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The Food Environment Around Public Schools and the Consumption of Junk Food for Lunch by Québec Secondary School Students

Québec 🔷🔷

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Highlights

- In Québec, more than half (52%) of secondary school students had not eaten junk food for lunch during the week preceding the study, while a little less than half (48%) had eaten junk food for lunch one or more times.

- Close to 40% of students in Québec public secondary schools have access to at least two fast-food restaurants within 750 metres.

- Consumption of junk food two or more times per week is associated with obesity and other negative health measures among young people.

- The proportions of young people consuming junk food two or more times per week are significantly higher in schools with two (27%) or three (26%) fast-food restaurants within a 750-metre radius than in those with only one (19%) or none (19%).

- Other factors also influence the consumption of junk food among Québec students attending public schools: being a boy, being in a family with shared custody, having parents with no more than or no secondary school diploma or being in a school in a very disadvantaged neighbourhood or in an urban setting.

- Independently of these factors, the presence of fast-food restaurants around schools significantly increases the proportion of students who consume junk food for lunch. Our analysis indicates that the risk of consuming junk food at lunchtime is 50% higher for students with access to two or more fast-food restaurants within a 750-metre zone around the school.

Summary

Background

In Québec, the government strategy for promoting healthy lifestyle habits and preventing weight-related problems focuses on environmental factors. The majority of the actions proposed are intended to modify physical, political, economic and sociocultural environments so that it is easier for individuals to make healthier choices (Lachance, Pageau, & Roy, 2006). In order to specify which environmental changes must be made, analyses must be conducted to document the relationships between environments—particularly the physical environment—and food choices. The present study was designed to address this need for knowledge.

Objective

Within a prevention and healthy lifestyle habits promotion perspective, this report aims to analyze the relationships between the food environment around schools and the consumption of junk food by public secondary school students.

Methodology

To address our objective, a geographic information system was used to characterize the food environment around public high schools. The schools were geolocalized using a database of the Ministère de l'Éducation, de l'Enseignement supérieur et de la Recherche [ministry of education, higher education and research]. Fast-food restaurants were geo-localized using another database from the ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec [Québec's ministry of agriculture, fisheries and food]. This information was linked to data on junk food consumption from the *Enquête québécoise sur la santé des jeunes du secondaire* [Québec Health Survey of High School Students (QHSHSS)]. Hierarchical logistic regression models were used to measure the association between the characteristics of the schools, the students and their families; the characteristics of the food environment around the schools; and the consumption of junk food by students.

Main results

Results show that exposure to fast-food restaurants in a school's neighbourhood is significantly and positively associated with junk food consumption, after controlling for variables associated with characteristics of schools, students, and their families. The risk of consuming junk food during lunchtime was 50% higher among students with access to two or more fast-food restaurants within a 750-metre zone around the school, as compared to students without a fast-food restaurant near their school (odds ratio (OR): 1.50; confidence interval (CI) 95%: 1.28–1.75).

Conclusion

In Québec, the food environment around public schools is considered a relevant target for interventions to improve young people's eating habits. Thus, municipalities can apply zoning bylaws to limit the presence of certain types of businesses near schools. Actions to change the range of foods offered by food outlets can also be undertaken. For groups of young people who are more at risk, these interventions must be complemented by other measures, such as campaigns to promote healthy lifestyle habits or subsidized school meals for disadvantaged students.

1   Introduction

The increase in obesity prevalence in Western countries is one of the most studied public health issues (Jorgensen et al., 2013; Pouliou & Elliott, 2010). Indeed, it represents a particularly complex social phenomenon resulting from social changes that have converged to increase several weight gain risk factors, at both the individual and environmental levels (Sallis et al., 2012).

Between 1978-1979 and 2004, the prevalence of excess weight, overweight and obesity combined, rose by 55% among youth 2 to 7 years old in Québec.[1] In 2004, 23% of youth aged 2 to 17 had excess weight, with a third of that group suffering from obesity (7%) (Lamontagne & Hamel, 2009). In 2010-2011, the Québec Health Survey of High School Students 2010-2011(QHSHSS),revealed that 21% of youth 12 to 17 years old reported a weight that put them in the excess weight category, 7% for obesity and 14% for overweight. As for eating habits, 11% of boys and 7% of girls surveyed by the QHSHSS had eaten junk food for lunch at least three times during the previous week (Camirand, Blanchet, & Pica, 2012). Moreover, 35% of boys and 26% of girls reported having consumed sugary drinks, snacks, or sweets at least once a day (Camirand, Blanchet, & Pica, 2012).

Many factors can explain the increase in the weight of the population and poor eating habits. Most researchers consider three categories of factor: individual factors, behavioural factors (lifestyle habits), and environmental factors (Bauman et al., 2012). Within this last category of factors, the physical environment, defined by the natural environment on the one hand and the built or developed environment on the other, represents a promising target for public health intervention (Bergeron & Reyburn, 2010). With respect to schools, the built environment refers to all human-made elements that are exterior to the individual but within the limits of the school and its neighbourhood.

According to the Public Health Agency of Canada (2011), the school environment influences the adoption of healthy lifestyle habits. Schools are responsible for the food offered and for physical activities within their premises, with little influence beyond (Public Health Agency of Canada & Canadian Institute for Health

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[1]   Measured data.

Information, 2011). Furthermore, municipalities and community organizations can act in areas around schools, even if their power is more limited than that of schools. For example, municipalities cannot discriminate against persons or businesses throughout their territories or forbid the establishment of restaurants based on their menus (ASPQ, 2012).

