

Original quantitative research

Analysis of the geographical accessibility of vape shops in the vicinity of Quebec's secondary and college educational institutions

Éric Robitaille, PhD (1,2); Pascale Bergeron, MSc (1); Maxime Houde, MSc (1,3)

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Abstract

Introduction: A significant proportion of secondary school students and young adults in Quebec have experimented with electronic cigarettes (e-cigarettes). Both personal and environmental factors have been associated with the use of vaping products by youth. Geographical accessibility to the points of sale of these products may be one of these factors. The purpose of this study is to develop a profile of the spatial distribution of stores specializing in the sale of vaping products (vape shops) in the vicinity of secondary schools, colleges and CEGEPs in the province of Quebec.

Methods: We calculated the accessibility of businesses to account for geographical exposure. Analyses were conducted to provide a snapshot of the situation in Quebec and to identify associations between the characteristics of educational institutions and geographical accessibility to vape shops.

Results: A total of 299 vape shops were identified. Colleges are closer to a vape shop (median distance: 1.2 km) than are secondary schools (median distance: 2.3 km). Large private colleges located in urban areas are closer to specialized vape shops. Medium or large private secondary schools located in urban and more advantaged areas are also closer to a specialized vape shop.

Conclusion: This study is a step in developing an understanding of the location of vaping product shops and their geographical accessibility to young people. Important to consider is the geographical accessibility of young people to non-specialized shops that also sell e-cigarettes and then any potential connections between geographical accessibility to such non-specialized shops and the use of vaping products by young people.

Keywords: *electronic cigarette, e-cigarette, vaping, Geographic Information System (GIS), school, adolescents, young adults*

Introduction

Experimentation with electronic cigarettes (e-cigarettes) is widespread among secondary school students and young adults in Quebec. In 2014–2015, 27% of secondary school students in Quebec reported having used e-cigarettes in their lifetime, a proportion higher than in Canada overall (15% of students), and 8% reported having

used them within the last 30 days.¹ The same trends were observed in 2016–2017.² Of all the 18–24 year olds in Quebec in 2015, 32% had used e-cigarettes in their lifetime and 8% had used them recently.¹ Moreover, while the regular use of e-cigarettes among non-smoking adults over 35 years of age is a marginal phenomenon, a significant proportion of non-smokers among secondary school students use

Highlights

- In Quebec, we identified 299 points of sale specializing in vaping products (vape shops).
- Colleges are closer to a vape shop (median distance: 1.2 km) than secondary schools (median distance: 2.3 km).
- Area deprivation was not associated with the access to points of sale near college-level institutions.
- Quebec students attending private educational institutions, both college and secondary schools, and institutions located in urban areas have greater geographical accessibility to shops specializing in vaping products.

this product.¹ Recent longitudinal studies suggest that e-cigarette use among non-smoking youth may be an additional risk factor for smoking initiation.^{3–6}

Both personal and environmental factors have been associated with the use of vaping products by young people.⁷ Some studies suggest that, like tobacco products, geographical accessibility to the point of sale of these products may be one of the factors associated with their use. Access to as well as visibility of tobacco products through points of sale have been associated with their use among youth.^{8,9} Some American studies suggest that the same could be true for vaping products.^{10–12} Recent scientific investigations have focused

Author references:

1. Institut national de santé publique du Québec, Montréal, Quebec, Canada
2. Department of Social and Preventive Medicine, École de santé publique de l'Université de Montréal, Montréal, Quebec, Canada
3. Centre urbanisation culture société, Institut national de la recherche scientifique, Montréal, Quebec, Canada

Correspondence: Éric Robitaille, Institut national de santé publique du Québec, 190 Crémazie Blvd. East, Montréal, Quebec H2E 1P2; Email: eric.robitaille@inspq.qc.ca

on improving understanding of the spatial distribution of points of sale for vaping products in the USA,^{13,14} particularly in the vicinity of educational institutions.^{10-12,15,16}

Two US studies examined the impact of the geographical accessibility of the points of sale of vaping products on their use. One of these studies included shops specializing in the sale of vaping products alone (vape shops),^{10,11} while the other included both vape shops and tobacco outlets that also sell e-cigarettes.¹² The results of these analyses indicate a positive association between greater availability in shops selling vaping products that are near schools and the use of these products by students.

