



Student and school characteristics associated with use of nicotine replacement therapy: A multilevel analysis among Canadian youth

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ABSTRACT

Background: Research indicates that it is common for youths to use nicotine replacement therapy (NRT) despite limited empirical evidence for its effectiveness within this population. Since very little is known about the characteristics associated with NRT use by youth, the current study examined the association between ever and current use of NRT as a function of student characteristics and the characteristics of the schools they attend. **Methods:** This study used nationally representative student-level data from 29,296 grade 9 to 12 students who participated in the 2008–2009 Canadian Youth Smoking Survey (YSS). School-level data on the built environment surrounding schools were provided by DMST-Spatial, and data on school location were provided by the Canadian Census. Two multilevel logistic regression models were used to predict ever use of NRT and current use of NRT as a function of student and school characteristics among current smokers.

Results: Overall, 21.1% of youth smokers in Canada had ever used NRT and 5.1% were currently using NRT. Odds of ever and current NRT use were highest among daily smokers and boys, while youths who had made multiple quit attempts or participated in a quit and win contest were more likely to be ever NRT users. Attending a school located within an urban area increased youths' odds of ever and current NRT use, whereas higher density of pharmacies surrounding a school was inversely associated with current NRT use.

Conclusions: Characteristics of students and the schools they attend were associated with the likelihood of youth smokers using NRT. Significant between-school differences in NRT use exist, however further research is needed to identify which school characteristics account for these differences and understand how youth are accessing NRT.

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1. Introduction

Although nicotine replacement therapy (NRT) is a best practice among adult smokers attempting to quit (Fiore et al., 2000), the lack of conclusive evidence for its use among smoking youth has led to its inconsistent inclusion in best practice guidelines for youth smoking cessation (CAN-ADAPTT, 2011; Fiore et al., 2000; Fiore et al., 2008; MHNZ, 2007; Raw, McNeil, West, Arnott, & Armstrong, 2005). In Canada, where the current study was conducted, NRT is not considered a best practice for youth smoking cessation (CAN-ADAPTT, 2011), and its sale is restricted among youths (under 18 years old) so that only those who have a physician's prescription can purchase it (Physical Health Unit, 2004). Similar youth point-of-purchase restrictions exist in Finland (Rainio, Huhtala, & Rimpela, 2010), and the United States (Johnson, Klesges, Somes, Coday, & DeBon, 2004), but not in England (Raw et al., 2005) or New Zealand (MHNZ, 2007). Despite not being consistently

recommended for use, research indicates that a significant number of youths use NRT (Klesges, Johnson, Somes, Zbikowski, & Robinson, 2003; Lane, Leatherdale, & Ahmed, 2011; Rainio et al., 2010). To date, several studies describe the individual characteristics of youth who use NRT (Dalton et al., 2010; Klesges et al., 2003; Lane et al., 2011; Rainio et al., 2010;), youths' reasons for using NRT (Klesges et al., 2003; Raisamo, Doku, & Rimpelä, 2011), and how youth access NRT (Johnson et al., 2004). Although these studies provide important insights into the profile of NRT-using youth, no research that we know of has investigated whether characteristics of the schools youth attend are associated with their likelihood of using NRT. Given that school environment characteristics – such as tobacco retailer density surrounding schools – have been shown to be associated with odds of smoking among youths (Leatherdale, Brown, Cameron, & McDonald, 2005; Leatherdale & Strath, 2007), it seems possible that such a contextual relationship may exist with NRT use as well, as pharmacies represent locations where NRT can be accessed.

Although improved clinical evidence is required to inform policies that will either promote or discourage NRT use by youth, population-based research regarding NRT use by youth is necessary to target these policies at appropriate sub-populations. Understanding how

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individual and school characteristics impact youths' likelihood of NRT use would allow future policymakers to allocate resources to schools in need of better NRT access or abuse prevention. Therefore, the purpose of the present study was to: (1) investigate school-level differences in NRT use, and (2) identify student and school characteristics associated with NRT use in a nationally representative sample of Canadian youth smokers.

