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REPORT

Geographical analysis of the accessibility of fast-food restaurants and convenience stores around public schools in Québec

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Summary

Background

In Québec, nearly one in five children suffers from excess weight and the situation has greatly deteriorated over the past 25 years. This situation results from a large number of individual and environmental factors, including the food environment around schools. In the United States, a number of studies have documented the substantial presence of fast-food restaurants and convenience stores around schools. These types of food outlets are also more numerous around schools in disadvantaged neighbourhoods. In Québec, aside from the island of Montréal, not much is known about the food landscape around educational institutions or around schools in rural areas.

Method

Ten- and fifteen-minute walking zones were defined around public schools in Québec (n = 2302). Fast-food restaurants (n = 1787) and convenience stores (n = 3446) included in these zones were selected using a business directory and names of business. Logistic regression analyses were conducted using dichotomous variables (presence or absence of fast-food restaurants and convenience stores). Analyses were carried out for zones that are within 10- and 15-minute walks around schools. Different models were developed for schools located in rural settings and those in urban areas. Regression models also include variables that characterize the schools (education cycles and level of deprivation).

Results

Results show that within a 15-minute walk of public schools in Québec, there is a least one fast-food restaurant and one convenience store, or 37% and 62% respectively. These figures do not change significantly for most health regions in Québec. In urban settings, such as Montréal and Laval regions, there are more schools with food outlets nearby. High schools (rural and urban) are more likely to have at least one fast-food restaurant within a 10-minute walking distance. Schools located in urban settings where the level of deprivation is high are significantly more likely to have a fast-food restaurant nearby; this relationship is not significant for convenience stores. However, the probability that a convenience store is located within a 15-minute walking zone from a school is significantly greater for high schools in rural areas.

Conclusions

The close proximity of fast food restaurants and, more specifically, convenience stores around schools could counter the provincial government's efforts regarding the implementation of a healthy food policy in these schools. Further analyses of the proportion of students using these businesses, however, should be performed to better estimate their impact on the eating habits of young people.

Context

In Québec, more than one in five children aged 2 to 17 are considered to have excess weight: 15.5% are overweight and 7.1% are obese (1). In Canada, the percentage of youth who have excess weight has increased considerably over the past 25 years, rising from 15% in 1978-1979 to 26% in 2004 (1).

Although the sedentary lifestyle adopted by many children and adolescents has greatly contributed to this situation, the poor eating habits characteristic of these individuals are also a major factor (2). In the seven days preceding a broad survey of young Quebecers' diets, no less than 54% of them (9 to 11 years old) had eaten items from fast-food restaurants (3). Regular consumption of these types of foods, which are often very fatty and sweet, has been associated with an increased risk of obesity (4-6).

Adopting healthy lifestyle habits does not result only from individual goodwill, but rather from interaction between individual and environmental factors (social, economic, political, physical and media environments) (7-10). The food environment in various settings where young people are (family, residential neighbourhood, school) greatly influences their eating habits (11-12).

Thus, there has been much interest in food environments around schools as an element that can contribute to childhood obesity. A number of researchers have shed light on the concentration of fast food restaurants around schools in the United States (13-15). Such a concentration has also been demonstrated in Montréal, where almost 75% of schools were near (within a one-kilometre radius) at least one fast-food restaurant (16). This concentration appears to be even greater around high schools (14-15). In addition to fast-food restaurants, convenience stores are also often present around American schools (13-15).

Moreover, the food environments around schools vary based on a neighbourhood's socioeconomic status. Schools located in disadvantaged neighbourhoods are closer to fast-food restaurants and convenience stores (15) than those located in wealthier areas. In Canada, some studies have made similar findings (16) though others have not (17). It has also been demonstrated that a higher concentration of fast-food restaurants characterizes disadvantaged residential neighbourhoods (18-19), especially in Edmonton (20-21).

In addition, although some differences have been noted between food environments in urban and rural communities (17), the situation in rural settings continues to be relatively unknown. More studies are needed to better characterize the food environments around schools in rural areas.

In Québec, only a few studies have focused on the food environment in communities and around schools, and they are largely limited to the region of Montréal (16, 22, 23). Relatively little is known about regions outside the city. The current study aims to offset this lack of information.

Objective and questions

The objective of this study is to describe the food environments around public schools in Québec. More specifically, we will analyze access to fast-food restaurants and convenience stores around schools. We will then analyze the environment according to a school's level of deprivation, location (urban and rural, health region), and education (elementary (children aged between 5 and 12 years) or secondary (children aged between 12 and 17 years) schools, and integrated elementary/secondary schools). Our main research questions are as follows: How accessible are fast-food outlets and convenience stores around public schools in Québec? Does access vary by the health region in which the school is located? Does access to fast-food restaurants and convenience stores vary according to a school's level of deprivation?

Methods

Data

School databases

For this study, we used two databases from the Ministère de l'Éducation, du Loisir et du Sport du Québec (MELS). The first includes information on the geographical addresses of public educational institutions in Québec (n = 2356). This database was paired with a second one (MELSQ) that comprises data related to level of deprivation of public schools.