In Quebec as well as the rest of Canada, e-cigarettes are sold both in some non-specialized shops (such as convenience stores and gas stations) and in specialized shops (vape shops). In Quebec, points of sale specializing in vaping products, which are not accessible to minors, are authorized to display their products only indoors. However, since these shops remain visible from the outside, frequent exposure to them could provide an incentive for young people to use vaping products, for instance by increasing the perception of the accessibility of these products, a factor associated with e-cigarette use among secondary school students in Canada.¹⁷ Little data is currently available to capture this exposure in Quebec. Quebec organizations involved in tobacco control and public health have already mentioned the lack of valid information on the location of e-cigarette points of sale.^{18,19}

An analysis of the spatial distribution of specialized vape shops that are in the vicinity of Quebec educational institutions (secondary schools and colleges / CEGEPs*) will provide a better understanding of the geographical exposure of young people and young adults to the places where these products are sold. It will represent a first step in the development of knowledge on the geographical accessibility of young people to shops selling vaping products and the potential impact of this accessibility on the use of these products. Our article presents part of this analysis, which will be published in its entirety and

available on the Institut national de santé publique du Québec website.²⁰

Documenting the presence of specialized vape shops that are in the vicinity of secondary schools is important, as the school is the public place most frequented by adolescents. Colleges and CEGEPs are also attended by a significant proportion of minors, and the young adults who study there are also a priority for prevention of tobacco use in Quebec.²¹ Since November 2017, these post-secondary institutions have been required to have adopted a policy aimed at creating smoke-free environments.

Methods

Two steps were necessary to draw a portrait of geographical accessibility to specialized vaping product stores near educational institutions in Quebec: the development of a georeferenced directory of specialized vaping product shops in Quebec and of a georeferenced directory of educational institutions.

Directory of points of sale

Two main data sources were used to create the Quebec directory of stores specializing in vaping products: a list of stores from the Ministère de la Santé et des Services sociaux (MSSS) and a list based on an online search of business directories (via Yelp and Google). Figure 1 illustrates this process.

The list of 414 specialized vape shops supplied by the MSSS includes those that, after the adoption in 2015 of the province's *Tobacco Control Act*, applied to continue displaying their products inside their place of business, as permitted by the Act for establishments meeting certain criteria.²² As this list is not updated regularly, we verified whether the 414 vaping specialty shops were still in business using various online tools (Google Street View, Google, Yelp, Yellow Pages, Facebook, the online search tool of the Registraire des entreprises). In doing so, we reduced the list to 281 stores currently selling vaping products alone (Figure 1).

In the meantime, we conducted an online search to identify specialized vape shops open in Quebec at the time of our study (details of online search available on

request), via the Yelp (www.yelp.ca) and Google (www.google.ca) search engines. This methodology is based on the fact that government lists of the shops selling vaping products are rarely up-to-date.^{10,13,16,23} We obtained a list of 278 shops (Figure 1).

We merged these two lists (the MSSS and online search engine lists) and completed a final check of all 365 businesses found using the Google Street View online search engine and the Quebec Registraire des entreprises tool for some businesses, and telephone calls or a field visit for others (Figure 1). This data collection and verification process made it possible to identify 299 Quebec-based points of sale specialized exclusively in selling vaping products at the time of our study. These businesses were then geolocated using the Addresses Quebec website (<http://adressesquebec.gouv.qc.ca/index.asp>; n = 273) via their respective address or using Google Earth (<https://www.google.com/earth/>; n = 26).

Directory of institutions

For this analysis, we used files developed by the Ministère de l'éducation et de l'enseignement supérieur (Quebec Department of Education and Higher Education, MEES) that give the location of educational institutions in the Quebec school system to draw up lists of the secondary and college-level educational institutions.