2. Materials and methods

2.1. Study design, sampling and participants

This study used nationally representative data collected from 29,296 students in grades 9 to 12 within 372 secondary schools as part of the 2008–2009 Canadian Youth Smoking Survey (YSS). In brief, the target population for the data used in this study consisted of all young Canadian residents in grades 9 to 12 attending public and private secondary schools in the 10 Canadian provinces.¹ Youth residing in the Yukon, Nunavut, and the Northwest Territories were excluded from the target population, as were youth living in institutions or on First Nation Reserves and youth attending special schools or schools on military bases. The YSS survey was administered to students during class time and participants were not provided compensation. The survey design and sample weights allow us to produce population-based descriptive statistics within this manuscript. In 81% of participating schools, active information with passive consent was used to reduce demands on schools and to increase student participation rates. The researcher informed the parents of the students via mail and asked them to call a toll-free number if they refused their child's participation. Based on school or board request, active parental permission (signed parental permission for students to participate in the survey) was required in the remaining 19% of schools. The study response rates at the school board, school, and student level were 84%, 59%, and 73.2%, respectively. The University of Waterloo Office of Research Ethics and appropriate School Board and Public Health Ethics committees approved all procedures, including passive consent. Detailed information on the 2008–2009 YSS is available online (<http://www.yss.uwaterloo.ca>).

2.2. Measures

2.2.1. Student characteristics

Consistent with previous research (Lane et al., 2011), ever use of NRT was determined via a question that asked students "Have you ever tried any of the following? (Mark all that apply)" for which "Using nicotine patches, nicotine gum, or nicotine lozenges" was a possible response. Current use of NRT was measured by a question that asked students "In the last 30 days, did you use any of the following? (Mark all that apply)," for which "Nicotine patches, nicotine gum, or nicotine lozenges" was a possible answer.

Smoking status was measured by asking respondents if they had ever smoked 100 or more whole cigarettes in their lifetime (yes/no) and on how many of the last 30 days they smoked one or more cigarettes. Consistent with Health Canada's definitions of smoking status for the YSS (Health Canada, 2010), current smokers had smoked at least 100 cigarettes in their lifetime and at least one whole cigarette during the past 30 days. Current smokers were further classified as current daily smokers (smoked on each of the past 30 days) or current occasional smokers (smoked on fewer than 30 of the past 30 days). Never smokers were classified as individuals who had never tried smoking, not even a few puffs.

Number of previous quit attempts was determined from youth answers to the question "Have you ever tried to quit smoking

cigarettes?" (I have only smoked a few times, I have never tried to quit, I have tried to quit once, I have tried to quit 2 to 3 times, I have tried to quit 4 to 5 times, I have tried to quit 6 or more times). Participation in a quit smoking contest or smoking cessation counseling was determined via student responses to the question "In the last 12 months, have you taken part in any other anti-smoking activities or events, either at school or in the community? (Mark all that apply)." Students who marked "quit smoking contest" or "smoking cessation counseling" were included in the yes categories for these activities, and everyone else was included in the no categories.

Use of marijuana in the 12 months preceding the survey was determined through student answers to the YSS survey question, "In the last 12 months, how often did you use marijuana or cannabis? (A joint, pot, weed, hash...) (I have never used marijuana, I have used marijuana but not in the last 12 months, Less than once a month, 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, I do not know). The YSS also collected information on student demographics. Specific details on these measures are available online (www.yss.uwaterloo.ca).

2.2.2. School characteristics

School location was classified as either rural or urban by linking school postal code data with 2006 Canadian census data in the Postal Code Conversion File (PCCF) program. Statistics Canada classifies any census subdivision (municipality) as a Census Metropolitan Area (CMA) if it had a core population of at least 100,000 during the previous census (Statistics Canada, 2010b). For this study, schools located in census CMAs were classified as urban and all others were classified as rural, similar to the classification system used by Curry et al. (2007).

The 2008 DMTI-Spatial data were used to identify the number of pharmacies located within a 1-kilometer radius of each school. Consistent with previous research (Pouliou & Elliot, 2010), the process of identifying and linking the DMTI-Spatial data to the YSS student level data involved three steps: (1) geocoding the address for each YSS school; (2) creating 1-km circular buffers; and (3) linking the quantified built environment data for each school to the student-level data from each school. Arcview 3.3 (ESRI, 2002) software was used to geocode the school addresses and to create the 1-km buffers.