MELSQ annually calculates deprivation indices of the schools in the 69 school boards in the province. The Ministère uses these indices to introduce policies that aim to reduce the impact of deprivation of elementary and secondary school students. The data used to calculate these indices were taken from the Canadian census and concern the situation of families with children aged 0 to 18 years old from neighbourhoods where students attend the different schools. One of these indices is low-income cut-off (LICO), which measures the proportion of families living at or below the low-income cutoff point (24). LICO is calculated for each school, and schools are rated on a scale from 1 (not very deprived) to 10 (very deprived). This database includes 1878 elementary schools and 566 high schools (n = 2444). We were compelled to eliminate private schools from our sample because we used MELSQ data to define level of school deprivation.

Pairing the two databases allowed us to create a new database composed of 2302 spatially-locatable schools. A geolocation process was then completed using the addresses of public schools included on the MELSQ list. The process was conducted with an online tool and enabled us to geolocate 430 high schools, 1738 elementary schools, and 134 integrated elementary and secondary schools (n = 2302) (25).

Convenience store and fast-food restaurant database

The information about convenience stores and fast-food outlets comes from a commercial database (26) that contains the locations of over a million Canadian businesses and points of recreational interest. These businesses were geolocated on address (84% of cases), postal code (14%), and central point of the municipality (2%). Directory data were updated on 15 August 2007. Businesses in this database are classified according to the Standard Industrial Classification (SIC) introduced by

the American government in 1987. These four-digit codes illustrate each company's main activity. For our analyses, we selected all businesses in Québec whose main activity is classified under code 5411 (*Grocery Stores*) for convenience stores, and 5812 (*Eating Places*), 5461 (*Retail Bakeries*) and 5499 (*Miscellaneous Food Stores*) for fast-food restaurants. Categories 5461 and 5499 include a significant number of restaurants serving meals and pastries, such as Tim Hortons and Dunkin' Donuts. The business type classification used does not distinguish fast-food restaurants from table-service establishments. A fast-food restaurant is considered a food service outlet where the client orders or selects items and pays before consuming them (27). To select the fast-food restaurants included in the database, we opted for a method based on a list of large restaurant chains ($n = 1787$) (Table 1). This selection method has been used previously in a few studies (14, 28-32). A similar process was undertaken for convenience stores, since classification codes in the database did not distinguish these shops from grocery stores. We selected both large convenience store chains as well as businesses that included the words *dépanneur* and *accommodations* (convenience) in the company name ($n = 3446$) (Table 2).

Schools in urban or rural areas

We used geographical details from census metropolitan areas and census agglomerations to determine whether schools were located in urban or rural settings. Rural regions and small towns are linked to populations living outside the commuting zones¹ of large urban centres or outside census metropolitan areas or census agglomerations (34). Of the 2302 schools in our sample, 1587 are located in urban areas and 715 in rural settings. This classification, based on the schools' geographical situation, allows us to verify if their exposure to fast-food restaurants and convenience stores varies according to these characteristics (education level, level of deprivation) for schools in urban as well as rural settings.

¹ According to Statistics Canada, commuting is linked to the commuting flows of individuals who report living in a municipality and working in a different municipality. The latter must be located less than 250 km from the place of residence. Thus, commuting zones in urban centres are defined as being within a perimeter of 250 km around these centres or by the boundaries of census metropolitan areas and census agglomerations (33).

Analyses

Glanz et al. (2005) indicate that a nutrition environment which influences health and individual behaviours can be divided into four nutrition sub-environments: community; organizational; consumer; and information. The *community nutrition environment* is defined by the number and type of food outlets available to the population and the accessibility of these outlets. Accessibility to these sources can include stores that offer food products for consumption at home (convenience stores, grocery stores and supermarkets) and in restaurants (table-service and fast-food restaurants) (35).

The community nutrition environment can be characterized objectively using measures of accessibility to food outlets. These measures of accessibility can be represented by calculations of the distance between place of residence and the closest outlet; the number of businesses within a given sector or radius; and average distance between a participant's residence and all businesses or n number of businesses (36). We should note that other non-spatial measures can be taken into account in a consumer's use of various food outlets. However, these other dimensions of accessibility (economic accessibility, acceptability and convenience) are difficult to operationalize based on information acquired from business directories (37). For this reason, our analyses essentially focus on geographical accessibility to these food outlets.

For each geolocated school ($n = 2302$), 10- and 15-minute walking buffer zones were created (Figure 1). These buffer zones were built by analyzing the road network. There are two possibilities for creating buffer zones: the first uses the straight-line method, that is, measuring the closest distance between two points without taking the urban grid into consideration. This method produces circular buffer zones. The second option is more specific and takes into account the reality on the ground, since it is based on the road network. The process is relatively simple. The first step consists of geolocating the schools ($n = 2302$). Then, using the territory's local road network, it is possible to calculate the time needed to travel each stretch of road. In our case, the time needed was computed based on a walking speed of 4 km/hour. Using the Network Analyst extension of ArcGIS 9.2 and Service Area analysis, we combined the two items (location of schools and time needed to travel the stretches of road on foot) (38). With this function we can specify the size of buffer zones we wish to create (e.g. 10 or 15 minutes). Finally, the software computes all possible routes starting from the

school in order to create the buffer zones. A 15-minute walking buffer zone (radius of about 640 metres) was selected since it provides destinations within easy walking distance for individuals (39, 40). However, students' walking time is limited during lunchtime. For

these reasons, we also created 10-minute walking buffer zones (about 400 metres), a walking distance equal to the 400-metre buffer zones used in some other studies (14; 27; 41).