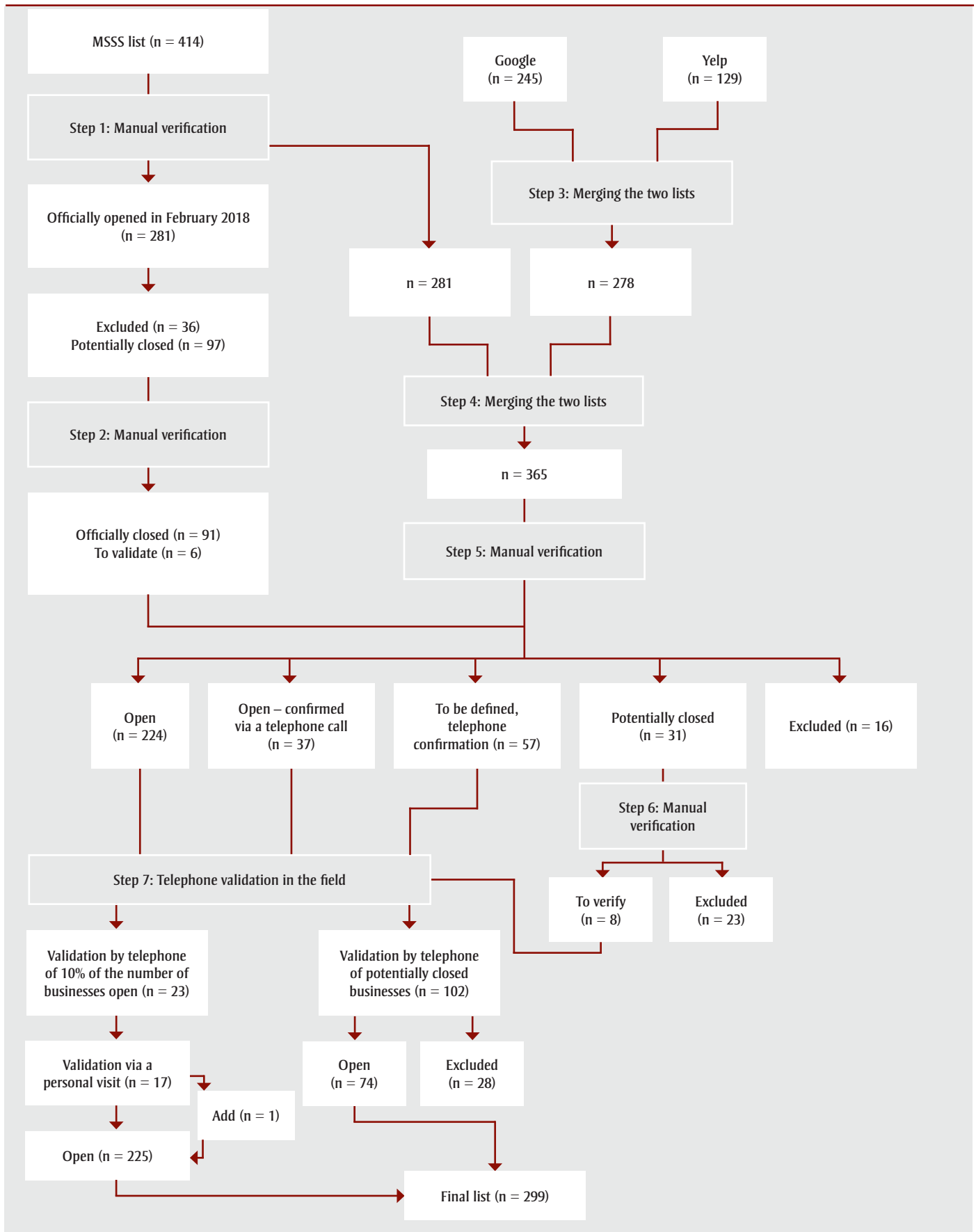
The MEES list of colleges obtained from the Quebec government's open data website identified 170 colleges at the time of this study, while the list of secondary schools includes 729 schools that were geolocated using their geographic coordinates (provided in the MEES list).

