelihood of type 1 error.<sup>49</sup> Like other researchers,<sup>27</sup> we used a four-step modelling procedure. Model 1 is a null model computed to assess whether there was significant within-cluster interdependence to warrant the use of a multilevel approach. The main purpose for Model 2 was to determine the school-level variables that would directly affect the likelihood of a student being an experimental smoker rather than a never smoker. Model 3 used a random coefficient regression model to assess the strength of the direct effects of both the school- and student-level correlates.

Model 4 was developed to assess the contextual interactions between the school-level and student-level predictor variables. The SAS PROC GLIMMIX<sup>50</sup> procedure provided the initial estimates that were used in the PROC NL MIXED analysis for each model. Predictor variables that were not significant at  $p < .05$  were removed until the final model only contained predictor variables that were significant at that  $p$  value. The intraclass correlation (ICC) measures the proportion of the total variance that occurs between schools. The  $\sigma^2_{\mu}$  denotes the school-level variance, whereas the logistic distribution for the individual residual implies a

**TABLE 1**  
List of variables included in the analysis

TTI domain	Specific question asked or how variable was derived	Coding for analysis
<b>Student-level intrapersonal</b>		
Grade	What grade are you in?	9, 10, 11, 12
Sex	Are you female or male?	0 = female 1 = male
Pocket money	About how much money do you usually get each week to spend on yourself or save?	0 = \$0 1 = \$1–20 2 = \$21–100 3 = \$101 +
Alcohol use	In the last 12 months, how often did you have a drink of alcohol that was more than just a sip? 1 = I have never drank alcohol; 2 = I did not drink alcohol in the last 12 months; 3 = I have only had a sip of alcohol; 4 = Every day; 5 = 4 to 6 times a week; 6 = 2 or 3 times a week; 7 = Once a week; 8 = 2 or 3 times a month; 9 = Once a month; 10 = Less than once a month. 11 = “I do not know” was not a valid response	0 = I have never drank alcohol 1 = Any use (options 2 to 10)
Marijuana use	In the last 12 months, how often did you use marijuana or cannabis? (a joint, pot, weed, hash...) 1 = I have never used marijuana; 2 = I have used marijuana but not in the last 12 months; 3 = Every day; 4 = 4 to 6 times a week; 5 = 2 or 3 times a week; 6 = Once a week; 7 = 2 or 3 times a month; 8 = Once a month; 9 = Less than once a month. 10 = “I do not know” was not a valid response	0 = I have never used marijuana 1 = Any use (options 2 to 9)
School connectedness	Students were asked whether they 1) felt close to people at school; 2) felt part of their school; 3) were happy at school; 4) felt that the teachers at school treated them fairly; and 5) felt safe at school. The responses were given on a 4-point Likert Scale. The five items of the school connectedness score were summed to give a final score from 0 to 5. Higher scores represented greater perception of school connectedness. This summation was consistent with previous literature, and the internal consistency of this scale was adequate ( $\alpha = 0.86$ ). <sup>16</sup>	0 = strongly disagree/disagree 1 = strongly agree/agree
Knowledge	Do people have to smoke for many years before it will hurt their health?	0 = no or I do not know 1 = yes
	Is there any danger to your health from an occasional cigarette?	0 = no or I do not know 1 = yes
Beliefs	Does smoking help people relax?	0 = no or I do not know 1 = yes
School rules	This school has a clear set of rules about smoking for students to follow. The responses were given on a 4-point Likert Scale, i.e. true, usually true, usually false, false and recoded as shown in right-hand column.	0 = usually false/false/I do not know 1 = true/usually true
<b>Student-level social context</b>		
Parent(s) smoke(s)	Do any of your parents, step-parents, or guardians smoke cigarettes?	0 = no or I do not know 1 = yes
Sibling(s) smoke(s)	Do any of your brothers or sisters smoke cigarettes?	0 = no or I do not know or I have no brothers or sisters 1 = yes
Friend(s) smoke(s)	How many of your closest friends smoke cigarettes?	0 = 0, 1 = 1, 2 = 2, 3 = 3, 4 = 4, 5 = 5 or more