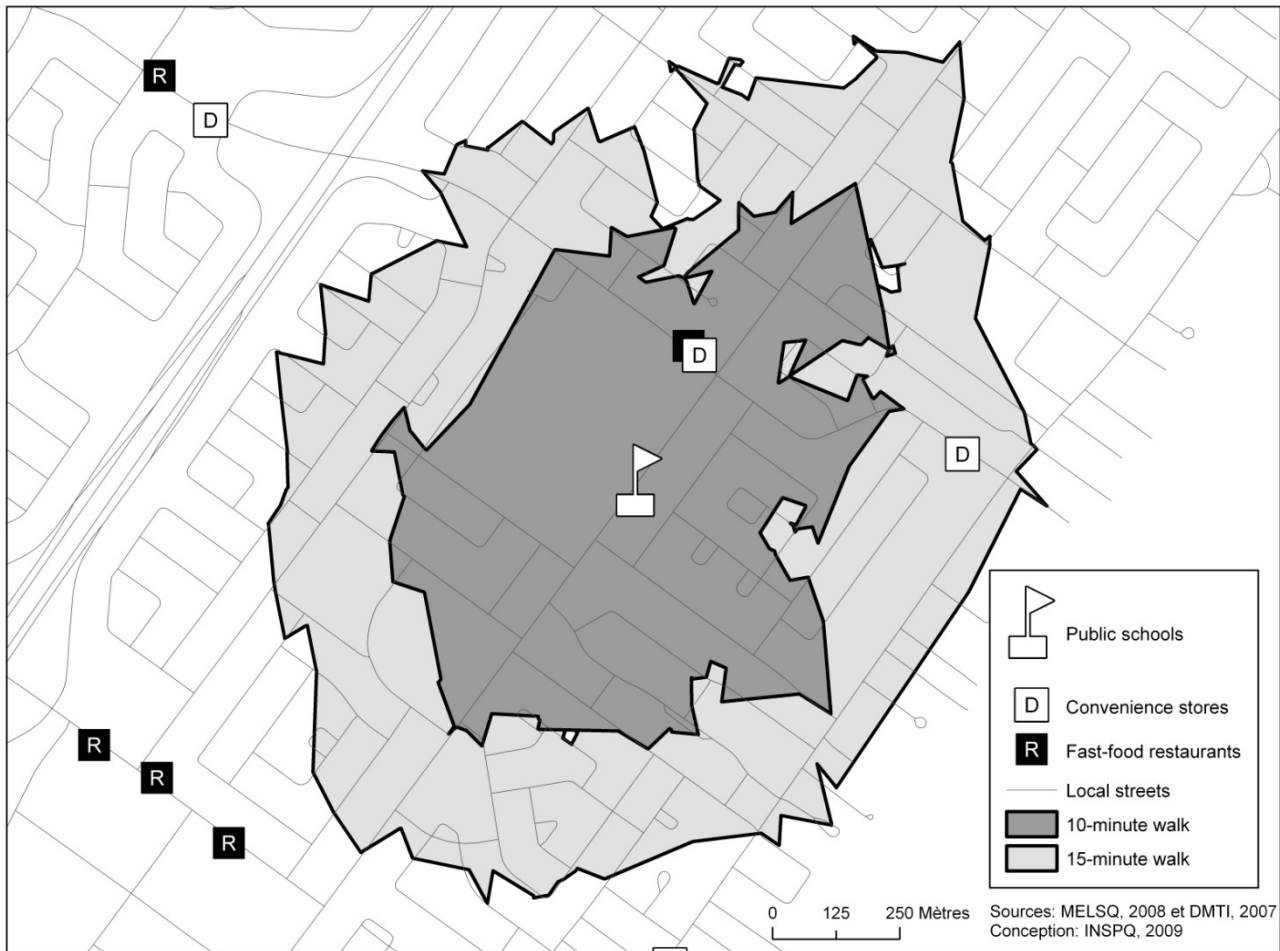


Figure 1 10- and 15-minute walking buffer zones, schools, fast-food restaurants and convenience stores

Table 1 List of fast-food restaurants included in the analyses

Name of the chain	Number of restaurants
A & W	78
BURGER KING	70
DOMINO'S PIZZA	26
DUNKIN DONUTS	132
HARVEY'S	76
LA BELLE PROVINCE	149
LAFLEUR	25
MCDONALD'S	261
PFK/KFC	210
SUBWAY	443
TIM HORTONS	275
VALENTINE	114
WENDY'S	12
QUIZNOS SUB	20
Total	1787

Table 2 List of convenience stores included in the analyses

Name of the chain	Number of outlets
COUCHE-TARD	474
PROVI-SOIR	37
PETRO-CANADA	14
PÉTRO-T	2
BONI-CHOIX	1
BONISOIR	55
DÉPANNEUR	2888
ACCOMODATION	39
Total	3446

First, we calculated the number of fast-food restaurants and convenience stores around each school. Then we divided this information into schools with a fast-food restaurant or convenience store within a radius of 10- and 15-minute walking distances, and schools with no fast-food restaurant or convenience store within these same distances.