It is therefore important to study the characteristics of the built environment around schools. This is why, in 2009 and 2014, the Institut national de santé publique du Québec (INSPQ) [Québec's public health institute] documented the geographic accessibility of fast-food restaurants and convenience stores in the vicinity of public schools in Québec (Robitaille, Bergeron, & Lasnier, 2009; Lalonde & Robitaille, 2014). The results of the 2014 analysis show that more than half of Québec public schools (59%) are located less than 750 metres away from a fast-food restaurant. Children and adolescents spend much of their time at school and are subject to the influence of its environment.

Indeed, some studies have shown significant associations between characteristics of the food environment around schools and young people's diets (Laxer & Janssen, 2013; He, Tucker, Irwin, et al., 2012; Davis & Carpenter, 2009). A Canadian study has also established significant positive associations between the density of fast-food restaurants and convenience stores around schools and the purchases made by youth in these restaurants or the frequency of their visits to these places during lunchtime (He, Tucker, Gilliland, et al., 2012). Finally, other studies have reported significant associations between exposure to fast-food restaurants around schools and higher risks of being overweight or obese, or of having a higher body mass index (BMI) (Sanchez et al., 2012; Davis & Carpenter, 2009; Gilliland et al., 2012).

Studies have been mostly conducted in Ontario and in the United States. To our knowledge, only one study has considered the Québec context: Van Hulst et al. (2012), explored the association between density and proximity of grocery stores, fast-food restaurants, and convenience stores, and the consumption of fruits, vegetables, sugary drinks, take-out food, and snacks among 512 students between 8 and 10 years old in the region of Montréal. Using an index to characterize the food environment, the researchers reached the conclusion that a high density of fast-food restaurants

and convenience stores around a school is associated with a diet of poor nutritional value.

As part of the current effort to develop environments that promote healthy lifestyle habits, analyzing the association between the accessibility of fast food in the vicinity of secondary schools and students' consumption of junk food during lunchtime will help public health actors better appreciate the influence of schools' local contexts on youths' diets. With a better understanding of the determinants of youth's diet, actors will be better placed to justify and implement relevant and effective strategies to improve students' diets, both inside and outside of school. The objective of this analysis is to assess the links between the food environment around public secondary schools in Québec and secondary school students' consumption of junk food[2] during lunchtime.

This report begins by describing the methodology used and then presents descriptive analyses of junk food consumption during lunchtime by Québec students. Finally, the relationships between junk food consumption during lunchtime, the characteristics of students, the socioeconomic environment, the setting, and the food environment around schools are analyzed and explained. The Conclusion and Discussion sections identify the main findings of the analyses and propose possible actions for transforming the environments around schools to make them more conducive to a healthy diet.

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[2]   The term "junk food" used in the present document refers to food low in nutritional value and rich in calories. According to the *Vision de la saine alimentation* [vision for a healthy diet], such food should be considered occasional foods and should be present in lesser quantity and frequency in our food environment (MSSS, 2010).

2 Methodology

2.1 Data used

Four databases were used for this study. The first, the QHSHSS provides data on young people. Two databases from the ministère de l'Éducation, de l'Enseignement supérieur et de la Recherche (MEESR) [ministry of education, higher education and research] provide geolocations for public schools and the means to assign them levels of socioeconomic deprivation. A fourth database from the ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ) [ministry of agriculture, fisheries and food] was used to identify and geolocate fast-food restaurants.

2.2 Québec Health Survey of High School Students (QHSHSS)

The main objective of the QHSHSS was to generate an overview of the physical, mental, and psychosocial health, as well as the lifestyle habits, of Québec secondary school students. It was conducted by the Institut de la statistique du Québec [Quebec's institute of statistics] and funded by the ministère de la Santé et des Services sociaux (MSSS) [Québec's ministry of health and social services]. The target population was all students from first to fifth year in Québec public and private schools, both Francophone and Anglophone. The data were collected, using a self-administered electronic questionnaire, from 63,196 secondary school students in 16 health regions of Québec, which ensured representativeness of data at the regional scale. Regions 17 (Nunavik) and 18 (Terres-Crie-de-la-Baie-James) are not included in the survey. Various issues were covered by the survey, including perception of health status, self-reported weight, lifestyle habits (diet, physical activity, cigarette use, alcohol consumption, drug consumption, sexual behaviour, etc.), and mental and psychosocial health (Pica & Institut de la statistique du Québec, 2012). Given the many issues covered in the QHSHSS 2010-2011, two versions of the questionnaire were developed. The majority of questions appear in both versions, but some appear only in one of the two. Each version was assigned at random to about half of the students in each class. Thus, 50.7% of secondary school students, close to 32,000, answered questions on issues related to lifestyle habits. The analyses conducted for this

document only concern student respondents enrolled in public schools. Using MEESR data to establish school deprivation levels means that students in private schools must be excluded from the sample, as the index is only calculated for public schools in Québec. The sample used for analyses therefore includes 26,655 students distributed among 374 schools. The QHSHSS data were used to evaluate junk food consumption during lunchtime and to build a socioeconomic profile of the students.

2.3 The variable of interest: junk food consumption during lunchtime

The QHSHSS assessed junk food consumption using the following question:

> "In the past school week (Monday to Friday), how many times did you eat in a restaurant or snack bar foods like French fries, poutine, hamburgers, pizzas, pocket pizzas, chicken wings, fried chicken, hot dogs or pogos..."

Young people then had to specify the time of day: breakfast, lunch, supper, or some other time of the day or evening.