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variance of  $\pi^2/3 = 3.29$ . This formula considers that the observed binary response actually represents a threshold continuous variable where 0 is observed below the threshold and 1 above.<sup>48</sup>

All analyses used SAS version 9.2 (SAS Institute Inc., Cary, NC, US).<sup>50</sup>

## Results

### *Student- and school-level characteristics*

Of the sample of grade 9 to 12 students, 16 044 (54.8%) were classified as never smokers and 2028 (6.9%) were classified as experimental smokers. The remainder

were not included in our study. Boys made up 51% of the sample. The prevalence of experimental smoking did not differ by sex ( $\chi^2 = 0.02$ ;  $p = 0.89$ ;  $df = 1$ ). With that exception, all other student characteristics tested were significant ( $p < .001$ ).

**TABLE 1 (continued)**  
**List of variables included in the analysis**

TTI domain	Specific question asked or how variable was derived	Coding for analysis
<b>School-level broader societal</b>		
Location	School location was derived from the school postal codes using the Postal Code Conversion File that provided a link between the postal code and Statistics Canada's standard Census geographical areas. <sup>46</sup> For the analysis, areas were classified as rural (Census population < 50 000) or urban (Census population ≥ 50 000).	0 = rural 1 = urban
SES	2006 Census median household income data were used as a proxy measure for school-level SES, as has been done in previous studies. <sup>44</sup> This variable is continuous and the unit change was in intervals of \$10 000 for ease of interpretation.	Numeric data by units of \$10 000
Tobacco retailer density	2008/09 DMTI and EPOI data provided numeric data about the number of tobacco retailers within a 1 km radius of each sampled secondary school. The EPOI data file consists of a national database of more than 1.6 million Canadian business and recreational points of interest ( <a href="http://www.dmtispatial.com">http://www.dmtispatial.com</a> ). DMTI-EPOI data were obtained through geocoding the address for each participating school using Arcview 3.3 software. <sup>47</sup> A 1 km radius was selected as representative of the distance most high school students would walk to and from their school. <sup>44</sup>	Numeric (each 1 unit change)

**Abbreviations:** DMTI, Desktop Mapping Technologies Inc.; EPOI, Enhanced Points of Interest; SES, socio-economic status; TTI, Theory of Triadic Influence; YSS, Youth Smoking Survey.

The proportion of experimental smokers increased from grade 9 to 12; as the number of friends who smoke increased from 1 to 5; and as the amount of weekly pocket money increased (Table 2). The percentage of experimental smokers who used marijuana (36.8%) or alcohol (14.2%) was strikingly higher than the percentage of experimental smokers who did not use marijuana (2.4%) or alcohol (1%).

Of the total sample of 133 secondary schools, 69 were located in urban areas. The average experimental smoking rate among students in grades 9 to 12 in the 133 secondary schools was 6.2% (range, 0%–17.4%), and this was lower in urban schools (5.7%) than in rural schools (6.6%). The percentage of experimental smokers (11.1%; 1325/11 977) in urban schools did not significantly differ from that in rural schools (11.5%; 703/6095). The mean number of tobacco retailers within a 1-kilometre radius of the schools was 5.8 (standard deviation [SD] 10; range, 0–49 km). The mean household income within the postal code around each school was \$56 424 (SD \$14 574; range, \$30 784–\$97 706).

### *Multilevel analysis of experimental smoking*

Table 3 shows results of the multilevel logistic regression analyses. The results from the null model (Model 1) showed a significant between-school random variation (Estimate [Standard Error (SE)] = 0.23 [0.05];  $p < .001$ ) in the likelihood of experimental smoking among grade 9 to 12 students. The estimates suggest that the school a student attends accounts for 6.5% of the variability in their likelihood of being an experimental smoker versus a never smoker. Model 2 results show that only school location was important, as students in urban schools were less likely to be experimental smokers than never smokers (adjusted odds ratio [AOR] = 0.74, 95% CI: 0.60–0.91) compared to students in rural schools. This neighbourhood characteristic explained 11.9% of the between-school variability in the likelihood of a student being an experimental smoker. The number of tobacco retailers within a 1-kilometre radius around a school was not associated (AOR = 0.99, 95% CI: 0.97–1.01) with experimental smoking. Additionally, the median household income that was used as a proxy measure for school neighbourhood SES was not associated (AOR = 0.93,

95% CI: 0.86–1.01) with the likelihood of a student being an experimental smoker versus a never smoker.