We calculated the average number of food outlets and the proportion of schools with at least one fast-food restaurant and one convenience store within the 10- and 15-minute walking distances. Variables included in the analyses include location of school (urban or rural), education level (elementary, secondary, integrated elementary/secondary), and school socioeconomic deprivation (low-income cutoff index, quartiles). Descriptive analyses were performed, using the proportion of schools with at least one food outlet within 10- and a 15-minute walking distances and the average number of food outlets within these same distances. To verify if the differences between the proportions of schools with at least one fast-food restaurant and one convenience store within the various walking zones are

significant, we conducted non-parametric chi-square tests as well as proportion tests. T-tests for independent samples were used for the average number of food outlets.

For multivariate analyses, we opted for a logistic regression model using as dependent variable the presence or absence of fast-food restaurants and convenience stores within a 10- and a 15-minute walking radius around each school, given that a good number of schools did not have food outlets present. Regression analyses were conducted for schools located in rural settings and those in urban areas. This option was chosen to verify if a school's exposure to these food outlets would always be significant, notwithstanding its location. Statistical analyses were performed using SPSS 16.0 (42).

Finally, the proportion of schools with at least one outlet within a 15-minute walking radius was also calculated for health regions in Québec. Regional analyses were carried out for schools in urban areas and those in rural settings. Statistical tests were then produced by comparing the values obtained for the rural regions and those for the rest of the province. The objective here was to determine if the proportion of schools with at least one nearby food outlet differed significantly in a given region compared with the rest of the health regions in Québec. Bonferroni corrections were made to adjust levels of significance for multiple comparisons (43).

Results

Fast-food restaurants

Overall, 22% and 37% of public schools in Québec are within a 10- and 15-minute walking distance respectively from a fast-food restaurant (Table 3). The proportion of schools within a 10-minute or less walking radius of a fast-food restaurant is higher for high schools (29%) than for elementary schools (21%). School exposure to a fast-food restaurant is much higher in urban (29%) than rural (7%) settings. This difference remains constant for 15-minute walking zones, although the proportion of schools in rural areas with at least one fast-food restaurant within this zone rises to 11%, a 38% increase compared to 10-minute zones. According to descriptive analyses, it appears that the proportion of schools with a fast-food restaurant within a 10-minute walking radius is significantly higher for schools for which the low-income cutoff (LICO) index is in the most deprived quartile (43%) compared with schools in the least deprived quartile (10%). Schools in the most deprived quartile (4) have an

average of 1.01 fast-food restaurants in a 10-minute zone, whereas those in the least deprived quartile have an average of 0.19 restaurants within this zone.

Table 3 Average number of fast-food restaurants and proportion of schools with a least one fast-food restaurant within a radius of 10- and 15-minute walking distance, by education level, location (urban, rural), and low-income cutoff (LICO) index

	Number of schools	Average number of fast-food restaurants within a 10-minute walking zone	% of schools with a least one fast-food restaurant within a 10-minute walking zone	Average number of fast-food restaurants within a 15-minute walking zone	% of schools with a least one fast-food restaurant within a 15-minute walking zone
All schools	2302	0.47	22.20	1.09	36.84
Education level					
(1) Elementary (ref.)	1738	0.42	20.60	1.01	34.75
(2) Secondary	430	0.62**	29.30***	1.37***	46.28***
(3) Integrated elementary/secondary	134	0.57	20.15	1.19	33.58**
Location					
(1) Urban (ref.)	1587	0.63	29.13	1.49	48.46
(0) Rural	715	0.10***	6.80***	0.20***	11.05***
LICO index quartiles					
(1) (ref.) (least deprived)	573	0.19	9.90	0.88	29.32
2	577	0.30**	17.01***	1.02	36.92**
3	579	0.37***	18.58***	1.02	35.92**
4 (most deprived)	573	1.01***	43.30***	1.43***	45.20***

* p < 0.05.

** p < 0.01.

*** p < 0.001.

Results of logistic regression analyses, which model the presence or absence of at least one fast-food restaurant in 10- and 15-minute walking zones around schools, are similar to those obtained from univariate analyses (Table 4). High schools are more likely to have at least one fast-food restaurant within a 10-minute walking zone than elementary schools, both in urban (OR = 1.39; 95% CI 1.07–1.83)² and rural settings (OR = 2.32; 95% CI

1.11–4.84). Results are similar for 15-minute walking zones. Finally, schools in urban areas and in the most deprived quartile are more likely to have at least one fast-food restaurant in a 10-minute walking zone than less deprived schools (urban, 10 minutes: OR = 1.58; 95% CI 1.16–2.17). Results are similar for 15-minute walking zones; however, the level of significance of the relationship is higher (OR = 1.99; 95% CI 1.50–2.65). For schools in rural locations, this association is not significant for 10-minute zones but becomes significant for 15-minute zones for schools in deprivation quartile 2 (OR = 2.16; 95% CI 1.05–4.42). Figure 2 illustrates the increase in the proportion of schools with at least one fast-food restaurant within a 15-minute walking zone, based on the school's deprivation level and location (urban and rural).