The present analysis uses the consumption of junk food specifically during lunchtime at a restaurant or snack bar during the school week. It is worth noting that "The indicator for frequency of junk food consumption at a restaurant or snack bar does not take into account junk food that is home-delivered or that is picked up in person but consumed elsewhere (drive-through, take-out). Moreover, this indicator does not measure the frequency of consumption over the weekend. The data obtained might therefore underestimate the intake of food from this type of restaurant" (Camirand, Blanchet, & Pica, 2012:76).

The variable of interest in the hierarchical logistic regression models is the consumption of junk food during lunchtime. For the purposes of analysis, the students were divided into two groups: those who had eaten junk food at lunchtime two times or more per week and those who had eaten it once or not at all. Consumption of junk food two or more times per week, a consumption frequency already used in other studies, is linked to obesity and other negative health measures for young people (Boutelle et al., 2007; French et al.,

2001; Laxer & Janssen, 2013; Pereira et al., 2005). This level of consumption is therefore considered excessive.

2.4 Explanatory variables relating to schools

2.4.1 SCHOOL LOCATION AND DEGREE OF DEPRIVATION

A first database from the MEESR provided geolocations for secondary education institutions in the province of Québec. A second database was used to determine the socioeconomic environments of the secondary schools. The MEESR calculates deprivation indices yearly for public schools across Québec. It uses these indices to implement policies in order to reduce the impact of student deprivation in primary and secondary public schools. The data used to calculate these indices are taken from the Canadian census and focus on the situation of families with children aged 0 to 18 living in neighbourhoods where the students attending various schools reside. The socioeconomic index, called *indice de milieu socio-économique* (IMSE), is constructed from two variables: maternal education level and the parents' unemployment rate. These variables are used because they stand out as the strongest explanatory variables for poor educational outcomes (Baillargeon, 2005). The IMSE is calculated for each school, and the schools are categorized from 1 (low deprivation) to 10 (high deprivation). Using data from the MEESR, to establish school levels of deprivation means that students enrolled in private schools are excluded. For this analysis, a school is considered disadvantaged if it falls within the lowest three deciles of deprivation calculated by the MEESR. The aim is to compare the situation of students at very disadvantaged schools to that of all students at less disadvantaged schools.

2.4.2 SCHOOLS IN URBAN AND RURAL SETTINGS

The geographic breakdown of census population centres was used to determine whether schools were located in urban centres or rural areas. "A population centre has a population of at least 1,000 and a population density of 400 persons or more per square kilometre, based on the current census population count" (Statistics Canada, 2012). Schools located outside a population centre were considered rural.

2.4.3 EVALUATING THE FOOD ENVIRONMENT AROUND SCHOOLS

To evaluate the food environment around schools, a 750-metre buffer zone was constructed around each school. A buffer zone[3] is a surface within a predetermined Euclidean[4] or network[5] distance based on a starting location, in this case, the school (Figure 1).

For a greater level of precision (Gilliland et al., 2012; Seliske et al., 2013), network distance (excluding the highway network and including trails) was used to establish sausage network buffers for a threshold distance of 750 metres around the schools (Forsyth, Van Riper, et al., 2012; Forsyth, Larson, et al., 2012). This threshold is similar to that used in several scientific publications from the United States, where distances of 800 metres or half a mile are used (Davis & Carpenter, 2009; Forsyth, Wall, et al., 2012; Sanchez et al., 2012). The buffer zones were used to define the territory in order to operationalize the indicator of the number of fast-food restaurants near schools (Figure 1). This indicator was dichotomized between schools having 0 or 1 fast-food restaurant and those with two or more fast-food restaurants.

This cut-off was selected based on the descriptive analysis results that showed that a high proportion of students consumed junk food twice or more per week when schools had two or more fast-food restaurants within a 750-metre radius (Figure 3).

Information on fast-food restaurant locations was taken from the MAPAQ food sales licence database for 2009. This database compiles information on various food service licences. For this study, the classifications "food stand" (snack bar), "take-out restaurant" and "quick-service restaurant" were grouped together. Food stands are defined as motorized vehicles or establishments where light meals are prepared and served, and either eaten on the spot or taken away. This category includes food trucks. Take-out restaurants are establishments whose main business is the preparation and sale of food to be taken away or delivered.

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[3] Also called "radius," "catchment area," "zone of influence" or "service area."
[4] As the crow flies.
[5] Along the road network.

Figure 1   Example of a 750-metre buffer zone around a school
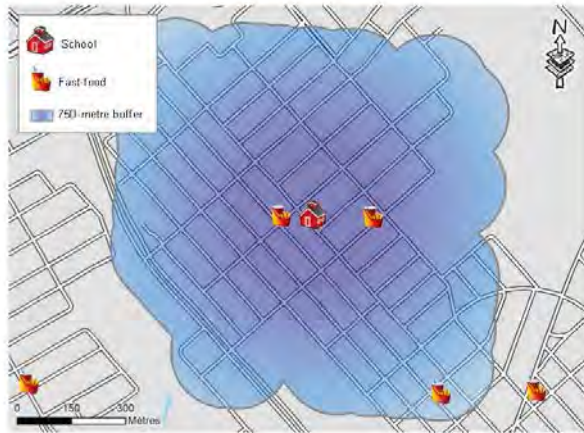
Lastly, quick-service restaurants are establishments with a service counter and occasionally tables, whose main business is the preparation of a specialty menu, such as burgers, chicken, or hot dogs. This process resulted in the identification of 4,826 fast-food restaurants in Québec.