Model 3 identified the school-level characteristics that were significantly associated with the odds of a student being an experimental smoker when adjusting for student-level characteristics. When we first examined each of the three school-level variables separately (adjusting for the student-level variables), the location (AOR = 0.62, 95% CI: 0.46–0.82; urban vs. rural; data not shown) and the neighbourhood SES (AOR = 0.88, 95% CI: 0.79–0.98; data not shown) where schools were located were significantly associated with the odds of a student being an experimental smoker. However, when we put all the school-level (location, SES and number of tobacco retailers) and student-level variables in one final model, only school location (urban vs. rural) remained significant (AOR = 0.66, 95% CI: 0.49–0.89; see Table 3). None of the contextual interactions in Model 4 (results not shown) were associated with the outcome variable.

In summary, the final model suggests that there were no sex differences (AOR = 1.00, 95% CI: 0.86–1.16) in the

**TABLE 2**  
**Descriptive statistics (weighted) for secondary students by smoking category, Canadian Youth Smoking Survey, 2008 (n = 18 072)**

Characteristics	Experimental smokers (n = 2028)	Never smokers (n = 16 044)
Sex, %		
Male	11.2	88.8
Female	11.3	88.8
Grade, %		
9	8.4	91.6*
10	9.7	90.3
11	12.5	87.5
12	15.7	84.3
Weekly pocket money in \$, %		
0	4.8	95.2*
1–20	8.8	91.2
21–100	14.6	85.4
> 100	17.4	82.6
Alcohol use, %		
No	1.0	99.0*
Yes	14.2	85.8
Marijuana use, %		
No	2.4	97.6*
Yes	36.8	63.2
Do people have to smoke for many years before it will hurt their health?, %		
No	15.9	84.1*
Yes	9.9	90.1
Is there any danger to your health from an occasional cigarette?, %		
No	15.6	84.4*
Yes	9.7	90.3
Does smoking help people relax?, %		
No	4.4	95.6*
Yes	18.4	81.6
Mean school connectedness score (SD)	3.75 (1.47)	4.20 (1.27)*
Perception of clear smoking rules, %		
No	7.9	92.1*
Yes	12.1	87.9
At least one parent smokes, %		
No	8.4	91.7*
Yes	16.6	83.4
At least one sibling smokes, %		
No	9.3	90.7*
Yes	22.8	77.2
Number of friends who smoke, %		
0	2.4	97.6*
1	16.6	83.4
2	25.5	74.5
3	36.2	63.8
4	32.4	67.6
5	41.6	58.4

**Abbreviation:** SD, standard deviation.

**Note:** Weighted Chi-square tests used for categorical variables and independent t-tests used for continuous variable i.e. mean school connectedness score.

\*  $p < .001$ .

likelihood of a student being an experimental smoker versus a never smoker. The odds of a student being an experimental smoker decreased when they attended an urban school (AOR = 0.66, 95% CI: 0.49–0.89) compared with a rural school. In terms of student-level findings, students who were in grade 10 and 11 were less likely to be experimental smokers than never smokers compared with those who were in grade 9 (grade 10 vs. grade 9: AOR = 0.75, 95% CI: 0.61–0.93; Grade 11 vs. grade 9: AOR = 0.71, 95% CI: 0.57–0.89). On the other hand, the odds of a student being an experimental smoker versus a never smoker increased with the amount of weekly pocket money they had to spend (\$1–\$20 vs. no pocket money: AOR = 1.59, 95% CI: 1.20–2.11; > \$100 vs. no pocket money: AOR = 2.23, 95% CI: 1.66–2.99); a student's belief that smoking can help people relax (AOR = 3.37, 95% CI: 2.85–3.97); a student's perception that there are clear school rules on smoking (AOR = 1.56, 95% CI: 1.27–1.92); low school connectedness (AOR = 0.87, 95% CI: 0.83–0.92); and alcohol use (AOR = 3.51, 95% CI: 2.41–5.12). Marijuana use appeared to be very important as the odds of a student being an experimental smoker was more than 15 times higher (AOR = 15.4, 95% CI: 12.96–18.26) if the student reported using marijuana.

