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Short Communication

Exploring the association between E-cigarette retailer proximity and density to schools and youth E-cigarette use

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ABSTRACT

Limited evidence exists examining the association between e-cigarette retailer density and e-cigarette use among youth. This study explored whether e-cigarette retailer proximity and density to schools were associated with youth use of e-cigarettes in 4 Canadian provinces. Between October and December 2017, an online search identified e-cigarette retailers within 500 m, 1000 m, and 1500 m circular buffer zones around high schools ($N = 122$) that participated in the COMPASS study in 2017–18. Retailer proximity/density data were linked to student-level data ($N = 63{,}400$ students). Multilevel regression models examined the association between e-cigarette retailer proximity and density and ever and current e-cigarette use, controlling for relevant covariates. Results indicated the average school had < 1 e-cigarette retailer within 500 m, 1000 m, and 1500 m. Significant between-school variability in the likelihood of ever [$\sigma^2_{\mu 0} = 0.215$ (0.030), $p < .0001$] and current [$\sigma^2_{\mu 0} = 0.258$ (0.036), $p < .0001$] e-cigarette use was found among students. However, after controlling for relevant covariates, e-cigarette retailer proximity and density surrounding a school were not significantly associated with the likelihood of ever or currently using e-cigarettes. These findings suggest that students are accessing e-cigarettes through other sources.

1. Introduction

The prevalence of e-cigarette use among youth has increased, such that by 2015, 25.7% and 6.3% of Canadian youth aged 15–19 years reported ever and past 30-day use of e-cigarettes, respectively (Reid et al., 2017). A variety of reasons for this growth exist, including increased availability and accessibility of these products through retail locations. The influence of the built environment on youth smoking has been documented in previous work (Gwon et al., 2017). However, there is limited evidence for a similar association between e-cigarette retailer density and youth e-cigarette use, particularly in Canada where e-cigarettes containing nicotine became legally available in May 2018 (Government of Canada, 2018). Before this time, e-cigarettes that did not contain nicotine and that did not make a health claim could be legally sold, although nicotine-containing e-cigarettes were available in physical retail locations, particularly vape shops, and through online retailers (Hammond et al., 2015).

Evidence to-date indicates that e-cigarette retailers are located within close proximity to schools. In one study of two counties in Kentucky, USA, an estimated 67.5% of sampled schools (including elementary, middle, and high schools, and two colleges/universities) had at least one tobacco retailer that also sold e-cigarettes within 1-mile (1.61 km) of the school (Hahn et al., 2015). In another study from Orange County, California, USA, over half of public middle and high schools had a least one e-cigarette specialty retailer within 1-mile of the school (Bostean et al., 2017). Finally, in another study from New Jersey, USA, although there were no e-cigarette specialty retailers close to public high schools, e-cigarettes were available in over half of tobacco retailers (Giovenco et al., 2016).

Current evidence is mixed with respect to the association between e-cigarette retailer proximity or density and youth e-cigarette use. One study identified a significant positive association between e-cigarette retailer density within a half-mile of a high school and the likelihood that a student ever and currently used e-cigarettes (Giovenco et al., 2016). Another study also identified a significant positive association between the presence of e-cigarette specialty retailers within one-quarter mile of a middle school and the likelihood of e-cigarette ever use, although a similar association was not identified among high school students or for e-cigarette current use among middle or high school students (Bostean et al., 2016). To our knowledge, within Canada there is no policy that restricts e-cigarette or cigarette retailer zoning, although such a policy has been discussed in previous Canadian

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studies (Chan and Leatherdale, 2011; Kaai et al., 2013). Given the conflicting evidence to date and the lack of Canadian evidence, the objectives of this study were to explore whether e-cigarette retailer proximity and density were associated with ever and current use of e-cigarettes among high school students in 4 Canadian provinces.

2. Material and methods

This study used data collected from a convenience sample of 66,435 students in grades 7 to 12 as part of the 2017–18 COMPASS study (www.compass.uwaterloo.ca) (Leatherdale et al., 2014). In 2017–18, 61 schools from Ontario, 8 schools from Alberta, 37 schools from Quebec, and 16 schools from British Columbia, Canada participated in the study. The University of Waterloo Office of Research Ethics and participating school board ethics committees approved all procedures.