Institutional characteristics

In addition to the level of education (college or secondary school), we used two institutional characteristics in our analyses: the educational system (private or public) and the size of the student population. We also took into account the characteristics of the location of the institutions, namely the level of deprivation of the area in which the institutions are located as well as the rural or urban nature of the region.

* General and vocational college.

FIGURE 1
Steps in building the Quebec directory of points of sale specializing in vaping products



Institutions were broken down into four categories based on the size of their student population: very small, small, medium and large.

Each educational institution was assigned a dissemination area identifier based on its location. We linked this information to a material deprivation index used in public health surveillance.²⁴ This index is composed of indicators from Statistics Canada's 2011 National Household Survey: the proportion of people aged 15 and over without a secondary school certificate or diploma; the proportion of people aged 15 and over who are employed; and the average income of people aged 15 and over. We assigned a quintile from the material deprivation index²⁴ to the area in which each educational institution was located. We then divided the institutions into those in advantaged environments (quintiles 1, 2 and 3) and those in disadvantaged environments (quintiles 4 and 5).

We defined the rural or urban character of the area in which the institution was located based on whether it is located within or outside a population centre.[†]

Dependent variable

The dependent variable is a measure of geographical accessibility, that is, proximity to points of sale,²⁶ and corresponds to the distance (in metres) from an establishment to the nearest vape shop. This distance was calculated on the basis of the road network, using ArcGIS software version 10.5.1 (Esri Canada, Toronto, ON).

Statistical analyses

First, we conducted descriptive analyses in order to obtain the distribution of the variable of interest (distance in metres to the nearest shop) according to the various variables related to the characteristics of the educational institutions and their location. Subsequently, univariate and multivariate generalized linear models were used to measure the associations between the distance to the nearest shop and the characteristics of the institutions. Schools with missing data were excluded from the analysis of generalized linear models in order to use the same samples for model construction.

These statistical analyses were intended to identify associations to extract the type of institution and the category of student population, as these students are more exposed to the presence of a specialized shop near their educational institution.²⁷ We used a bottom-up step selection starting from an empty model and adding independent variables. Using the Akaike Information Criterion (AIC), we were able to select the model that best explained the data.²⁸ We used a logarithmic function to correct the asymmetry in the distribution of the dependent variable and reduce the weight dedicated to extreme values in the estimate of the parameters of the regression models. Multivariate statistical analyses were performed with SPSS version 19 (IBM, Chicago, IL, USA).

Results

This study identified 299 points of sale specializing exclusively in vaping products distributed across Quebec (Figure 2).

For the entire province of Quebec, the median distance of secondary schools to the nearest specialized vape shop is 2278 m (Table 1). More precisely, the median distance is 1993 m for private institutions and 2454 m for public institutions. The shortest median distance to the nearest shop is for educational institutions in advantaged areas (1979 m).

For the entire province of Quebec, the median distance of secondary schools to the nearest specialized point of sale is 1231 m (Table 2), specifically 1001 m for private educational institutions and 1381 m for public educational institutions. The median distance to the nearest shop is lower for educational institutions located in more advantaged areas (1231 m).

Distance to points of sale is treated as a continuous variable in a generalized linear regression model. Medium-sized (versus very small) and large (versus very small) educational institutions as well as urban (versus rural) institutions tend to have a specialized vape shop located closer. Private (versus public) educational institutions, as well as those located in disadvantaged (versus advantaged) areas, are geographically more distant from a vaping product shop (Table 3).

Public (versus private), small (versus very small) and medium-sized (versus very small) college institutions are significantly more geographically distant from a vaping product shop. Institutions located in rural areas are significantly further from a vape shop than urban institutions (Table 4).

