

Research Paper

Cite this article: Lambert-De Francesch J, Saint-Onge K, Muhajarine N, Blanchet R, and Gauvin L (2026). Characteristics of the retail food environment and acceptability of policies promoting healthier restaurant food environments: to what extent are these concepts associated? *Public Health Nutrition* 29: e97, 1–9. doi: [10.1017/S1368980026102341](https://doi.org/10.1017/S1368980026102341)

Received: 20 September 2025

Revised: 28 January 2026

Accepted: 4 March 2026

Keywords:

Retail food environment; Policy; Public opinion; Restaurants; Multilevel analyses; Canada

Corresponding author:

Jessica Lambert-De Francesch; Email: jessica.lambert-de.francesch@umontreal.ca

Characteristics of the retail food environment and acceptability of policies promoting healthier restaurant food environments: to what extent are these concepts associated?

Jessica Lambert-De Francesch^{1,2} , Kadia Saint-Onge³, Nazeem Muhajarine⁴, Rosanne Blanchet¹ and Lise Gauvin^{1,2}

¹École de santé publique de l'Université de Montréal, Montreal, Canada; ²Centre de recherche du Centre Hospitalier de l'Université de Montréal, Montreal, Canada; ³Département de kinésiologie, Université Laval, Quebec, Canada and ⁴Department of Community Health and Epidemiology, University of Saskatchewan, Saskatoon, Canada

Abstract

Objective: This study explores associations between clusters characterising urban Canadians' retail food environments and their acceptability levels of three policies aimed at promoting healthier restaurant food environments (RFE). **Design:** The three examined policies related to (1) proposing healthier menu default options, (2) restricting the establishment of fast-food restaurants near schools and (3) eliminating unhealthy foods from municipal buildings' food outlets. Retail food environment clusters were available for 1- and 3-km buffer zones from the centroid of participants' residential dissemination area. Retail food environment data were extracted from *Can-FED*, whereas acceptability data were provided by the *THEPA* dataset. **Setting:** Retail food environments present across Canada's seventeen most populated census metropolitan areas. **Participants:** Urban-dwelling Canadians (*n* 27 162). **Results:** Results from multivariate multilevel logistic regression analyses showed that those who were surrounded by the greatest relative density of both healthy food outlets (HFO) and fast-food outlets (FFO) within a 3-km buffer zone were less likely to be in complete agreement with the fast-food zoning policy than the reference category. Findings also indicated that, within a 1-km buffer zone, those whose retail food environment was categorised as being the least healthy (no HFO and highest relative density of FFO) were less likely to be in complete agreement with the unhealthy food elimination policy than the reference category. **Conclusions:** This study provides new evidence of associations between retail food environments and RFE policy acceptability, which may help orient the implementation of these policies.

Canada has been at the forefront of important food policy and planning efforts⁽¹⁾. As highlighted by the most recent version of the FOOD-EPI Canada report, a document benchmarking Canada's food policy efforts in comparison to best practices observed globally, the Canadian government has notably been paving the way in terms of food labelling policies and food policies banning the use of partially hydrogenated oils in foods. Despite these accomplishments, the FOOD-EPI Canada report emphasises the need for additional policy to regulate the restaurant food environment (RFE). To this effect, currently, there are limited Canadian regulations controlling the availability and nutritional quality of restaurant food offerings^(1,2).

Greater public acceptability of policies aiming to render the RFE more conducive to health may be a pivotal factor in promoting restaurant policy action in Canada. Indeed, within democratic societies, high public acceptability of proposed policies has been shown to increase policymakers' will for policy change, increasing political feasibility^(3,4). Additionally, high levels of policy acceptability provide insights as to the collective desire to adhere to the policy, favouring policy effectiveness^(4,5).

Despite the importance of RFE policy acceptability for both political will and policy compliance, limited research has examined public acceptability of RFE policies⁽⁶⁾. Furthermore, whether it be RFE policies (specifically) or food policies (more broadly), previous research has mainly focused on assessing policy- and person-related correlates of food policy acceptability^(7,8). Regarding the latter, previous studies have indicated that select sociodemographic and select health-related characteristics are associated with acceptability of specific RFE policies^(6,9–11). However, limited research has been directed towards exploring environmental correlates of food policy acceptability⁽⁶⁾.

Ecological approaches in food environment research, which notably focus on the interlinkages between surrounding retail food environments and food behaviours, have significantly improved our comprehension of eating behaviours and have facilitated the implementation of strategies to modify them^(12–14). From this perspective, examining the retail food environment

© The Author(s), 2026. Published by Cambridge University Press on behalf of The Nutrition Society. This is an Open Access article, distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike licence (<https://creativecommons.org/licenses/by-nc-sa/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the same Creative Commons licence is used to distribute the re-used or adapted article and the original article is properly cited. The written permission of Cambridge University Press or the rights holder(s) must be obtained prior to any commercial use.



correlates of food policy acceptability may help enhance our general comprehension of food policy acceptability and may serve as a lever to promote the implementation of healthy RFE policies.