2.1. Student-level measures

Lifetime e-cigarette use was assessed with a single question: "Have you ever tried an electronic cigarette, also known as an e-cigarette?" Students that indicated "Yes" were categorized as ever e-cigarette users, while those that indicated "No" were categorized as non-users. Current (past 30-day) e-cigarette use was assessed with a single question: "On how many of the last 30 days did you use an e-cigarette?" Students that reported using an e-cigarette on any days in the last 30 were categorized as current e-cigarette users, while all others (including never users) were categorized as non-current users.

Students also self-reported their gender (male, female), grade (9, 10, 11, 12, or other), ethnicity (White, Black, Asian, Latin American/Hispanic, Off-Reserve Aboriginal, or Mixed/Other), weekly spending money ($0, $1–5 $6–10, $11–20, $21–40, $41–100, More than $100), cigarette smoking behaviors (ever use and past 30-day use), and the number of close friends that smoke cigarettes (None, 1, 2, 3, 4, or 5 or more friends).

2.2. School-level measures

Consistent with previous research (Patte et al., 2018), urbanicity was determined based on school postal codes and Statistics Canada classifications of "rural" area and "small," "medium," and "large urban" population centers (Statistics Canada, n.d.). Based on these definitions, 52 schools were classified as "rural/small urban" (which were combined due to the low frequency of rural schools), 15 were classified as "medium urban", and 56 were classified as "large urban".

2.3. E-cigarette retailer proximity and density

Between October and December 2017, an online search was conducted to identify e-cigarette retailers located near secondary schools participating in the COMPASS study on the YellowPages website (www.yellowpages.ca). We included the search terms 'vape' and 'e-cig' (and the French terms 'cigarette électronique' and 'vapotage' when searching around schools in Quebec) to identify e-cigarette retailers. The results of this search primarily identified "vape" shops (likely specialty retailers) and did not seem to identify traditional tobacco retail locations (e.g., tobacco shops, convenience stores). Using the postal codes of each school and each e-cigarette retailer, we geocoded each address and created circular buffers that were within 500 m, 1000 m, and 1500 m of each school (0.31, 0.62, and 0.93 miles, respectively) using ArcGIS. A 1000 m circular buffer is consistent with previous smoking literature (Gwon et al., 2017) and is believed to approximate how far students would actively commute to school (McCarthy et al., 2009). Given the relative lack of evidence in this area, we were also interested in exploring whether the association differed for closer (i.e., 500 m) and farther (i.e., 1500 m) distances. The number of e-cigarette retailers that fell within each circular buffer was used to calculate the e-cigarette retailer proximity/density data used in this study. The e-cigarette retail proximity/density data for each school were linked to student-level data for each school.

2.4. Analyses

Descriptive statistics identified the mean number of e-cigarette retailers within 500 m, 1000 m, and 1500 m of each school. Two null, multilevel regression models examined whether ever and current e-cigarette use varied across schools through calculation of the intraclass correlation coefficient (ICC). The next set of multilevel models examined whether e-cigarette retailer proximity at each distance and e-cigarette retailer density at each distance were associated with ever and current e-cigarette use in separate models (12 models total), while adjusting for province, school urbanicity, student-level characteristics (grade, gender, ethnicity, spending money, peer smoking, cigarette smoking status), and student-level clustering within schools. Students with missing outcomes ($n = 1359$) or covariates ($n = 1676$) were excluded from the analyses (representing 4.6% of the total sample), leaving a final sample of 63,400 students. All analyses were performed using SAS software, Version 9.4 (SAS Institute Inc, 2012).

3. Results

3.1. E-cigarette retailer proximity

Only 2.4% ($n = 3$) of schools in the sample had at least one e-cigarette retailer within 500 m, 13.8% ($n = 17$) had at least one retailer within 1000 m, and 20.3% ($n = 25$) had at least one retailer within 1500 m of the school (Table 1). A higher percentage of schools in "medium urban" and "large urban" locations had at least one retailer close to the school. Similarly, a higher percentage of schools in Ontario and Quebec had at least one retailer close to the school.