Discussion

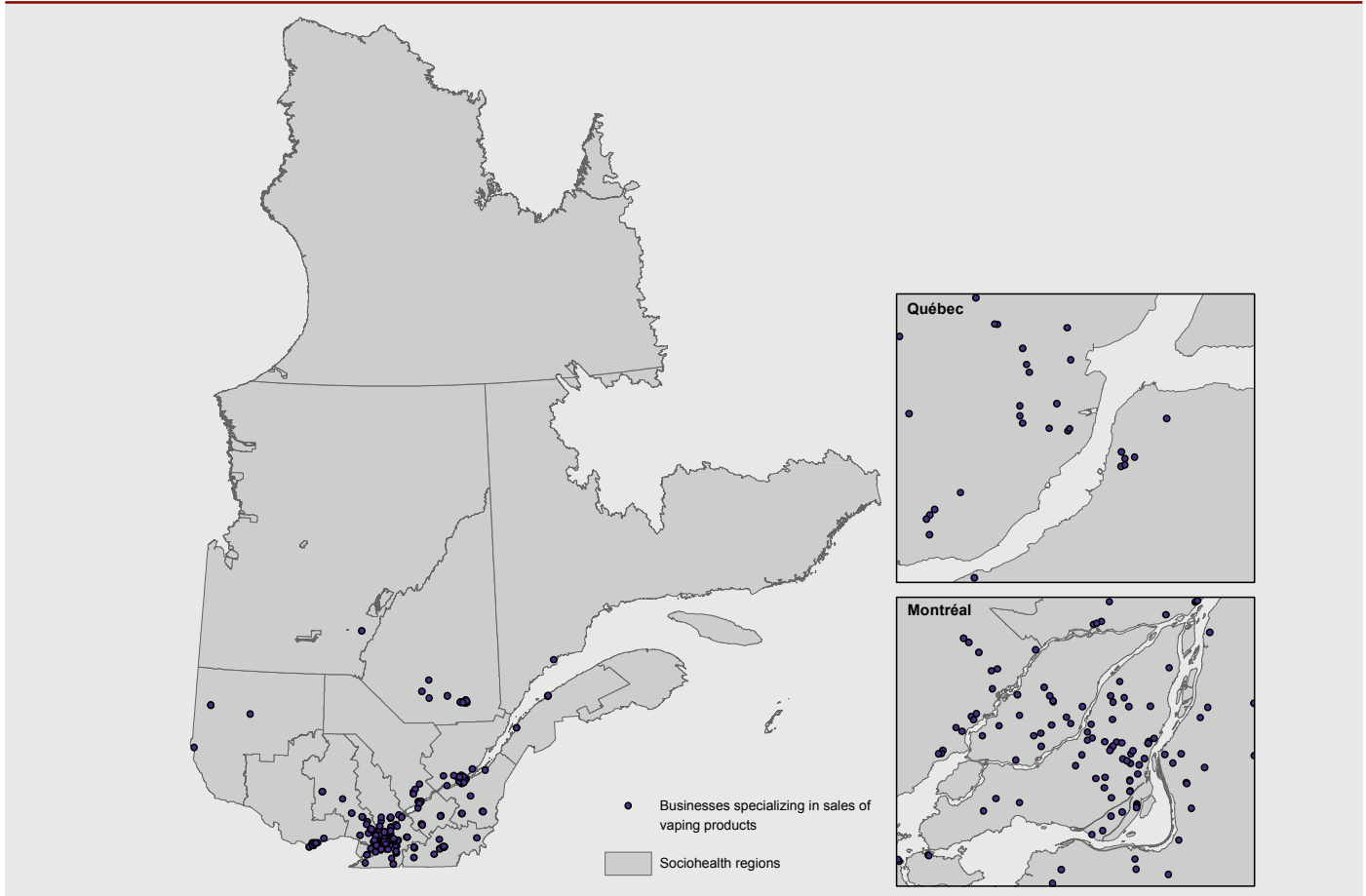
First, our study sought to build a georeferenced directory of specialized vape stores in Quebec, so that we could link them to educational institutions. We found that 299 businesses exclusively selling vaping products were open in Quebec in early 2018. Although a detailed analysis of the evolution of the presence of specialized shops in Quebec was beyond the scope of our study, the development and validation of our database leads us to believe that the number of this type of shop could be decreasing. The MSSS list compiled in 2015, which was used to build our directory, contained 414 businesses, while our final directory contains 299. A decrease in this type of business has been observed elsewhere, particularly in France.²⁹ The tightening of the legal framework and the decline of vaping as a fashion trend could be two factors that might explain this decline.