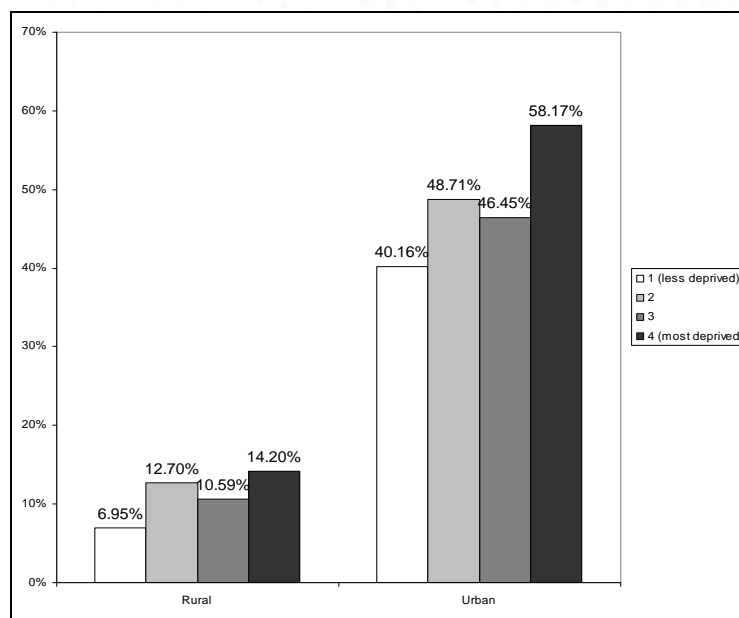
² OR or odds ratio: An odds ratio is a statistic generated by a logistic regression. It can be used to assess whether, other things being equal, schools with specific characteristics (education level and LICO index quartile) are more or less likely to have at least one food outlet within 10- or 15-minute walking buffer zones. For example, if we consider the risk for a high school of having at least one food outlet compared with an elementary school (reference category), an odds ratio near 1.0 means there is no difference between the two groups. An odds ratio less than 1.0 indicates that members of the group under study (i.e. high schools) are less likely to have a food outlet nearby than schools in the referent group (i.e. elementary schools). An odds ratio greater than 1.0 indicates that members of the group under study are more likely to have a food outlet nearby than schools in the referent group (44).

Table 4 Results of logistic regression models, associations (odds ratio [OR]) between proximity (10- and 15-minute walking distances) of at least one fast-food restaurant and school characteristics (n = 2302)

	Fast-food restaurant, 10-minute walking distance (rural)	Fast-food restaurant, 10-minute walking distance (urban)	Fast-food restaurant, 15-minute walking distance (rural)	Fast-food restaurant, 15-minute walking distance (urban)
	Logistic, OR (95% CI)	Logistic, OR (95% CI)	Logistic, OR (95% CI)	Logistic, OR (95% CI)
Education level				
(1) Elementary (ref.)				
(2) Secondary	2.321* (1.112–4.843)	1.399** (1.070–1.828)	2.209** (1.201–4.065)	1.367** (1.060–1.761)
(3) Integrated elementary/secondary	1.464 (0.535–4.011)	1.222 (0.723–2.067)	1.432 (0.631–3.248)	1.270 (0.778–1.943)
LICO index quartiles				
1 (least deprived)				
2	1.584 (0.677–3.706)	1.450* (1.051–1.999)	2.156* (1.051–4.422)	1.452** (1.091–1.934)
3	1.355 (0.556–3.305)	1.295 (0.941–1.783)	1.736 (0.817–3.689)	1.310 (0.988–1.738)
4 (most deprived)	1.334 (0.564–3.156)	1.584** (1.156–2.171)	1.872 (0.905–3.871)	1.991*** (1.496–2.650)

* p < 0.05.
 ** p < 0.01.
 *** p < 0.001.

Figure 2 Proportion of schools with at least one fast-food restaurant within a 15-minute walking zone, by location (urban/rural) and LICO



Convenience stores

Overall, 48% and 62% of public schools in Québec are within a 10- and a 15- minute walking distance, respectively, from a convenience store (Table 5). Results of descriptive analyses show that the proportion of schools with at least one convenience store within a 10-minute walking radius does not differ significantly according to education cycle. However, when the 15-minute zone around the school is considered, the proportion of high schools with at least one convenience store nearby is moderately higher (68%). The average number of convenience stores per school is also slightly higher for high schools (high school: 2.94; elementary: 2.45). As is the case for fast-food restaurants, the proportion of schools with at least one convenience store within a 10-minute walking zone is much higher in urban (60%) than in rural (22%) areas. This difference remains

constant for 15-minute walking zones. Nevertheless, the proportion of schools in rural areas rises to almost 31% and those in urban settings to almost 77%. These initial descriptive analyses demonstrate that the proportion of schools with at least one convenience store within 10- and 15-minute zones does not fluctuate significantly based on a school's level of deprivation. The average number of convenience stores appears to be greater for the most deprived schools based on the LICO index compared with the least deprived ones. Results of logistic regression analyses for presence or absence of at least one convenience store within 10- and 15-minute walking buffers around schools show almost no significant association with a school's characteristics. The probability that a convenience store is located in a 15-minute walking zone from a school is significantly greater for high schools in rural areas (OR = 2.568; 95% CI 1.639–4.024) (Table 6).