3.2. E-cigarette retailer density

The vast majority of schools did not have an e-cigarette retailer close to the school, and the average school had < 1 retailer within 1500 m of the school (Table 1). E-cigarette retailer density generally increased as the distance from the school increased. Additionally, retailer density was generally higher in "large urban" areas relative to "rural/small urban" areas, and higher in Quebec relative to all other provinces.

3.3. Multilevel model results

Half of the sample (50.5%) was female and 24.1% of students were in grade 9, 24.5% in grade 10, 23.3% in grade 11, 15.3% in grade 12, and 12.8% in "other" grade (the highest grade in Quebec is grade 11 and "other" grade included students in grades 7 and 8 from Quebec). More students reported ever using e-cigarettes than cigarettes (36.4% versus 23.5%), and over twice as many students reported currently using e-cigarettes as cigarettes (22.2% versus 9.8%).

The null models suggest there is significant between-school variability in the likelihood of ever [$\sigma^2_{\mu 0} = 0.215$ (0.030), $p < .0001$] and current [$\sigma^2_{\mu 0} = 0.258$ (0.036), $p < .0001$] e-cigarette use among students; the school a student attended accounted for approximately 6.1% of the variability in the likelihood of ever using e-cigarettes and 7.3% of the variability in the likelihood of currently using e-cigarettes. After controlling for relevant covariates, e-cigarette retailer proximity was not significantly associated with ever or current e-cigarette use (Table 2). Rather, the prevalence of e-cigarette use appeared to be higher among students that attended a school that did not have an e-cigarette retailer close to the school. Similarly, after controlling for relevant covariates, e-cigarette retailer density was not significantly associated with ever or current e-cigarette use. Similar findings were

Table 1
E-cigarette retailer proximity and density within 500 m, 1000 m, and 1500 m of high schools, overall and by urbanicity and province, 2017–18 COMPASS study (N = 122 high schools).

		Percent of schools with at least one e-cigarette retailer (i.e., proximity)	E-cigarette retailer density		
			Mean	Minimum	Maximum
500 m					
Overall		2.4	0.02	0	1
Urbanicity	Rural/small urban	1.9	0.02	0	1
	Medium urban	0.0	0.00	0	0
	Large urban	3.6	0.04	0	1
Province	Ontario	3.3	0.03	0	1
	Quebec	2.6	0.03	0	1
	Alberta	0.0	0.00	0	0
	British Columbia	0.0	0.00	0	0
1000 m					
Overall		13.8	0.23	0	3
Urbanicity	Rural/small urban	7.7	0.13	0	2
	Medium urban	20.0	0.20	0	1
	Large urban	17.9	0.32	0	3
Province	Ontario	14.8	0.21	0	3
	Quebec	18.4	0.32	0	2
	Alberta	0.0	0.00	0	0
	British Columbia	6.3	0.19	0	3
1500 m					
Overall		20.3	0.58	0	8
Urbanicity	Rural/small urban	11.5	0.31	0	4
	Medium urban	33.3	0.53	0	2
	Large urban	25.0	0.84	0	8
Province	Ontario	23.0	0.57	0	7
	Quebec	23.7	0.71	0	4
	Alberta	0.0	0.00	0	0
	British Columbia	12.5	0.56	0	8

obtained when analyses excluded younger students (grades 7 and 8) and only included younger students from Quebec.

4. Discussion

Surprisingly, only 1 in 10 high schools in our sample had at least one e-cigarette retailer within walking distance (1000 m) of the school. There was also wide variability in e-cigarette retailer density across schools; although many schools did not have an e-cigarette retailer within 1500 m, some schools had up to 8 e-cigarette retailers in close proximity. Given that e-cigarettes containing nicotine only recently became legally available for sale in Canada (Government of Canada, 2018), it is possible that the number of e-cigarette retailers may increase in the future as a function of new corporations that sell nicotine-based e-cigarettes entering the Canadian market. Additional surveillance data are warranted to examine how potential changes in the e-cigarette retail environment may impact e-cigarette use among youth populations over time.