The main objective of our study was to examine, according to various characteristics, the geographical accessibility of specialized vape shops in Quebec that are in the vicinity of educational institutions. This analysis revealed that, in Quebec, colleges had greater accessibility to such specialized shops than did secondary schools. The same situation was observed in the USA: no specialized shop was found within 800 m of secondary schools in New Jersey,¹³ while 30% of all colleges across the USA were located within 1.6 km of a vape shop.¹⁶ However, the situation appears to vary across the USA: a study in California found that 28% of secondary schools had such a vape shop within an 800 m radius.¹⁰

A variety of reasons may explain why colleges and CEGEPs in Quebec tend to have greater geographical accessibility to this type of business. One explanation is that college campuses are generally located in more densely populated areas or urban agglomerations, which makes them more likely to be located near any business.

[†] "A population centre [is] an area with a population of at least 1,000 and a density of 400 or more persons per square kilometre. All areas outside population centres [are] defined as rural areas."²⁵

FIGURE 2
Spatial distribution of the 299 businesses specializing in the sale of vaping products in Quebec



Sources: MSSS, 2017; Yelp, 2018; Google, 2018. Compilation: INSPQ, 2018.

Our analysis also showed that more educational institutions in urban areas than in rural areas are located near specialized vape shops in Quebec. The same situation

has been observed in the United States. According to a study conducted across the USA, there is a greater availability of specialized vape shops in urban census areas

(0.47 average availability) than in rural areas (0.23 average availability).¹⁴ According to another US study, greater proximity to specialty shops is associated with urban areas: median distance from the nearest shop is 1.1 miles in the city; 1.9 miles in the suburbs; 6.3 miles in a smaller town or village; and 7.9 miles in rural areas).¹⁶

TABLE 1
Number, median distance, mean and standard deviation at the nearest point of sale, according to the characteristics of the secondary institution and its location

Secondary schools	Number	Median distance (m)	Mean distance (m)	Standard deviation
Characteristics				
Private institution	169	1 993	5 452	19 051
Public institution	543	2 454	47 591	145 594
Very small (1–115 students)	164	3 380	89 307	218 183
Small (118–429 students)	172	3 036	42 601	103 782
Medium (431–863 students)	177	2 054	19 609	84 505
Large (868–2540 students)	176	1 970	6 506	35 341
Environment				
Advantaged area	442	1 979	20 081	87 599
Disadvantaged area	270	3 711	66 249	172 858
Urban	578	1 914	15 219	60 705
Rural	134	33 492	134 076	247 027
Combined	712	2 278	37 589	128 712

Our study revealed that private educational institutions are located closer to specialized vape shops in Quebec. This situation was also observed in the USA: vape shops were more likely to be closer to private colleges (2.6 km for median proximity) than public ones (3.2 km for median proximity). The authors suggested that one of the reasons is that this type of trade potentially targets populations that are more socioeconomically advantaged and therefore more likely to attend private schools.¹⁶

One of the objectives of our analysis was to examine the proximity of specialized vape shops to educational institutions

TABLE 2
Number, median distance, mean and standard deviation at the nearest point of sale, according to the characteristics of the college and its location

College	Number	Median distance (m)	Mean distance (m)	Standard deviation
Characteristics				
Private institution	78	1 001	2 033	2 695
Public institution	92	1 381	30 624	98 290
Very small (5–106 students)	37	942	1 406	1 261
Small (107–497 students)	36	927	47 375	138 623
Medium (502–1930 students)	37	1 750	27 180	70 820
Large (1944–11 062 students)	36	1 122	1 236	685
Environment				
Advantaged area	102	1 231	12 326	44 607
Disadvantaged area	47	1 750	36 101	122 346
Urban	152	1 077	12 100	48 727
Rural	18	7 104	63 154	173 837
Combined	170	1 231	17 506	73 549

according to the level of material deprivation of the area. Our analysis revealed that vape stores are closer to secondary schools in advantaged areas, but area deprivation was not associated with accessibility to points of sale in conjunction with colleges.