2.3. Data analysis

Prevalence estimates were calculated for NRT use within the entire YSS sample ($n = 29,296$) by gender, smoking status, and province of residence. Descriptive analyses of NRT use, grade, smoking status, number of previous quit attempts, participation in a quit and win contest, participation in smoking cessation counseling, and past month marijuana use were performed by gender (male/female) in the sub-population of the YSS sample classified as current smokers ($n = 3630$). Survey weights were used to adjust for differential response rates across regions or groups in all descriptive analyses.

Similar to previous research (Leatherdale, 2010; Roberston-Wilson, Leatherdale, & Wong, 2008), a three-step modeling procedure was used to examine the student and school characteristics associated with NRT use. Step 1 examined whether differences in NRT ever use or current use varied significantly across schools. Unconditional models with random intercepts for ever and current NRT use by current smokers produced estimates of school-level variance (σ^2). School-level variance estimates from Step 1 were used to calculate the intraclass correlation coefficients (ICCs), which indicate the proportion of the variability in the odds of NRT use accounted for by random variation between schools (Merlo et al., 2006).

In Step 2, student-level variables were entered into initial models of NRT ever and current use based on their hypothesized significance to NRT use. Variables were then removed from the models in a stepwise fashion, using backward elimination, until all student-level variables had p -values less than 0.1. The group of variables entered into the initial

¹ In 2008, these 10 Canadian provinces represent over 99.9% of the total Canadian population (Statistics Canada, 2010a).

models included all of the variables examined in the present study, as well as numerous other variables that were eliminated from the models of NRT use due to non-significant p -values during the elimination procedure. The student-level variables that were not retained in the final models due to statistical insignificance were: amount of weekly disposable income, self-identification as a smoker, belief that smokers can quit any time they want, number of cigarettes smoked per day, attendance at classes where the health effects of smoking were discussed, alcohol use, parent and sibling smoking, and friend smoking. In accordance with a priori hypotheses regarding their significance in final models of NRT use, gender, grade, smoking status, province of residence, and urban/rural location of schools were retained in all final models of NRT use predictors, regardless of their significance during backwards elimination. In Step 3, grand-mean centered pharmacy density was added to the models of NRT use, and retained if it had a p -value of less than 0.1. This formed the final multilevel models of NRT use among Canadian youth smokers.

Although Model 1 (NRT ever use among current smokers) was missing data for 483 of the 3630 youth smokers in the sample, an additional analysis where missing values were coded into the multilevel model indicated that the missing values did not significantly impact the magnitude or direction of associations in Model 1.

3. Results

3.1. Sample characteristics

A description of the general characteristics of the 2008–2009 YSS sample is available elsewhere (Leatherdale, Rios, Elton-Marshall, & Burkhalter, 2011). Within the entire Canadian youth population (grades 9 to 12), 3.6% ($n = 59,792$) had ever used NRT, and 0.8% ($n = 13,287$) were current NRT users at the time of the YSS survey. Among ever and current NRT users in the entire population, 7% and 15%, respectively, had never smoked. During the 2008–2009 school year, 66.2% of Canadian youths attended schools that were located in urban areas. Among all schools surveyed, there was a mean of 1.6 (SD: 2.4, range: 0–26) pharmacies within a one kilometer radius of each school.

Among current smokers, prevalence of lifetime NRT use was 21.1%, with 5.1% of current smokers reporting current NRT use. The preceding descriptive statistics are from the current smoking youth population in Canada. NRT use varied significantly by province in Canada, as shown in Fig. 1. NRT ever use was highest in British Columbia (30.9%) and lowest in Newfoundland (15.8%), whereas NRT current use peaked in

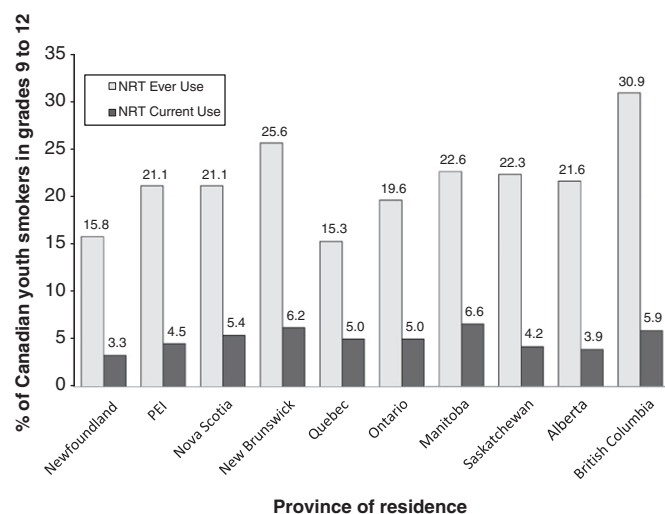


Fig. 1. Prevalence of ever and current NRT use among current smokers by province, 2008–2009, Canada.