In terms of social context correlates, a student who reported that at least one parent (AOR = 1.29, 95% CI: 1.11–1.50) or sibling (AOR = 1.45, 95% CI: 1.22–1.73) smoked cigarettes was at an increased risk of being an experimental smoker versus a never smoker. In addition, the odds of a student being an experimental smoker increased significantly as the number of closest friends who smoke cigarettes increased, that is, AOR ranged from 3.69 (95% CI: 2.96–4.59) for one close friend versus no friends who smoke) to AOR of 10.52 (95% CI: 7.10–15.60) for four close friends versus no friends who smoke. Between schools variation was not accounted for by these student-level factors. School-to-school variation remained significant even after adjusting for student-level factors.

**TABLE 3**  
**Multilevel logistic regression analysis of the student- and school-level variables that were related to the odds of being an experimental smoker versus a never smoker, Canadian Youth Smoking Survey, 2008 (n = 18 072)**

Characteristics	Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>
	Model estimates (SE)	AOR (95% CI)	AOR (95% CI)
<b>Student-level intrapersonal factors</b>			
Sex			
Girl (Ref)	—	—	1.0
Boy	—	—	1.00 (0.86–1.16)
Grade			
9 (Ref)	—	—	1.0
10	—	—	0.75 (0.61–0.93)*
11	—	—	0.71 (0.57–0.89)*
12	—	—	0.82 (0.64–1.05)
Weekly pocket money, \$			
0 (Ref)	—	—	1.0
1–20	—	—	1.59 (1.20–2.11)*
21–100	—	—	2.03 (1.54–2.68)**
> 100	—	—	2.23 (1.66–2.99)**
Does smoking help people relax?			
No (Ref)	—	—	1.0
Yes	—	—	3.37 (2.85–3.97)**
Do people have to smoke for many years before it will hurt their health?			
No (Ref)	—	—	1.0
Yes	—	—	0.66 (0.55–0.79)**
Is there any danger to your health from an occasional cigarette?			
No (Ref)	—	—	1.0
Yes	—	—	0.62 (0.52–0.73)**
There are clear school rules on smoking			
No (Ref)	—	—	1.0
Yes	—	—	1.56 (1.27–1.92)**
Alcohol use			
No (Ref)	—	—	1.0
Yes	—	—	3.51 (2.41–5.12)**
Marijuana use			
No (Ref)	—	—	1.0
Yes	—	—	15.4 (12.96–18.26)**
Mean connectedness score	—	—	0.87 (0.83–0.92)**
<b>Student-level social context factors</b>			
At least one parent smokes			
No (Ref)	—	—	1.0
Yes	—	—	1.29 (1.11–1.50)*
At least one sibling smokes			
No (Ref)	—	—	1.0
Yes	—	—	1.45 (1.22–1.73)**

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## Discussion

Since some youth experience nicotine dependence within as little as a day after first inhaling cigarette smoke,<sup>22</sup> dissuading them from experimenting with cigarettes is an important way of preventing smoking. Our study identified four notable findings valuable to future tobacco control prevention programming. First, the likelihood of a student being an experimental smoker varied significantly across schools, a finding consistent with other research on youth smoking behaviour.<sup>27,51</sup> This suggests that the characteristics of a student's school are associated with the likelihood that they will be an experimental smoker above and beyond the individual student's characteristics. Although school accounted for a modest 6.5% of the variability, when distributed across the broader secondary school population in Canada, it represents a notable amount of variation that cannot be ignored.