A similar situation exists in the USA. A study conducted in New Jersey, USA, showed that neighbourhoods with an average median household income—as opposed to the lowest—were more likely to be associated with a higher number of specialized vape shops.¹³ In another study

conducted in New Jersey, USA,³⁰ more shops (specialized and non-specialized) selling e-cigarettes were identified near schools with fewer students eligible for free school meals than near less advantaged schools.

Some researchers have hypothesized that this type of business potentially targets populations that are more socioeconomically advantaged and yet still have high proportions of smokers.¹⁶ In fact, the e-cigarette, especially the starting device, is more expensive than tobacco and therefore requires, to a certain extent, more resources. As we have seen, more private educational institutions are located near such shops in Quebec, probably also because a more affluent clientele attends these schools.

It is important to note, however, that across the USA there appears to be a greater availability of specialized vape shops in both urban and rural census areas where fewer people own their own homes, an indicator of lesser socioeconomic advantage. Similarly, the availability of specialized vape stores would be expected to be more prevalent in areas where fewer people have a level of education equal to or higher than college level; however, the associations between the proportion of people living below the poverty line in an area and the availability of vape shops were not significant.¹⁴

TABLE 3
Generalized linear regression model: distance from the 689 secondary schools in Quebec to the nearest specialized shop selling vaping products

Log (distance to the nearest point of sale ^a , in meters)	Univariate model		Final multivariate model	
	B ^a	95% CI	B ^a	95% CI
Intercept			4.49***	4.35 to 4.64
Characteristics				
Private institution	Ref.	–	Ref.	–
Public institution	0.34***	0.21 to 0.47	0.23***	0.11 to 0.34
Very small	Ref.	–	Ref.	–
Small	–0.10	–0.25 to –0.07	–0.00	–0.13 to 0.13
Medium	–0.43***	–0.59 to –0.27	–0.25***	–0.38 to –0.11
Large	–0.59***	–0.75 to –0.43	–0.36***	–0.50 to –0.28
Environment				
Urban	Ref.	–	Ref.	–
Rural	–1.1***	–1.21 to –0.97	–0.92***	–1.04 to –0.79
Advantaged area	Ref.	–	Ref.	–
Disadvantaged area	0.46***	0.35 to 0.57	0.21***	0.11 to 0.31

Abbreviations: CI, confidence interval; ref., reference.

^a Distance (in metres) from the educational institution to the nearest point of sale. B is the regression coefficient in the multivariate analysis. A high positive coefficient is related to an increase in the log (distance) of the point of sale closest to the educational institution. A negative coefficient is related to a decrease in the log (distance) of the point of sale closest to the educational institution.

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

Strengths and limitations

To our knowledge, this is one of the only profiles of the spatial distribution of businesses specializing in the sale of vaping products in Quebec and Canada. The presence of specialized vape shops in the study area was carefully validated (by phone, in person and through the use of various databases). We included several types of schools (private and public, secondary schools and colleges), with variable enrolment. We also took into account the characteristics of the location of these institutions, namely the types of environment (urban or rural, disadvantaged or advantaged). From this point of view, there seems to be an interaction between the urban or rural character and the type of education (private or public), and between the type of education and level of deprivation. Such analysis is beyond the scope of this article, and further research is recommended.

TABLE 4
Generalized linear regression model: distance from the 126 colleges in Quebec to the nearest specialized shop selling vaping products

Log (distance to the nearest point of sale ^a , in meters)	Univariate model		Final multivariate model	
	B ^a	95% CI	B ^a	95% CI
Intercepted			3.50***	3.07 to 3.93
Characteristics				
Private institution	Ref.	—	Ref.	—
Public institution	0.48***	0.22 to 0.74	0.51***	0.26 to 0.75
Very small	Ref.	—	Ref.	—
Small	0.42*	0.06 to 0.77	0.27	−0.01 to 0.56
Medium	0.52**	0.17 to 0.88	0.20	−0.10 to 0.51
Large	−0.22	−0.38 to 0.34	−0.31	−0.64 to 0.02
Location				
Urban	Ref.	—	Ref.	—
Rural	−0.86***	−1.30 to −0.42	−0.66***	−1.04 to −0.27
Advantaged area	Ref.	—	N/A	N/A
Disadvantaged area	0.19	−0.09 to 0.47	N/A	N/A

Abbreviations: CI, confidence interval; ref., reference.