2.5   Covariates

The covariates for the analyses were age, sex, family situation, perceived health, parents' schooling, the level of deprivation and the setting (rural/urban area) of the school. These variables were selected because they have been shown to be significantly associated with junk food consumption and have already been used in other studies on the impact of environmental characteristics on young people's diets (Buck et al., 2013; Davis & Carpenter, 2009; Gebremariam et al., 2012; He, Tucker, Irwin, et al., 2012; Shields & Shooshtari, 2001).

2.6   Data modelling

Hierarchical logistic regression models were used to measure the association between the presence of fast-food restaurants in the vicinity of schools and junk food consumption during lunchtime. The regression analysis is based on four successive models. Each model was constructed on the preceding one while adding variables to attempt to explain the variable of interest, junk food consumption for lunch twice or more per week. For this analysis, the variables characterizing the students and their families were entered first in the

empty model, without control variables, followed by variables related to school characteristics and finally by the variable indicating the presence of fast-food restaurants in a 750-metre radius around the school. This type of analysis can establish that environmental variables contribute to explaining the variable of interest, beyond what is explained by individual variables for students and their schools.

3   Results

3.1   Description of the study population

Table 1 presents the individual, family, and environmental characteristics of the students and schools that make up the population being studied. Slightly more than half of the students in this analysis are boys. They are mostly over the age of 14 years (72.4%). Close to 60% of them are from two-parent families. Around 7 out of 10 students perceive themselves as being in excellent health (69.1%). Only 8.1% of students are from a family where the parents have not attained a secondary school diploma (DES). Almost 30% of students attend a school in a disadvantaged neighbourhood. Most students are enrolled in a school in an urban setting (89.7%). Finally, 41.2% of the students in the sample have access to at least two fast-food restaurants within a 750-metre zone around their school.

Table 1   Student sample characteristics

Individual and family variables	
Sex	**%**
Girl	48.8
Boy	51.2
Age	
13 or under	27.6
14 or more	72.4
Family situation	
Two-parent	58.1
Blended	13.1
Shared custody	11.0
Single-parent	16.0
Other	1.9
Perceived health	
Excellent	69.1
Good	26.2
Adequate or poor	4.8
Parents' schooling	
College or university	73.7
DES	18.2
Less than DES	8.1
Variables for schools and the built food environment around schools	
School deprivation	
Less deprived	71.7
More deprived	28.3
Rural/urban area	
Rural	10.3
Urban	89.7
Number of fast-food restaurants (750 metres)	
None or 1	58.8
2 or more	41.2

3.2   Highlights of junk food consumption during lunchtime

A majority of students had not consumed junk food for lunch during the previous week (52.1%), while close to 26% had consumed junk food once, and 22.0% had consumed junk food two times or more. Eating junk food for lunch during the school week is more common among boys than among girls (Figure 2).

Figure 2   Frequency of junk food consumption at a restaurant or snack bar during lunchtime over the previous school week, students in Québec public schools, 2010-2011
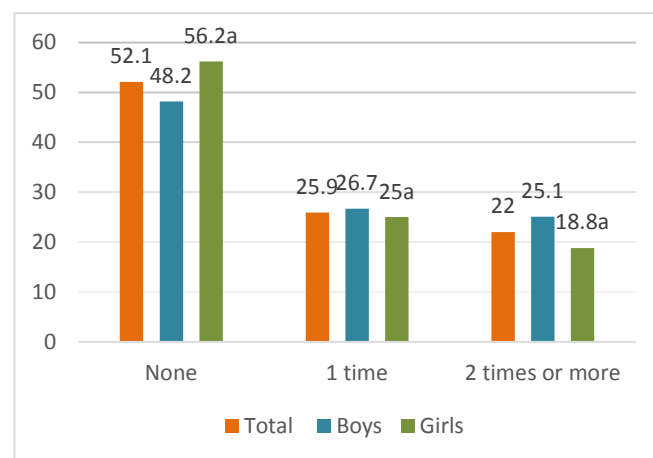
a   For a given number of occasions, the same exponent expresses a significant difference between boys and girls at the 0.05 threshold.

Source: QHSHSS, 2010-2011.

3.3   Exposure to fast-food restaurants within 750 metres or less and consumption of junk food during lunchtime

This section discusses the univariate analyses that were performed to measure possible associations between exposure to fast-food restaurants within 750 metres of a school and consumption of junk food during lunchtime.

The results show that students attending schools without a fast-food restaurant within a 750-metre radius consumed junk food for lunch less frequently. The proportion having not consumed at all varies from 57.4% when there is no fast-food restaurant to 45.0% when there are two fast-food restaurants. The proportions of students consuming junk food for lunch twice or more per week are significantly higher in schools with two (26.6%) or three or more (25.9%) fast-food restaurants in a 750-metre radius than in those with only one fast-food restaurant (19.1%) or none (19. 1%) (Figure 3).

The results of bivariate analyses (Table 2, second column) show significant links between junk food consumption during lunchtime twice or more per week and sex, age, family situation, perceived health, parents' schooling, school setting, school deprivation level, and the number of fast-food restaurants within a 750-metre radius around

the school. Based on these results, multivariate hierarchical analyses were performed to evaluate the relationships between consumption of junk food during lunchtime and exposure to fast-food restaurants within

750 metres around schools, while controlling for variables related to the characteristics of secondary school students, their families, and the schools they attend.