Table 5 Average number of convenience stores and proportion of schools with a least one convenience store within a 10- and a 15-minute walking radius, by education cycle, location (urban, rural), and low-income cutoff (LICO) index

	Number of schools	Average number of convenience stores within a 10-minute walking zone	% of schools with a least one convenience store within a 10-minute walking zone	Average number of convenience stores within a 15-minute walking zone	% of schools with a least one convenience store within a 15-minute walking zone
All schools	2302	1.24	47.96	2.50	62.38
Education level					
(1) Elementary (ref.)	1738	1.25	47.76	2.45	61.33
(2) Secondary	430	1.30	50.00	2.94*	68.60**
(3) Integrated elementary/secondary	134	0.85*	44.03	1.68**	55.97
Location					
(1) Urban (ref.)	1587	1.66	59.58	3.41	76.56
(0) Rural	715	0.30***	22.21***	0.47***	30.91***
LICO index quartiles					
1 (least deprived)	573	1.08	44.85	2.17	60.91
2	577	1.15	46.97	2.34	60.83
3	579	1.25	50.43	2.44	62.87
4 (most deprived)	573	1.48**	49.56	3.04**	64.92

* p < 0.05.

** p < 0.01.

*** p < 0.001.

Table 6 Results of logistic regression models, associations (odds ratio [OR]) between proximity (10- and 15-minute walk) of at least one convenience store and school characteristics (n = 2302)

	Convenience store, 10-minute walking distance (rural)	Convenience store, 10-minute walking distance (urban)	Convenience store, 15-minute walking distance (rural)	Convenience store, 15-minute walking distance (urban)
	Logistic, OR (95% CI)	Logistic, OR (95% CI)	Logistic, OR (95% CI)	Logistic, OR (95% CI)
Education level				
(1) Elementary (ref.)				
(2) Secondary	1.554 (0.936–2.578)	0.902 (0.699–1.164)	2.568*** (1.639–4.024)	0.925 (0.689–1.242)
(3) Integrated elementary/secondary	1.567 (0.852–2.881)	0.990 (0.603–1.625)	1.403 (0.795–2.478)	0.990 (0.556–1.764)
LICO index quartiles				
1 (least deprived)				
2	1.230 (0.757–2.000)	1.074 (0.807–1.429)	1.235 (0.791–1.930)	0.935 (0.674–1.298)
3	1.198 (0.728–1.970)	1.241 (0.934–1.647)	1.100 (0.791–1.930)	1.033 (0.745–1.433)
4 (most deprived)	0.720 (0.422–1.230)	1.330 (0.998–1.772)	0.876 (0.547–1.402)	1.204 (0.860–1.686)

* p < 0.05.
 ** p < 0.01.
 *** p < 0.001.

Results of regional analyses

Regional analyses are based on the proportion of schools with food outlets nearby, that is, within a 15-minute walking distance. These descriptive analyses were carried out for schools in urban areas and those in rural settings (Table 7).

For schools located in urban areas, results reveal that the Montréal and Laval health regions have significantly higher proportions of schools with convenience stores nearby. These figures are significantly lower than in the rest of Québec for the regions of Chaudière-Appalaches, Côte-Nord and Saguenay–Lac-Saint-Jean. Montréal is the only region where the percentage of schools with at least one fast-food restaurant nearby is higher than in the rest of the province. The figure is significantly lower for the regions of Chaudière-Appalaches, Côte-Nord and Laurentides.

For schools located in rural areas, results of our analyses demonstrate that the proportion of schools with a fast-food restaurant nearby is similar for most health regions. The only significant difference is for the Laurentides region, where the percentage of schools with a fast-food restaurant nearby is higher than in the rest of Québec. The Laurentides region also has a higher proportion of schools with at least one convenience store within a 15-minute walking zone. The figure is significantly lower for the regions of Chaudière-Appalaches and Mauricie et Centre-du-Québec than for the rest of the province.

Table 7 Proportion of schools with at least one food outlet within a 15-minute walking zone, by health region