Manitoba (6.6%) and was lowest in Newfoundland (3.3%). The majority (35%) of current and ever NRT users had made between two and three quit attempts, but 16–32% had never tried to quit. A summary of the descriptive statistics for Canadian youth smokers can be found in Table 1.

3.2. Between-school differences associated with NRT use by youth smokers

Among current smokers in grades 9 to 12, significant between-school random variation in the odds of ever using NRT was identified ($\sigma_u^2 = 0.092$); school-level differences accounted for 2.7% of the variability in the odds of ever using NRT versus not using NRT. Significant between-school random variation in the odds of currently using NRT was also identified ($\sigma_u^2 = 0.312$), with school-level differences accounting for 8.6% of the variability in the odds of currently using NRT versus not currently using NRT. Considered at the population level, these effect sizes were significant enough to warrant further investigation via addition of explanatory variables to the models of NRT use. In Step 2, multilevel models of NRT ever and current use (Table 2) showed that only 0.64% ($\sigma_u^2 = 0.021$) of the variability in the odds of ever using NRT and 2.7% ($\sigma_u^2 = 0.092$) of variability in the odds of currently using NRT could be explained by random between school differences. This change indicates that the addition of school-level variables (urban/rural location of school and pharmacy density within a one kilometer radius) explained 77.2% of the between-school differences in odds of ever NRT use and 70.4% of the between-school differences in the odds of current NRT use.

3.3. Student and school characteristics associated with NRT use by youth smokers

As shown in Table 2, males were significantly more likely to be ever (OR: 1.22, 95% CI 1.01, 1.47) or current (OR: 1.51, 95% CI 1.11, 2.04) NRT users than females. Grade was not found to be significantly correlated with NRT ever or current use, except for among grade 12 students, who were 0.46 (95% CI 0.29, 0.74) times less likely to be current NRT users than grade 9 students. Being a current daily smoker significantly increased odds of ever (OR: 2.44, 95% CI 2.00, 2.97) and current (OR: 2.74, 95% CI 1.98, 3.80) NRT use, while odds of ever NRT use increased as number of past quit attempts increased (see Table 2). Past participation in smoking cessation counseling increased youths odds of currently using NRT (CI: 2.83, 95% CI 1.40, 5.70), and past participation in a quit and win contest increased youths likelihood of ever using NRT (OR: 1.87, 95% CI 1.09, 3.20). Past year marijuana use was positively correlated with odds of ever NRT use among Canadian youth smokers; however marijuana use was not significant enough a predictor to be retained in the final model of current NRT use.

School characteristics were also associated with likelihood of NRT use. Attending a school located in an urban area rather than a rural one significantly increased Canadian youth smokers' odds of ever (OR 1.28, 95% CI 1.03, 1.60) or currently (OR 1.93, 95% CI 1.31, 2.82) using NRT. Pharmacy density within a one kilometer radius of schools was inversely associated (OR 0.85, 95% CI 0.76, 0.95) with the odds of current NRT use, meaning that even when gender, grade, province of residence, daily/occasional smoking status, participation in smoking cessation counseling and urban/rural location of school were controlled for, a one-unit increase in the number of pharmacies in a one kilometer radius of a school decreased students' likelihood of using NRT by 15%.

4. Discussion

The prevalence of ever NRT use (3.6%) reported for the entire population of Canadian youths in this study was lower than estimates from youth populations in the United States (5.3%) (Klesges et al., 2003), or Finland (10%) (Raisamo et al., 2011), despite similar

Table 1
Weighted descriptive statistics for the sample of current smokers (grades 9–12) by gender, 2008–2009, Canada.