Figure 3 **Frequency of junk food consumption for lunch at a restaurant or snack bar during the previous school week, by number of fast-food restaurants within a 750-metre radius of the school, students in Québec public schools, 2010-2011**
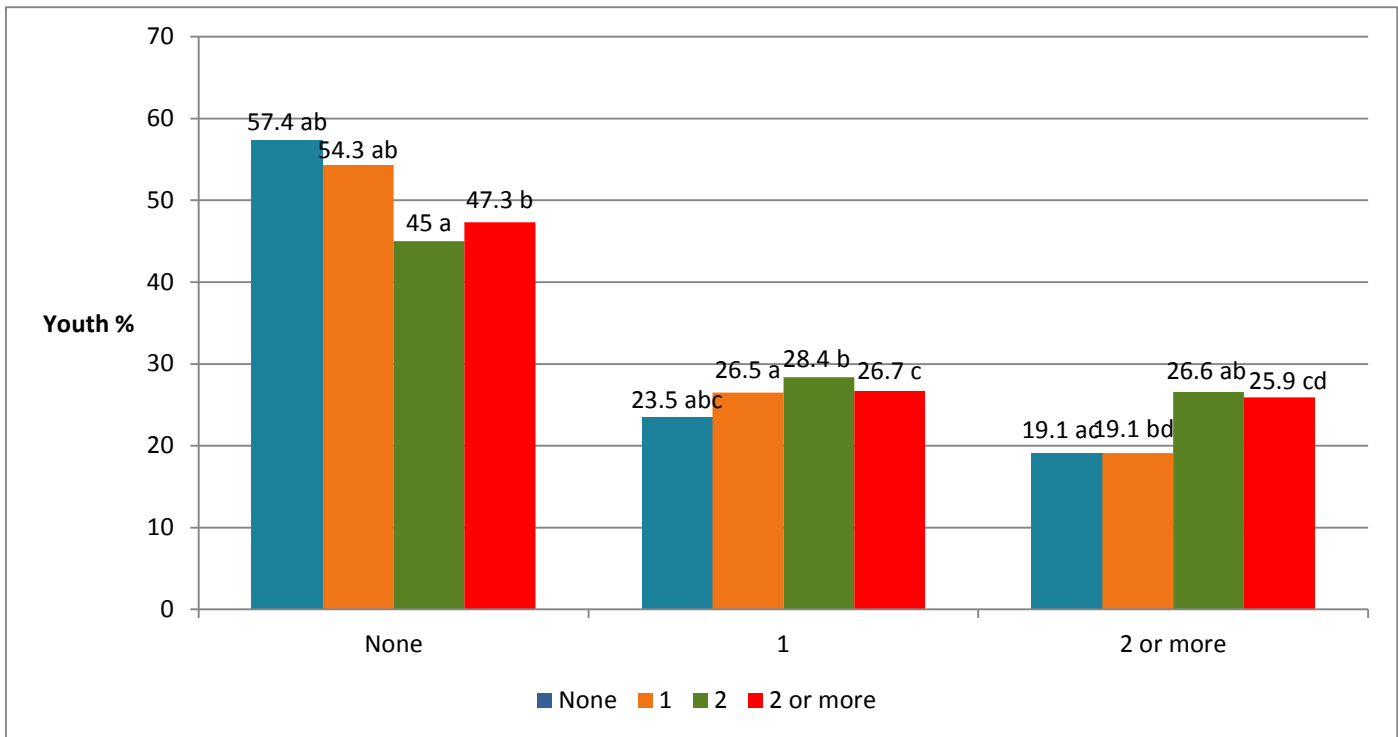
[abcd] For a given proportion, the same exponent expresses a significant difference between the level of exposure to fast-food restaurants (none, 1, 2, and 3 or more) at the 0.05 threshold.

Source: QHSHSS, 2010-2011.

3.4   Results of hierarchical analyses

The first model is a model without any variables (model A). It serves to verify whether there is variability, between schools, of students' junk food consumption during lunchtime. Each consecutive model is constructed by adding variables to the preceding model. The second model (model B) adds variables related to student characteristics. The third model (model C) adds variables related to student characteristics and those related to the socioeconomic environment and setting of the school (IMSE and rural/urban school setting). The final model (model D) adds the measure characterizing the food environment within a 750-metre radius around the school, more specifically the exposure to fast-food restaurants.

The results of the hierarchical analyses[6] indicate that there are differences in junk food consumption for lunch between schools.

The model without control variables, or empty model, (model A, Table 2) shows a high median odds ratio (MOR) of 2.32. A high MOR means that the characteristics measured for schools (e.g., setting, level of deprivation, and presence of fast-food restaurants) can explain the variation in junk food consumption for lunch twice or more per week.

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[6]   Hierarchical logistic regression models were built using the GLIMMIX procedure available in the SAS software package (SAS Institute, 2011). To optimize convergence of the hierarchical models, the Newton–Raphson technique was applied to verify whether the latest variables added explained the dependent variable more than those that were already in the previous model.

The second model (model B) illustrates the relationships between the probability of consuming junk food for lunch and the individual characteristics of students. The results show that the following characteristics are associated with significantly higher probabilities of consuming junk food for lunch twice or more per week: being a boy (OR 1.56; CI 95%: 1.39–1.74), being in a shared custody family (OR: 1.20; CI 95%: 1.03–1.39), being in a family of a type other than two-parent, blended, shared custody, or single-parent (OR: 1.73; CI 95%: 1.19–2.52), perceiving oneself to be in good health (OR: 1.17; CI 95%: 1.05–1.30), perceiving one's health as adequate or poor (OR: 1.47; CI 95%: 1.18–1.83), and having parents whose schooling is less than a DES (OR: 1.31; CI 95%: 1.08–1.60). The variables introduced in model B do not explain the variability in junk food consumption between schools, since there is an increase of 2.9%[7] in the variance between schools from model A to model B.