To our knowledge, these are the first Canadian data to quantify the influence of the school environment on student e-cigarette use. Our data indicate that the school environment accounted for 7.3% of the variability in the likelihood a student currently used e-cigarettes. Previous evidence indicates that the school a student attended was significantly associated with their likelihood of using e-cigarettes (Corsi and Lippert, 2016) and other tobacco products (Cole and Leatherdale, 2014). The results of this study provide additional evidence for the importance of the school environment in preventing youth substance use. Additional data are needed to identify school-level factors, such as

Table 2
Association between e-cigarette retailer proximity and ever and current e-cigarette use, 2017–18 COMPASS study (N = 63,400 students, N = 122 high schools).

		Ever used e-cigarettes		Currently used e-cigarettes	
		%	AOR (95% CI)[a]	%	AOR (95% CI)[b]
E-cigarette retailer proximity					
Model 1: any retailers within 500 m	No	36.53	1.00	22.23	1.00
	Yes	33.10	1.04 (0.68, 1.60)	20.65	1.29 (0.71, 2.33)
Model 2: any retailers within 1000 m	No	37.08	1.00	22.65	1.00
	Yes	32.81	0.92 (0.75, 1.13)	19.65	1.01 (0.76, 1.34)
Model 3: any retailers within 1500 m	No	37.13	1.00	22.52	1.00
	Yes	33.79	1.01 (0.85, 1.20)	20.93	1.12 (0.88, 1.42)
E-cigarette retailer density					
Model 4: each additional retailer within 500 m		–	1.04 (0.68, 1.60)	–	1.29 (0.71, 2.33)
Model 5: each additional retailer within 1000 m		–	0.98 (0.88, 1.10)	–	1.04 (0.89, 1.21)
Model 6: each additional retailer within 1500 m		–	1.00 (0.95, 1.05)	–	1.03 (0.96, 1.10)

[a] From separate logistic regression models examining the likelihood of ever using e-cigarettes (n = 23,089) versus never using e-cigarettes (n = 40,311) for e-cigarette retailer proximity at each distance (i.e., 500 m, 1000 m, 1500 m) and e-cigarette retailer density at each distance, controlling for relevant factors.

[b] From separate logistic regression models examining the likelihood of currently using e-cigarettes (n = 14,063) versus not currently using e-cigarettes (n = 49,337) for e-cigarette retailer proximity at each distance and e-cigarette retailer density at each distance, controlling for relevant factors.

exposure to marketing and peer norms, that impact e-cigarette use and are amenable to change.

In line with evidence from California, USA (Bostean et al., 2016), the study findings suggest that e-cigarette retailer proximity and density around high schools are not significantly associated with student ever or current e-cigarette use. It is possible that youth access e-cigarettes through retail sources closer to their home and not their school. Alternatively, youth may purchase e-cigarettes online rather than through a physical retail location, which may be more convenient and allow them to bypass age verification measures (Williams et al., 2015). Finally, it is likely that students obtain e-cigarettes from social sources, such as family and friends (similar to accessing cigarettes (Croghan et al., 2003)). Additional data are necessary to identify how students access e-cigarettes and to compare policy environments that may influence e-cigarette access and use behaviors in order to inform appropriate regulation.

The current study is the first to explore the association between e-cigarette retailer proximity/density on youth e-cigarette use in Canada. This study only identified e-cigarette retailers online using a single search engine and the results did not appear to identify other retailers that may sell e-cigarettes (e.g., tobacco shops or convenience stores) (Czoli et al., 2018). Other studies have used multiple online search engines (Giovenco et al., 2016; Bostean et al., 2016). The current results likely underestimate the total number of retailers that sell e-cigarettes and the availability around schools. Given the rapidly changing language to refer to these devices, the survey may underestimate the number of e-cigarette users. Although the data are not nationally or provincially representative, they include e-cigarette retail data from a large, diverse sample of students.

5. Conclusions

Many schools have e-cigarette retailers in the surrounding environment and the school environment appears to influence student e-cigarette use. This study did not find an association between e-cigarette retailer proximity or density and youth e-cigarette use. Students may access e-cigarettes through other sources. Future work should identify the modifiable characteristics of the school environment that can be leveraged to address youth e-cigarette use.

Declaration of Competing Interest

The authors have no conflicts of interest to declare.

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