Health region	Urban			Rural		
	Schools	% of schools with a least one fast-food restaurant within a 15-minute walking zone	% of schools with a least one convenience store within a 15-minute walking zone	Schools	% of schools with a least one fast-food restaurant within a 15-minute walking zone	% of schools with a least one convenience store within a 15-minute walking zone
Abitibi-Témiscamingue	40	37.50%	77.50%	31	12.90%	51.61%
Bas-Saint-Laurent	28	35.71%	60.71%	61	6.56%	37.70%
Capitale-Nationale	121	49.59%	66.12%	32	21.88%	43.75%
Chaudière-Appalaches	64	29.69% [‡]	59.38% [‡]	103	6.80%	18.45% [‡]
Côte-Nord	26	26.92% [‡]	46.15% [‡]	25	12.00%	36.00%
Estrie	60	45.00%	66.67%	62	12.90%	29.03%
Gaspésie-Îles-de-la-Madeleine	3	66.67%	100.00%	66	10.61%	28.79%
Lanaudière	85	34.12%	76.47%	49	4.08%	30.61%
Laurentides	109	33.03% [‡]	66.06%	40	27.50% ⁺	60.00% ⁺
Laval	79	60.76%	91.14% ⁺	nd	nd	nd
Mauricie et Centre-du-Québec	104	37.50%	67.31%	63	7.94%	17.46% [‡]
Montréal	404	69.80% ⁺	91.58% ⁺	106	10.38%	27.36%
Montréal	404	69.80% ⁺	91.58% ⁺	nd	nd	nd
Nord-du-Québec	nd	nd	nd	12	33.33%	33.33%
Outaouais	77	33.77%	64.94%	24	16.67%	25.00%
Saguenay-Lac-Saint-Jean	65	35.38%	60.00% [‡]	41	4.88%	34.15%
Québec	1587	48.46%	76.56%	715	11.05%	30.91%

[‡] Significantly lower.

⁺ Significantly higher.

nd: no data.

Discussion

Results of our analyses show that most public schools in Québec are located near at least one convenience store or fast-food restaurant. Indeed, approximately 62% of schools are within a 15-minute walk to a convenience store, and almost 37% to a fast-food restaurant. Moreover, results indicate that schools whose students originate from economically disadvantaged areas are significantly more likely to have a fast-food restaurant within a 15-minute walking zone, in both rural and urban regions. This gradient is also significant for 10-minute walking zones in urban areas.

Results of our analyses are partially consistent with several other studies that have examined characteristics of the food environment around schools in relation to neighbourhood socioeconomic levels (14-17; 27; 41).

The proportions of schools with at least one fast-food restaurant or convenience store within walking distance, as highlighted in our study, are comparable to the figures in the other studies that have looked at urban areas. Indeed, Simon et al. (2008) have shown that 23% of schools in Los Angeles County have a least one fast-food restaurant within a 400-metre zone. Almost 29% of schools in our sample that are located in urban settings have at least one fast-food restaurant within a 10-minute walking zone (about 400 metres around schools). In a Chicago study, Austin et al. (2005) note that 35% of schools have a least one fast-food restaurant within a 400-metre radius. Finally, Kesten and Daniel (2007) estimate that in the Greater Montréal area, 42% of schools have at least one fast-food restaurant within a 500-metre radius.

Like other studies, our results show that high schools are significantly more likely to have at least one fast-food restaurant within a walking zone (14; 15; 27). As a possible explanation for this situation, Simon et al. (2008) and Zenk and Powell (2008) point to the high concentration of adolescents in a same place as target customers for chain fast-food restaurants. Moreover, high-school students have much more autonomous mobility than elementary school children. High-school students can go to these businesses on their way to school, during lunch and after school. The greater presence of fast-food restaurants around high schools applies to schools located in both urban and rural areas. Further research is required to determine the proportion of students who go to these businesses. In the United States, between 5% and 15% of students go to these establishments during lunchtime (45). To our knowledge, no study has attempted to measure this aspect in Québec.

Results of our study show that schools attended by students from economically disadvantaged areas (LICO) are more likely to be in the vicinity of fast-food restaurants. These results corroborate those of some studies that have examined the same topic (14; 16). However, other studies have not found a clear link between the presence of fast-food restaurants and neighbourhood deprivation level (17; 27; 41). These contradictory findings could result from the methodological choices used to construct indicators of a neighbourhood's socioeconomic status. In our study, we used the residential deprivation level of students registered in the various schools and not that of the neighbourhood in which a school is located. In another study, it would be interesting to analyze the links between level of deprivation of the neighbourhood in which a school is located and access to food outlets.

As regards the proximity of convenience stores to schools, our analysis corroborates the results of other similar studies. Zenk and Powell's study (2008) shows that, in large American cities, almost 56% of high schools are within an 805-metre walking distance of at least one convenience store. The situation is even more troubling for public schools in Québec located in urban settings: our study results indicate that nearly 77% of these schools are within less than a 15-minute walking distance (about 600 metres) from a convenience store. The figure for all Québec schools is also higher than the results in the Canadian study conducted by Seliske et al. (2009) (63% vs 58%). Our findings have also demonstrated that the probability of having a convenience store within walking distance is not explained, in most models, by a school's characteristics (education level, level of

deprivation, location). The probabilities of having a convenience store within walking distance are significantly higher for high schools in rural settings. These results contradict those of Zenk and Powell (2008), who show that schools in higher income neighbourhoods are less likely to have at least one convenience store within an 805-metre walking distance. According to our results, all public schools in Québec have significant access to convenience store-type businesses, regardless of education level and the deprivation level of students who patronize them.

There are a few limitations in our study. First, we have looked into only food outlets that work against adoption of healthy lifestyle habits. In the future, a more complete portrait should also take into account grocery stores, produce vendors and other food outlets that encourage adoption of healthy lifestyle habits (46; 47). It would be interesting to analyze the proximity of schools to these various types of food outlets. It is possible that schools where children come from more socioeconomically advantaged settings are located near these types of businesses. Several studies have looked at the absence of such businesses in socioeconomically disadvantaged neighbourhoods. In the British literature, these zones are called food deserts (48; 49).