Parameter		Females (n = 79,817)	Males (n = 113,639)	Total (n = 193,456)
Ever use of nicotine replacement therapy	Yes	21.1	21.1	21.1
	No	78.9	78.9	78.9
Current use of nicotine replacement therapy	Yes	5.4	4.9	5.1
	No	94.6	95.1	94.9
Grade	9	17.6	13.7	15.3
	10	24.8	26.0	25.5
	11	27.7	28.8	28.3
	12	29.9	31.6	30.1
Smoking status	Current occasional smoker	45.9	50.7	47.9
	Current daily smoker	54.1	49.3	52.1
Number of previous quit attempts	Only smoked a few times	3.9	5.2	4.6
	Zero	22.2	28.2	25.7
	1	25.8	27.5	26.8
	2–3	34.8	25.3	29.2
	4–5	7.5	6.4	6.8
	6+	5.8	7.4	6.7
	Yes	2.5	2.2	2.3
Participated in a quit and win?	No	97.5	97.8	97.7
	Yes	#	2.5	2.0
Participated in quit smoking program or counseling?	No	98.7	97.5	98.0
	Yes	5.5	12.3	9.4
In the last 12 months, how often did you use marijuana or cannabis? (A joint, pot, weed, hash...)	I have never use marijuana	9.6	6.5	7.8
	I have used marijuana, but not in the last 12 months	12.9	7.6	9.8
	Less than once a month	13.0	9.9	11.2
	1 to 3 times a month	15.8	13.9	14.7
	1 to 3 times a week	14.3	13.7	13.9
	4 to 6 times a week	25.8	33.8	30.5
	Every day	3.2	2.3	2.7
	I do not know			

Numbers are reported as percentages.

#Data not reportable due to low numbers in the numerator or denominator.

restrictions on youth NRT access in these countries. Among smoking youth in Canada, provincial NRT use prevalence varied on an even greater scale, similar to the observed variation among adult NRT users in Canada (Reid & Hammond, 2011). This finding suggests that both nationally and internationally, there are contextual influences on NRT use that may extend beyond government legislation. Understanding these regional influences will be critical to focusing appropriate preventive measures in the future. At the time of the present study, no Canadian surveillance data indicating the proportion of NRT youths accessed from pharmacies versus social or alternative sources (i.e., online purchase, other commercial outlets) were available. Including standardized questions about where youths access their NRT and collecting national data on different sources of NRT in future youth surveillance tools is necessary to advance this goal.

Consistent with previous research (Klesges et al., 2003; Lane et al., 2011; Raisamo et al., 2011), the present study found that a small proportion of youth NRT users were not smokers. Although such inappropriate [and potentially harmful (Cooke & Bitterman, 2004; Mills, Wu, Lockhart, Wilson, & Ebbert, 2010)] use could be viewed as grounds for increasing controls on youth NRT access, such actions may be unnecessary. In Raisamo et al.'s (2011) recent study of youths' reasons for and frequency of NRT use, it was found that most non-smoking youths who use NRT simply wish to try it, and rarely use NRT more than a few times, therefore the potential for bodily harm is likely negligible for most individuals. The present study also found that a significant proportion of youth smokers use NRT in the absence of a quit attempt. Although such non-standard use of NRT has been documented in both youth (Klesges et al., 2003) and adult (Hammond et al., 2008) smoking populations, more research is needed to understand if this has an impact on smoking cessation trajectories in youths.

To the best of our knowledge, this is the first study to identify that school environment has a significant impact on youths' likelihood of using NRT. This finding suggests that future interventions aimed at altering NRT use among youths should be implemented in school

settings to broaden their impact. Urban location of schools was shown to be positively associated with NRT use by youth smokers, while pharmacy density was shown to have a negative association with current NRT use. The unexpected direction of pharmacy density's association with NRT use could be due to a number of reasons. It is possible that a direct relationship exists, where in youths attending schools with a high density of pharmacies in a one kilometer radius may be more apt to attempt to access NRT via direct purchase (and be declined based on age), whereas youths with fewer pharmacies surrounding their schools may be more likely to (successfully) access NRT via social sources. Another possibility that was ruled out via exploratory analyses (not shown) is that urban/rural status was confounding the relationships between pharmacy density and NRT use. Given the paucity of school level factors included in this analysis, the most probable cause of the unexpected relationship between pharmacy density and NRT use is that pharmacy density was acting as a proxy variable for one or more variables that was not included in the present analysis.