Second, our results supported TTI and also expanded on existing literature<sup>31–35</sup> by showing that variables related to school location (i.e. rural vs. urban setting and the school neighbourhood SES [when analyzed alone]) were associated with experimental smoking after controlling for student-level characteristics. However, stronger and more in-depth studies would be necessary to help public health practitioners identify the specific characteristics in rural schools or schools located in low SES neighbourhoods that predispose students to experimental smoking.<sup>31–35</sup> Moreover, school location (urban vs. rural), neighbourhood SES and tobacco retailer density only explained part of the between-school variability; more surveillance activities are required to evaluate other types of school-level data such as linkages with the community and media and the role of school-based tobacco control programs and policies.<sup>42,52,53</sup>

In contrast to other researchers' findings on experimental smoking,<sup>28</sup> we found that the number of tobacco retailers located around secondary schools was not associated with the outcome variable. This suggests that the number of tobacco retailers around a school is more important for those students who are susceptible

**TABLE 3 (continued)**  
**Multilevel logistic regression analysis of the student- and school-level variables that were related to the odds of being an experimental smoker versus a never smoker, Canadian Youth Smoking Survey, 2008 (n = 18 072)**

Characteristics	Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>
	Model estimates (SE)	AOR (95% CI)	AOR (95% CI)
<b>Number of friends who smoke</b>			
0 (Ref)	—	—	1.0
1	—	—	3.69 (2.96–4.59)**
2	—	—	5.87 (4.69–7.35)**
3	—	—	8.56 (6.59–11.12)**
4	—	—	10.52 (7.10–15.60)**
5	—	—	9.51 (7.59–11.91)**
<b>Societal (school-level) factors</b>			
Tobacco retailer density (each 1 unit change)	—	0.99 (0.97–1.01)	0.99 (0.97–1.02)
<b>Location</b>			
Rural (Ref)	—	1.0	1.0
Urban	—	0.74 (0.60–0.91)*	0.66 (0.49–0.89)*
Median household income (each \$10 000 unit change)	—	0.93 (0.86–1.01)	0.92 (0.82–1.03)
Random variance (estimate [SE])	0.23 (0.05)**	0.20 (0.04)	0.28 (0.07)
Intraclass Correlation <sup>d</sup> $\sigma^2_{\mu} / (\sigma^2_{\mu} + \pi^2/3)$	0.065	0.056	0.079

**Abbreviations:** AOR, adjusted odds ratio; CI, confidence interval; Ref, reference category; SE, standard error.

**Note:** Dependent variable: Experimental smoker=1 and Never smoker=0.

<sup>a</sup> Random intercept only (null model computed to assess whether there was significant within-cluster interdependence to warrant the use of a multilevel approach).

<sup>b</sup> School-level variables only that would directly affect the likelihood of a student being an experimental smoker compared to a never smoker.

<sup>c</sup> School- and student-level variables.

<sup>d</sup> Measures of the proportion of the total variance that occurs between schools.

\*  $p < .05$ .

\*\*  $p < .001$ .

to smoking<sup>30</sup> or established smokers<sup>36-39</sup> than for students who are still experimenting with cigarettes. TTI variables drawn from the individual level may offer an explanation. Previous studies found that regular smokers were more likely to use retail sources, that is, buy cigarettes from tobacco retailers while experimenters used social sources such as “borrowing” cigarettes from friends or family, which made the location of retailers less important in our study.<sup>54</sup>

Third, the intrapersonal findings (i.e. grade, attitudes, pocket money, perception of anti-smoking rules, alcohol and marijuana use, school connectedness) from our study were consistent with existing literature.<sup>21,26</sup> For example, students who reported pro-smoking attitudes, such as

believing that smoking can help people relax, were more likely to be experimental smokers. This is not surprising; the TTI posits that adolescents’ perceptions and beliefs represent the most proximal level of influence because they reflect the adolescents’ ability to resist pressures to initiate and progress into advanced smoking behaviour.<sup>21</sup> The amount of pocket money students had available was also associated with experimental smoking, a finding consistent with that of Mohan et al.<sup>24</sup> Parents and guardians who give their adolescent children pocket money need to understand how this money is spent.