Another limitation is linked to use of commercial business directories and selecting businesses based on their names. According to Simon et al. (2008), directories produced by health authorities are more complete than commercial directories. Their study results show that a significant number of food outlets were not listed in commercial databases compared with health databases. However, the authors of a Canadian study point out that commercial data sources are valuable tools in the evaluation of commercial environments relevant to eating behaviours. By comparing the food environments of some Montréal neighbourhoods chosen according to field observations and commercial business databases, results show a percentage agreement of 73% between these two sources of information (50). Use of the names of large food chains as a method of selection tends to underrepresent the true numbers since independent businesses are eliminated. These independent outlets could also strongly characterize access to food retailers in rural settings. To circumvent this problem, analyses should be performed using business database listings that are more comprehensive than the one used in the current study (27).

The definition of buffer zones (10- and 15-minute walking distance) could underrepresent access to food around some schools in rural and urban settings where motor vehicle use is higher. For example, Seliske et al. (2009) used 5-kilometre buffer zones around schools to define access to food retailers in the neighbourhood where a school is located (17). However, our objective was to analyze access to food within a zone around schools where students can move easily and in a reasonable amount of time (round trip under 30 minutes).

Yet, our study revealed that a number of public schools in Québec are located in the vicinities of fast-food restaurants and that a considerable proportion of these schools are near convenience stores. Some questions have emerged from these findings: Can the close proximity of Québec schools to fast-food restaurants, and especially to convenience stores, offset efforts to implement food policies in schools? Does access to these types of food outlets influence young people's eating habits? Should we put policies in place to restrict student access to these businesses in Québec?

In relation to the implementation of a food policy in schools, the accessibility of food retail outlets such as fast-food restaurants or convenience stores could work against students' adopting healthy eating habits (51). The results of a few studies show that school faculty and staff see young people's food choices as barriers to successful implementation and continuity of interventions promoting healthy lifestyle habits in schools (52; 53). Once these interventions have been implemented, young people appear to use a school's eating facilities less, and eat at food outlets located around it. This statement is hypothetical, however, and to our knowledge, empirical verification has not been attempted (54; 55).

Our study provides a portrait of the food environment around Québec schools. It would be pertinent, in future research, to link these data to those about young people's eating habits. A few studies attempt to measure the associations between proximity of food establishments around schools and students' eating habits or body weight (measured by BMI). Van der Horst (2008) concludes that the proximity of food outlets around schools does not influence adolescents' eating habits. Moreover, results of this study have shown the presence of more snack food stores near schools is associated with reduced soft drink consumption (56). However, another study demonstrated that the proximity of fast-food restaurants around schools is associated with consumption of fewer servings of fruits and vegetables, consumption of more servings of soda, and a higher risk of being overweight (51).

In the United States, several researchers have suggested using zoning regulations to limit the number of certain food outlets (e.g. fast-food restaurants and convenience stores) in some neighbourhoods or around schools (46; 57; 58). The City of Los Angeles has even adopted a regulation prohibiting the establishment of new fast-food restaurants for a one-year period. Strategies have also been adopted to reduce accessibility to products such as tobacco, alcohol and firearms (7). Some of these strategies use zoning regulations to achieve the public health goal of limiting access (57).

However, municipalities in Québec do not have the same powers as their American counterparts. Recent studies in Québec have attempted to verify if provincial legislative powers would allow limiting the presence of food outlets that are "harmful" to healthy lifestyle habits (59; 60). Results of Paquin's study (2008) reveal that classifying food businesses in zoning regulations must be more specific (60). The way these regulations currently stand, it would be difficult to use them to encourage development of the built environment likely to positively influence the population's lifestyle habits. Bourdeau and LeChasseur (2009) consider that it would be possible to limit the presence of some food outlets around schools, not quantitatively but qualitatively. The current *Act respecting land use and development* includes tools that allow municipalities to limit certain businesses that are incompatible with the immediate environment (e.g. architectural integrity). In the case of the immediate environment of a school, such a tool could be used to encourage implementation of businesses that offer healthy eating products. Still according to Bourdeau and LeChasseur (2009), this type of regulation could require an evaluation mechanism to ensure a healthy food supply. However, at this time, municipalities do not have the necessary resources to put this type of measure in place (59).

Conclusions

Our study results show that a number of public schools in Québec are located in proximity to a fast-food restaurant. This is especially true of public high schools located in urban settings. The proportions of schools with nearby food outlets do not fluctuate significantly for most health regions in the province. In urban settings, such as the Montréal and Laval regions, there are more schools with food outlets nearby. High schools (rural and urban) are more likely to have at least one fast-food restaurant within a 10-minute walking distance. Schools where students are from lower income families are also more likely to be near a fast-food restaurant. A large majority of Québec schools are within walking distance of at least one convenience store, regardless of their level of deprivation. Future studies should explore the relationships among proximity of these food outlets to schools, student characteristics, and eating habits.

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