The third model (model C) introduces school characteristics into the model, i.e., the level of deprivation and the setting (urban or rural) of the school. The results show that these two variables explain a significant portion of the variability in junk food consumption during lunchtime between schools. Indeed, the variance change rate (VCR) decreases by 25.1% between model A and model C. In other words, the level of deprivation and setting of the school explain 25.1% of the variance between schools. Students are significantly more at risk of consuming junk food for lunch twice or more per week in schools with a high level of deprivation (OR: 1.44; CI 95%: 1.22–1.71) or located in an urban setting (OR: 1.39; CI 95%: 1.16–1.66).

The fourth model (model D) includes all the variables from the other models as well as the variable on exposure to fast-food restaurants within a 750-metre radius around schools. The results show that exposure to fast-food restaurants explains 7.5% of the variability in junk food consumption during lunchtime. Compared to students attending a school with fewer than two fast-food restaurants in its vicinity, students exposed to two or more fast-food restaurants within a 750-metre radius around their school have a risk of consuming junk food for lunch twice or more per week that is 50% greater (OR: 1.50; CI 95%: 1.28–1.75) when controlling for variables related to students, their families, and schools.

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[7] Model B (0.7991) – model A (0.7763)/model A (0.7763) = 0.0293 *100 = 2.93%.

Table 2 Relationships between exposure to fast-food restaurants and consumption of junk food during lunchtime twice or more per week, students in Québec public schools, 2010-2011 (n = 26,655)

	Bivariate analyses	Model A	Model B	Model C	Model D
Sex					
Girl (ref.)	1		1	1	1
Boy	1.42 (1.27 – 1.58)		1.56 (1.39-1.74)	1.49 (1.33-1.68)	1.49 (1.33-1.68)
Age					
13 or less (ref.)	1		1	1	1
14 or more	1.17 (1.02 – 1.34)		1.10 (0.97-1.26)	1.12 (0.97-1.30)	1.12 (0.97-1.29)
Family situation					
Two-parent (ref.)	1		1	1	1
Blended (4)	1.09 (0.93 – 1.27)		1.06 (0.90-1.24)	1.05 (0.89-1.25)	1.05 (0.89-1.25)
Shared custody (3)	1.24 (1.08 – 1.43)		1.20 (1.03-1.39)	1.20 (1.02-141)	1.20 (1.02-141)
Single-parent (2)	1.08 (0.91 – 1.28)		1.21 (0.96-1.31)	1.11 (0.93-1.33)	1.11 (0.93-1.33)
Other (1)	1.76 (1.29 – 2.42)		1.73 (1.19-2.52)	1.67 (1.14-2.42)	1.56 (1.08-2.25)
Perceived health					
Excellent (ref.)	1		1	1	1
Good (2)	1.16 (1.05 – 1.28)		1.17 (1.05-1.30)	1.21 (1.09-1.42)	1.21 (1.09-1.35)
Adequate or poor (1)	1.31 (1.04 – 1.67)		1.47 (1.18-1.83)	1.49 (1.17-1.88)	1.49 (1.18-1.88)
Parents' schooling					
College or university (ref.)	1		1	1	1
DES (2)	1.28 (1.13 – 1.46)		1.26 (1.11-1.43)	1.24 (1.09-1.42)	1.25 (1.09-1.43)
Less than DES (1)	1.30 (1.07 – 1.57)		1.31 (1.08-1.60)	1.27 (1.04-1.56)	1.26 (1.03-1.55)
Variables related to school					
School deprivation					
Less deprived (ref.)	1			1	1
More deprived (1)	1.36 (1.16 – 1.61)			1.44 (1.22-1.71)	1.39 (1.18-1.63)
Rural/urban area					
Rural (ref.)	1			1	1
Urban (1)	1.20 (1.02 – 1.41)			1.39(1.16-1.66)	1.27(1.06-1.52)
Number of fast-food restaurants (750 metres)					
None or 1 (ref.)	1				1
2 or more	1.55 (1.32 – 1.82)				1.50(1.28-1.75)
School variance (SE)		0.7763 (0.06)	0.7991(0.06)	0.6207(0.05)	0.5857(0.05)
MOR[8] (CI 95 %)		2.32 (2.11-2.53)	2.35(2.14-2.56)	2.12(1.93-2.31)	2.08(1.989-2.27)
PCV[9]		Reference	2.94%	-25.06%	-32.54%

A: Empty model.

B: Model adjusted for sex, age, family situation, perceived health, and parents' schooling.

C: Model adjusted for level of deprivation and setting of school.

D: Model adjusted for exposure to fast-food restaurants within a 750-metre radius.

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[8] The heterogeneity between schools was estimated using the median odds ratio (MOR). The MOR is calculated from the parameters of school variance. $MOR = \exp(0{,}95 * \sqrt{V_e})$. An MOR of 1 means that there is no variation between schools in the probability of consuming junk food during lunchtime twice or more per week. A high MOR represents a large difference between schools in junk food consumption (Merlo et al., 2006; Halonen et al., 2012; Esser et al., 2014).

[9] The proportional change in variance (PCV) was calculated based on a model with no explanatory variables. The PCV is calculated with the following equation: $PCV = \frac{V_{e1} - V_{e2}}{V_{e1}} x100$ where V_{e1} is equal to the variance of the initial model and the variance of the model including the covariates. A decrease in the variation by school means that the model variables explain, in part, the variability in junk food consumption between schools (Esser et al., 2014).