These findings provide an important foundation for future research in this field, however are themselves subject to limitations. More school-level variables are needed to create robust models of NRT use by youths. This is evidenced by the unexpected direction of pharmacy density's association with NRT use and the fact that a significant proportion of unexplained between-school variation in NRT use exists in the final multilevel models. NRT is an unscheduled drug in Canada, meaning that its sale is permitted at non-pharmacy retail locations (National Association of Pharmacy Regulatory Authorities, 2012). This could have led to a slight undercounting of NRT retail locations accessible to youth, however because NRT is only widely available at pharmacies (The Lung Association, 2011), the impact of non-pharmacy NRT sales on the present findings are likely negligible. Because the YSS was not designed with the research questions of this study in mind, there were limitations in the breadth and depth of data that were collected regarding NRT use. For example, the original questionnaire given to students did not differentiate between the different forms of NRT they used (i.e., gum, patch, lozenge),

Table 2

Multilevel logistic regression models examining student and school factors associated with NRT use among current smokers (grades 9–12), 2008–2009, Canada.

Parameters		Adjusted OR (95% CI)	
		Model 1:	Model 2:
		Ever NRT use (n = 3147 ^a)	Current NRT use (n = 3630 ^a)
<i>Student characteristics</i>			
Gender ^b	Female ^c	1.00	1.00
	Male	1.22 (1.01, 1.47)*	1.51 (1.11, 2.04)*
Grade ^b	9 ^c	1.00	1.00
	10	0.82 (0.62, 1.07)	0.69 (0.46, 1.04)
	11	0.92 (0.70, 1.20)	0.73 (0.49, 1.08)
	12	0.97 (0.73, 1.29)	0.46 (0.29, 0.74)
Smoking Status ^b	Current occasional smoker ^c	1.00	1.00
	Current daily smoker	2.44 (2.00, 2.97)*	2.74 (1.98, 3.80)*
Number of previous quit attempts	None ^c	1.00	–
	One	1.39 (1.05, 1.82)*	–
	Two to three times	2.41 (1.86, 3.11)*	–
	Four to five times	3.22 (2.24, 4.64)*	–
	Six or more times	4.18 (2.99, 5.84)*	–
Have you ever participated in smoking cessation counseling?	No ^c	–	1.00
	Yes	–	2.83 (1.40, 5.70)*
Have you ever participated in a quit and win contest?	No ^c	1.00	–
	Yes	1.87 (1.09, 3.20)*	–
Past year marijuana use.	Never use of marijuana ^c	1.00	–
	Lifetime use, but not in last 12 months	2.68 (1.64, 4.39)*	–
	Less than once a month	1.98 (1.21, 3.23)*	–
	One to three times a month	1.69 (1.02, 2.78)*	–
	One to three times a week	1.78 (1.10, 2.89)*	–
	Four to six times a week	1.83 (1.13, 2.96)*	–
	Every day	2.17 (1.39, 3.38)*	–
<i>School characteristics</i>			
School location ^b	Rural ^c	1.00	1.00
	Urban	1.28 (1.03, 1.60)*	1.93 (1.31, 2.82)*
Pharmacy density within 1 km radius of school		0.96 (0.91, 1.004)	0.85 (0.76, 0.95)*
School level random variance (σ^2_{ij})		0.02103	0.09235
ICC ^d		0.00635	0.0273

Odds ratios adjusted for all other variables in the table and controlling for province of residence.

N/A – not included in original backwards elimination model.

Model 1: 1 = Ever use of NRT (n = 679), 0 = Has never used NRT (n = 2468).

Model 2: 1 = Current use of NRT (n = 204), 0 = Does not currently use NRT (n = 3426).

^a Sum of individuals in same population may vary between different models due to missing values.^b Variables retained in model regardless of significance during backwards elimination.^c Reference group.^d Measure of the proportion of the total variance that is between-schools.* $p < 0.05$.

therefore, youth smoker preference for a specific type of NRT, or combinations of different NRTs cannot be identified. Also, due to the cross-sectional nature of this study, it is impossible to establish temporal relationships between the descriptive measures of interest and NRT use.