^a Distance (in metres) from the educational institution to the nearest point of sale. B is the regression coefficient in the multivariate analysis. A high positive coefficient is related to an increase in the log (distance) of the point of sale closest to the educational institution. A negative coefficient is related to a decrease in the log (distance) of the point of sale closest to the educational institution.

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

Some limitations should also be mentioned. Specialist vape shops are only a part of e-cigarette business in Quebec: vaping products are also available in other stores, in particular, in convenience stores, tobacconists and gas stations. Unlike specialized vape shops, minors can enter these places, although they cannot legally buy e-cigarettes; and like tobacco products, vaping products must not be visible to customers. Since not all of these businesses sell vaping products, a field visit would have been necessary to identify them, which was beyond the scope of our analysis. Thus, our profile underestimates the true geographical accessibility of points of sale for vaping products to young people near schools.

It would be relevant to continue this analysis to include these points of sale, not least because research in the USA has shown that they are present near schools.^{12,15} Moreover, the geographical accessibility of young people to the points of sale of various products (including tobacco and vaping products) can be defined differently from schools: near places of residence or near other places that youth frequent (e.g. sports, cultural

and recreational centres). In fact, it is increasingly recognized that research must also include several of these places simultaneously.³¹ Considering only accessibility near schools means that only a portion of the geographical accessibility of young people to the points of sale of these products is taken into account, even if the school is the public place most frequented by young people over the longest period. It would therefore be appropriate to expand on this research given that studies have shown that young people's accessibility to tobacco sales outlets in the vicinity of their homes is associated with the consumption of these products.³² Our analysis was not intended to examine the use of vaping products by young Quebecers based on the geographical accessibility of specialized vape shops that are near educational institutions.

Conclusion

Experimentation with e-cigarettes is widespread among young adults in Quebec and among many secondary school students. The factors associated with the use of vaping devices by youth are currently the subject of scientific research. It is

possible that geographical accessibility to shops selling these products may be one of these factors, as is the case for tobacco products. As these factors are still largely unknown in Quebec, we have undertaken to provide a snapshot of the geographical accessibility of points of sale specializing in vaping products that are in the vicinity of educational institutions.

Our analysis suggests that specialized vape shops are more easily accessible to students attending college than secondary school. They also appear to be more accessible to students attending private institutions than public ones. For secondary schools, those located in more advantaged areas are closer to a specialized vaping product point of sale. Speciality stores are closer to schools in urban areas than in rural areas.

Future investigations should examine geographical accessibility to all businesses that sell e-cigarettes (such as some convenience stores, tobacco stores and gas stations) and studying the impact of this accessibility on the use of vaping products by young people.

Public health experts agree on the need to limit the use of vaping products among young people in order not to induce nicotine dependence or to provide an incentive for the subsequent use of tobacco products. It is important to continue to improve scientific knowledge about vaping products, their use and marketing and the places where they are sold. In Quebec and Canada overall, legislation has been passed in an attempt to restrict young people's access to vaping products while allowing adults who want to quit smoking access to them. It is relevant and worthwhile to continue research in this changing regulatory environment.

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Conflict of interest

The authors declare that there are no conflicts of interest.

Authors' contributions and statement

ER and PB designed the project. ER, PB and MH designed the study. MH undertook

the data collection. ER and MH conducted the data analysis. ER wrote the manuscript. ER and PB contributed to the synthesis of the data. All the authors contributed to the discussion of the findings and their interpretation, as well as to the writing of the manuscript and approval of its final version. The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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