4   Discussion

The main objective of this analysis was to measure possible relationships between exposure to fast-food restaurants around Québec public schools and the consumption of junk food during lunchtime, based on data from the QHSHSS 2010-2011. The results showed that many students (41.2%) are exposed to the presence of more than one fast-food restaurant within a 750-metre radius. High exposure (two or more fast-food restaurants within a 750-metre radius) is significantly and positively associated with junk food consumption for lunch, when controlling for variables related to characteristics of schools (rural/urban and deprivation), students (age, sex, and perceived health), and their families (family situation and parents' schooling).

More specifically, the results showed that exposure to fast-food restaurants explained 7.5% of the variability in junk food consumption for lunch twice or more per week. Students attending schools with access to two or more fast-food restaurants within a 750-metre radius have a 50% higher risk of consuming junk food during lunchtime twice or more per week. Calculating the population attributable risk[10] (PAR%) reveals that 8.4% of junk food consumption is attributable to exposure to junk-food restaurants around schools. The results are similar to those of Laxer and Janssen's (2013) study showing that 13.5% of excessive junk food consumption is attributable to young people living in areas where the density of fast-food restaurants is higher (0.87 or more fast-food restaurants per square km).

Other studies have also reported significant associations between the characteristics of the food environment around schools and young people's diets, but not necessarily junk food consumption. In a longitudinal study, Smith et al. (2013) found a correlation between the distance to food outlets and indicators of dietary habits. Greater access to take-out

restaurants is linked to a less healthy diet, while greater access to grocery stores is linked to a healthier diet. The results of another study, by Seliske et al. (2013), showed an association between the presence of food vendors in the vicinity of schools and the dietary habits of students during lunchtime. Significant associations have also been reported in two studies on the dietary habits of 810 students in London, Ontario, aged 11 to 14 years (He, Tucker, Gilliland, et al., 2012; He, Tucker, Irwin, et al., 2012). The analysis results show a significant association between a greater number of fast-food restaurants around schools and the probability of students buying food in such restaurants. The authors also highlighted significant associations between a less healthy diet, the presence of convenience stores and fast-food restaurants around schools, and a high density of fast-food restaurants around schools.

The proportion of students with access to more than two fast-food restaurants within a 750-metre radius, established by our study (41.2%), is partially comparable to those in other studies. Several studies have also shown that secondary schools in particular are exposed to a significant presence of fast-food restaurants in their immediate environments. The results of our analyses are consistent, at least in part, with several studies on the characteristics of the food environment around schools in relation to neighbourhood socioeconomic levels (Simon et al., 2008; Seliske et al., 2009; Sturm, 2008; Austin et al., 2005; Walker, Block, & Kawachi, 2013; Kestens & Daniel, 2010; Robitaille, Bergeron, & Lasnier, 2009). Kestens and Daniel (2010) determined that the proportion of schools in the Montréal metropolitan region with a least one fast-food restaurant within a 500-metre radius was 42%.

Finally, analyses show that students from socioeconomically disadvantaged schools were significantly more at risk of consuming junk food during lunchtime twice or more per week. The students enrolled in these schools were probably exposed to fast-food restaurants more than were those enrolled in less deprived schools. Several studies have shown that disadvantaged schools were more exposed to fast-food restaurants (Day & Pearce, 2011; Lalonde & Robitaille, 2014; Simon et al., 2008; Sturm, 2008; Kestens & Daniel, 2010). According to the results of our analyses,

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[10]   The population attributable risk (PAR%) is a calculation of the proportion of cases of junk food consumption twice or more per week attributable to exposure to two or more restaurants within a 750-metre radius around the school. The APP is calculated using the following equation: $PAR = \left[\frac{P(OR-1)}{1+P(OR-1)} \right]$ where OR is the odds ratio measured in the hierarchical model of consumption for students whose school has two or more fast-food restaurants within a 750-metre radius and P is the prevalence of junk food consumption during lunchtime twice or more per week among students (Laxer et Janssen, 2013).

this exposure is linked to junk food consumption by students.

These results illustrate how characteristics of the food environment around schools appear to be associated with secondary school students' dietary habits. The food environment around schools could be a worthwhile target for interventions aimed at improving young people's diets.

4.1 Making the food environment around schools more conducive to healthy lifestyle habits

In the United States, the Centers for Disease Control and Prevention (CDC) suggest using zoning bylaws, in certain neighbourhoods or around schools, to limit the presence of certain food outlets (e.g., fast-food restaurants, convenience stores) and create built environments that are more favourable to a healthy diet (CDC, 2014). Another CDC study has illustrated the link between zoning policies favouring a healthy diet and greater availability of fruit and vegetable shops in a sample of rural communities in North Carolina (Mayo, Pitts, & Chriqui, 2013).