Future research should incorporate contextual measures – such as school policies regarding smoking and the existence of smoking cessation programs within schools – into multilevel models of NRT use. To inform future youth NRT policies, an improved understanding of types of NRT used by youths, how youths access NRT, and the effectiveness of NRT at improving cessation outcomes among youth smokers is required.

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Contributors

NL and SL had the original idea for the study and they designed it together with DH and JD. NL performed all statistical analyses and conducted literature searches of previous research studies. NL, SL, JD, and DH interpreted findings from the analyses and conceptualized the manuscript together. NL wrote the first draft of the manuscript and all authors contributed and to have approved the final manuscript.

Conflict of interest

All authors declare that they have no conflicts of interest.

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References

- CAN-ADAPT (2011). *Canadian practice-informed smoking cessation guideline: summary statements*. Toronto, Canada: Canadian Action Network for the Advancement, Dissemination and Adoption of Practice-Informed Tobacco Treatment, Centre for Addition and Mental Health (Retrieved from <http://www.can-adaptt.net/English/Guideline/Youth%20%28Children%20and%20Adolescents%29/Home.aspx>)
- Cooke, J. P., & Bitterman, H. (2004). Nicotine and angiogenesis: A new paradigm for tobacco-related diseases. *Annals of Medicine*, 36, 33–40.
- Curry, S. J., Emery, S., Sporer, A. K., Mermelstein, R., Flay, B. R., Berbaum, M., et al. (2007). A national survey of tobacco cessation programs for youths. *American Journal of Public Health*, 97(1), 171–177.
- Dalton, W. T., Klesges, L. M., Henderson, L., Simes, G., Robinson, L., & Johnson, K. C. (2010). Gender, smoking status, and risk behavior attitudes explain adolescents' patterns of nicotine replacement therapy use. *Addictive Behaviors*, 35, 147–151.