Our finding about students’ perceptions of anti-smoking school rules is consistent with that of other researchers who indicated that tobacco control school policies

or rules are not effective on their own but that suitable enforcement is necessary.<sup>14,16</sup> Our study did not assess enforcement; however, plausible explanations include that existing smokers tend to notice anti-smoking policies relevant to them or that schools develop and implement policies in response to higher rates of tobacco use.<sup>55</sup> Perhaps the experimental smokers in our study reflect individual differences in oppositional defiant tendencies or sensation-seeking behaviour (we did not measure these characteristics), as reported in other studies.<sup>56,57</sup>

Our finding that alcohol use predicted experimental smoking is consistent with that of other studies.<sup>22</sup> Most striking was the finding that if a student reported using marijuana the odds of them being an experimental smoker (vs. a never smoker) were more than 15 times higher (AOR 15.4, 95% CI 12.96–18.26) than for those students who did not report usage. Although it is not possible to determine whether marijuana use precedes tobacco use or vice versa using our cross-sectional data, this finding highlights adolescent multi-substance or multi-risk behaviour and the importance of schools prioritizing the prevention of substance use (whether tobacco, marijuana, alcohol or combinations of substances) by optimizing limited resources through the use of multi-pronged strategies that target multiple substance use.<sup>58-63</sup> This approach improves students’ educational outcomes and also encourages healthy social behaviours that help students resist substance abuse and feel more connected to their school.<sup>63-65</sup> Consistent with other research,<sup>25,66</sup> our results show that students who feel more connected to their school are less likely to initiate risky behaviour such as tobacco use. It is also consistent with current efforts in Canada (e.g. Pan-Canadian Joint Consortium for School Health<sup>64</sup> and New Brunswick Wellness Strategy<sup>65</sup>) to address “upstream” issues in school settings to create healthy environments and provide skills to enable youth to resist any form of substance use.

Fourth, the results about friends and family who smoke are consistent with existing evidence<sup>22,23,27</sup> and support the TTI,<sup>21</sup> which posits that this group forms the immediate social environment that contributes to the social pressure (e.g. by

reinforcing the behaviour through offering cigarettes or modelling smoking) on adolescents to experiment with tobacco. The implication for this finding is that school-based tobacco control programs should equip students with the necessary information and skills to deal with any form of pressure that may predispose them to experimental smoking.<sup>8</sup>

That students in grades 10 and 11 were less likely to be experimental smokers (vs. never smokers) than those who in grade 9 was consistent with results of studies that examined established smoking.<sup>20</sup> Students in higher grades may have moved on from experimental smoking to regular or established smoking. This suggests that school-based prevention strategies should be implemented early, in elementary school, and sustained into high school and post-secondary years (subject to availability of resources). Unlike one Chinese study,<sup>23</sup> we did not find sex to be associated with the outcome variable. However, although boys did not differ from girls in our analyses, their decisions to experiment with smoking may have different influences,<sup>67</sup> and to the extent that this is true, school-based interventions may still have to consider sex.

### Strengths and limitations

The strengths of this study include our use of nationally representative data of Canadian adolescents in different smoking stages. This study is also guided by a comprehensive theory (TTI) that targets broader and multiple influences of health-related behaviours including tobacco use.<sup>21</sup> We used a two-level multilevel logistic regression analysis to account for the clustering of students within the same school to reduce the likelihood of type 1 error.<sup>48</sup>

The study findings do not permit causal inferences due to the temporal sequence of our cross-sectional data. While self-report data are subject to response bias, the survey methodology ensured both student confidentiality and that the data were reliable and valid.<sup>41-43</sup> The exclusive reliance on Census data for school SES (proxy measure) has been criticized; instead the use of multiple neighbourhood

measures such as physical and socio-demographic characteristics is encouraged.<sup>44</sup> Future research should explore TTI further by investigating the relationship between experimental smoking and other student- and school-level variables that were not available in our dataset.

### Conclusion

Our findings expand on the knowledge about the student- and school-level characteristics that influence experimental smoking among secondary school students. Specifically, the characteristic of the school a student attends (i.e. being located in a rural location) can increase the likelihood of experimental smoking above and beyond individual-level influences. Our study highlights the importance of designing school-based tobacco control prevention policies and programs that are grade-sensitive and comprehensive in scope, including strategies that can increase students' attachment to their school and address multi-substance use, tobacco-related beliefs and the use of pocket money. These programs should also reach out to students who have friends and family members who smoke. Schools in rural areas may require additional resources.

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The views expressed herein do not necessarily represent the views of Health Canada.

### Conflict of interest

All authors declare that they have no conflict of interest.

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