Québec municipalities do not have the same powers as their American counterparts. Recent studies in Québec have attempted to verify whether, in the context of Québec laws and regulations, it might be possible to limit the presence of food outlets that are "harmful" to healthy lifestyle habits (Bourdeau & LeChasseur, 2009; Paquin, 2009). In Québec, zoning bylaws cannot discriminate against persons or businesses. It is therefore impossible to specifically prohibit a fast-food chain or to discriminate between types of restaurant based on their menus (ASPQ, 2012). The results of a study by Paquin (2009) show that the classification of food outlets in zoning bylaws needs to be more precise. According to Bourdeau and LeChasseur (2009), it should be possible to limit the presence of certain food outlets around schools not in a quantitative but rather in a qualitative way. Current urban development and planning law provides a few tools enabling municipalities to limit the presence of certain businesses that are deemed to be incompatible with their immediate environments (e.g., in terms of architectural integrity). In the case of school's immediate environment, such tools could promote the establishment of businesses offering products related to

a healthy diet and to a physically active lifestyle. Furthermore, according to Bourdeau and LeChasseur (2009), this kind of bylaw could require an evaluation mechanism to ensure that a healthy range of food is offered. In 2010, following a project of the Association pour la santé publique du Québec (ASPQ) [Québec public health association], three municipalities were in the process of adopting bylaws restricting the establishment of fast-food restaurants around schools (Gravel, 2010; Allard, 2012a; ASPQ, 2012). One of them, the municipality of Lavaltrie, adopted a resolution in 2010 to prohibit the establishment of fast-food restaurants within a 500-metre radius around schools. In the fall of 2012, the municipality of Rosemère adopted a new bylaw according to which restaurant activities around schools are limited to full-service restaurants (Granger & Mambo, 2013; Filteau, 2013). The towns of L'Assomption and Brossard have also adopted similar bylaws.

For businesses already in place that enjoy vested rights, other approaches could prove to be worthwhile, such as modifying the range of foods they offer, especially in the case of convenience stores. Gittelshon et al. (2012) have identified 16 projects, mainly based in the United States, to modify the range of food offered in small businesses (10 employees or less, with a surface area under 1,000 square feet). These projects focused on promoting foods with high nutritional value, making them more available, setting up tastings and promotional posters for healthy foods, reducing the availability of foods with low nutritional value, and putting healthier products on sale. The results showed that in the majority of cases, after the interventions, the range and sales of the healthy products that had been promoted increased. In 7 out of 16 initiatives, the participants (consumers and/or owners) stated they had gained knowledge regarding healthier products (Gittelsohn, Rowan, & Gadhoke, 2012).

4.2 Interventions to improve the quality of food intake of young people

Modifying the built environment around schools is not the only way to reduce young people's junk food consumption, but rather it is a strategy that can complement others. The results of our analyses have shown that junk food consumption during lunchtime was also strongly associated with characteristics of individuals (sex, age, and perceived health), their

families (family situation and parents' schooling) and their schools (urban/rural setting and level of deprivation). It is therefore important to focus on an integrated approach that addresses individuals as much as environments, whether they are political, economic, or sociocultural. The Québec *Framework Policy on Healthy Eating and Active Living (Going the Healthy Route at School)* has adopted just such an approach, targeting both individuals and environments. With respect to individuals, it recommends activities to develop cooking skills among students and their parents. For the school environment, the framework policy proposes measures concerning the nutritional composition of the food served as well as on how food services can be organized and on improving the setting for meals (MELS, 2007). In this regard, we can imagine that junk food is appealing to students not only due to the type of food offered, but also because of the conviviality and autonomy associated with a meal among friends at a fast-food restaurant. Schools therefore should also pay attention to the context in which meals are taken, by setting up areas for meals that are user-friendly and varied (more welcoming cafeterias, cafés with armchairs, multi-purpose rooms with tables for meals and various activities such as table football, ping-pong, etc.) (Frerichs et al., 2015; Huang et al., 2013; Gorman et al., 2007). For students from socioeconomically disadvantaged schools, who are more exposed to fast-food restaurants (Lalonde & Robitaille, 2014) and at greater risk of consuming junk food, measures for subsidized meals could be implemented (Bergeron & Paquette, 2014). Finally, the above interventions should be supported by actions addressing social norms, for example through media campaigns.

5   Limitations

The present study has some limitations. Given the transversal nature of the study, it is not possible to determine whether there are causal effects within the measured associations. Self-reported measures for junk food consumption during lunchtime could contain biases. However, the measure for junk food consumption is the one used most commonly in studies (French et al., 2001; Larson & Story, 2009). It is difficult to estimate bias when measuring consumption of junk food, which is generally recognized as bad for health. While actual consumption for girls could be higher than that reported, boys might have overestimated their

consumption, seeing it symbolically as a form of risk-taking, which is more frequent for adolescent boys. Moreover, the fast-food restaurant geolocation data might over- or underestimate the actual presence of these businesses (Liese et al., 2010; Paquet et al., 2008). However, by using MAPAQ's data on sales licenses, we believe that we have reduced this over- or underestimation (Cummins & Macintyre, 2009). Finally, our analyses focus on the food environment around schools. Further research will have to be undertaken to evaluate the impact of residential environment and of all the environments frequented by young people on a daily basis (Kestens et al., 2010; Larsen, Gilliland, & Hess, 2012; Van Hulst et al., 2012). Notwithstanding these limitations, our analysis has many strengths, notably the sample used, which is representative at the provincial scale, and the use of hierarchical models.

6   Conclusion

The results showed that many students are exposed to the presence of fast-food restaurants in the vicinity of schools. Exposure to two or more fast-food restaurants in a 750-metre radius is significantly and positively associated with consumption of junk food during lunchtime twice or more per week. These results indicate that, in Québec, the food environment around public schools is a relevant target for interventions promoting healthy lifestyle habits for young people. Thus, municipalities can apply zoning bylaws to limit the presence of certain types of business around schools. Actions to modify the range of foods available within certain food establishments can also be undertaken. Further studies should be conducted to measure the links between this exposure and the weight status of young people or other health measures.

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