- ESRI (2002). *ArcView GIS 3.3*. Redlands, CA.
- Fiore, M. C., Bailey, W. C., Cohen, S. J., Dorfman, S. F., Goldstein, M. G., Gritz, E. R., et al. (2000). *Clinical practice guideline: Treating tobacco use and dependence*. Rockville, MD: U.S. Department of Health and Human Services.
- Fiore, M. C., Jaen, C. R., Baker, T. B., Bailey, W. C., Benowitz, N. L., Curry, S. J., et al. (2008). *Clinical practice guideline: Treating tobacco use and dependence, 2008 update*. U.S. Department of Health and Human Services: Rockville, MD.
- Hammond, D., Reid, J. L., Driezen, P., Cummings, K. M., Borland, R., Fong, G. T., et al. (2008). Smokers' use of nicotine replacement therapy for reasons other than stopping smoking: Findings from the ITC four country survey. *Addiction*, *103*, 1696–1703.
- Health Canada (2010). *2008–09 youth smoking survey*. Ottawa, Canada: Minister of Supply and Services Canada (Retrieved July 25, 2010, from http://www.hc-sc.gc.ca/hc-ps/tobac-tabac/research-recherche/stat/_survey-sondage_2008-2009/result-eng.php)
- Johnson, K. C., Klesges, L. M., Somes, G. W., Coday, M. C., & DeBon, M. (2004). Access of over-the-counter nicotine replacement therapy products to minors. *Archives of Pediatrics & Adolescent Medicine*, *158*(3), 212–216.
- Klesges, L. M., Johnson, K. C., Somes, G., Zbikowski, S., & Robinson, L. (2003). Use of nicotine replacement therapy in adolescent smokers and non-smokers. *Archives of Pediatrics & Adolescent Medicine*, *157*, 517–522.
- Lane, N. E., Leatherdale, S. T., & Ahmed, R. (2011). Use of nicotine replacement therapy among Canadian youth: data from the 2006–2007 national youth smoking survey. *Nicotine and Tobacco Research*, *13*(10), 1009–1014.
- Leatherdale, S. T. (2010). The association between overweight and school policies on physical activity: a multilevel analysis among elementary school youth in the PLAY-On study. *Health Education Research*, *25*(6), 1061–1073.
- Leatherdale, S. T., Brown, K. S., Cameron, R., & McDonald, P. W. (2005). Social modeling in the school environment, student characteristics, and smoking susceptibility: A multi-level analysis. *Journal of Adolescent Health*, *37*, 330–336.
- Leatherdale, S. T., Rios, P., Elton-Marshall, T., & Burkhalter, R. (2011). Cigar, cigarillo, and little cigar use among Canadian youth: Are we underestimating the magnitude of this problem? *The Journal of Primary Prevention*, *32*(3–4), 161–170.
- Leatherdale, S. T., & Strath, J. M. (2007). Tobacco retailer density surrounding schools and cigarette access behaviors among underage smoking students. *Annals of Behavioral Medicine*, *33*(1), 105–111.
- Merlo, J., Chaix, B., Ohlsson, H., Beckman, A., Johnell, K., Hjerpe, P., et al. (2006). A brief conceptual tutorial of multilevel analysis in social epidemiology: Using measures of clustering in multilevel logistic regression to investigate contextual phenomena. *Journal of Epidemiology and Community Health*, *60*, 290–297.
- Mills, E. J., Wu, P., Lockhart, I., Wilson, K., & Ebbert, J. O. (2010). Adverse events associated with nicotine replacement therapy (NRT) for smoking cessation. A systematic review and meta-analysis of one hundred and twenty studies involving 177,390 individuals. *Tobacco Induced Diseases*, *8*(8), 1–15.
- Ministry of Health New Zealand (MHNZ) (2007). *New Zealand smoking cessation guidelines*. Wellington: Ministry of Health (Retrieved from http://www.hrphow.co.nz/uploads/5/1/5/3/5153926/nz_smoking_cessation_guidelines_1_aug_2007.pdf)
- National Association of Pharmacy Regulatory Authorities (2012, January 10). *Nicotine and its salts, for human use*. (Retrieved February 9, 2012, from: <http://napra.ca/pages/Schedules/Search.aspx>)
- Physical Health Unit (2004). *Prevention en pratique medicale: Cardiovascular disease*. Montreal: Association des Medecins Omnipraticiens de Montreal (Retrieved from <http://www.santepub-mtl.qc.ca/Publication/pdfppm/ppmmarch04.pdf>)
- Pouliou, T., & Elliot, S. J. (2010). Individual and socio-environmental determinants of overweight and obesity in urban Canada. *Health & Place*, *16*, 389–398.
- Rainio, S. U., Huhtala, H. S. A., & Rimpela, A. H. (2010). Use and acquisition of nicotine replacement therapy products among underage adolescents after deregulation of the sales. *Nicotine & Tobacco Research*, *12*(8), 870–873.
- Raisamo, S. U., Doku, D. T., & Rimpelä, A. H. (2011). Adolescents' self-reported reasons for using nicotine replacement therapy products: A population-based study. *Addictive Behaviors*, *36*, 945–947.
- Raw, M., McNeil, A., West, R., Arnott, D., & Armstrong, M. (2005). *Nicotine replacement therapy: Guidance for health professionals on changes in the licensing arrangements for nicotine replacement therapy*. London: Action on Smoking and Health (Retrieved from http://whyquit.com/NRT/NRT_Guidance_UK_1205.pdf)
- Reid, J. L., & Hammond, D. (2011). *Tobacco use in Canada: Patterns and trends* (2011 edition). Waterloo, ONT: Propel Centre for Population Health Impact, University of Waterloo.
- Roberston-Wilson, J. E., Leatherdale, S. T., & Wong, S. L. (2008). Social-ecological correlates of active commuting to school among high school students. *Journal of Adolescent Health*, *42*, 486–495.
- Statistics Canada (2010). *Population by year, by province and territory*. (Retrieved from <http://www40.statcan.gc.ca/101/cst01/demo02a-eng.htm>)
- Statistics Canada (2010). *Census metropolitan areas (CMAs) and census agglomerations (CAs) containing census tract(s)*. (Retrieved from www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-597/CMACA-RMRAR.cfm?Lang=E)
- The Lung Association (2011, July 4). *Smoking and tobacco: Medication to help you quit smoking*. (Retrieved February 9, 2012, from: http://www.lung.ca/protect-protégez/tobacco-tabagisme/quitting-cesser/medications-medicaments_e.php)