Recognising the benefits associated with better knowledge of food policy acceptability, the current study aims to examine the associations between the characteristics of urban Canadians' local retail food environment and their acceptability levels of distinct evidence-based RFE policies. These specifically regard changing the default side dish option for a healthier choice in restaurant settings, restricting the establishment of fast-food outlets (FFO) near schools and eliminating unhealthy foods from municipal buildings' food outlets. As all Canadian communities could benefit from advancements on the RFE policy front, links are explored across Canada's seventeen most populated census metropolitan areas. These include, in a decrescendo order of population density, (1) Toronto, (2) Montreal, (3) Vancouver, (4) Calgary, (5) Ottawa-Gatineau, (6) Edmonton, (7) Quebec City, (8) Winnipeg, (9) Hamilton, (10) London, (11) Halifax, (12) Victoria, (13) Fredericton, Moncton and Saint John, (14) Saskatoon, (15) Regina, (16) Sherbrooke and (17) Saint-John's.

Methods

This study links data from two pan-Canadian datasets: the *Targeting Healthy Eating and Physical Activity* (THEPA) survey dataset and the *Canadian Food Environment Dataset* (Can-FED).

Dataset description

The Targeting Healthy Eating and Physical Activity survey dataset: a focus on intervention acceptability

The pan-Canadian THEPA survey dataset offers insight into urban Canadians' acceptability levels of forty-five built environment and policy interventions. The THEPA survey dataset also provides, among other data, sociodemographic and health-related characteristics of survey participants. Eligibility criteria for the THEPA study entailed residing in one of Canada's seventeen most densely populated census metropolitan areas, minimally providing residential forward sortation area information (i.e., first three digits of six-digit postal code), speaking or reading English or French and being aged 18 years and over.

Participants were recruited either through random digit dialling or through personal email (containing the survey link). Participants' emails were obtained thanks to their former participation in online polls, conducted by international survey firms. Target sample size aims were of 1200 participants per census metropolitan area, with larger sample size aims established for Canada's three most densely populated census metropolitan areas. The actual sample size ranged from 1199 participants in Winnipeg to 4801 participants in Toronto. The THEPA survey dataset is representative of the urban Canadian population, as not only did this survey have large jurisdictional coverage and an important total sample size ($n = 27\,162$), but weights were also applied to create a dataset with characteristics that were commensurate with those of the population; see Lambert-De Francesch et al. (2024)⁽⁶⁾ for the weighting procedure. Survey data collection occurred between October and December 2020.

Among acceptability ratings of the forty-five built environment and policy interventions, three touched upon the RFE and were used as the outcome variables in this study. The three interventions were formulated as follows: (1) *change the usual side dish in restaurants for a healthier option like salad instead of fries*, (2) *impose*

municipal regulations to limit fast-food outlets around schools and (3) *eliminate the offer of chips, candy and other unhealthy foods in restaurants, cafeterias and vending machines in municipal buildings like arenas and recreation centres*. Participants were asked to indicate their acceptability levels for the implementation of each intervention within their residential neighbourhood using the following ordinal scale: completely agree, somewhat agree, somewhat disagree, completely disagree and do not know/prefer not to respond. Residential neighbourhood was defined as the area within a 15-min walking distance from their home address. Acceptability responses were then recoded into *complete agreement v. other*. The rationale underpinning the dichotomisation of the outcome variable was based on the fact that greater levels of acceptability with RFE policies are more likely to translate into policy enactment, contrary to lower levels of agreement⁽¹⁵⁾. As for the *do not know/prefer not to respond* case option, these responses were recoded as missing. Across the three RFE policies, the latter case option represented 5.29 % to 6.77 % of responses.

THEPA sociodemographic and health-related questions notably pertained to gender, age, highest level of educational attainment, income, country of birth, Indigenous status, frequency of consuming restaurant-prepared foods and perceived health status. The formulation of sociodemographic and health-related questions is available elsewhere^(6,16).

The general use Canadian Food Environment Dataset: a portrait of the retail food environment

The general use Can-FED is a pan-Canadian dataset. It covers both urban and rural areas⁽¹⁷⁾. Developed by Stevenson et al. (2022), Can-FED specifically provides data on retail food environment access according to each Canadian dissemination area, $n = 56\,312$ ⁽¹⁸⁾. A dissemination area is the smallest geographical unit of analysis in the Canadian census data⁽¹⁹⁾ and encompasses forward sortation areas (described above)⁽²⁰⁾.

As individuals may consume foods outside their respective dissemination area, all retail food environment indicators provided by Can-FED distinctively include a 1 and a 3-km buffer zone, calculated from each dissemination area's centroid. In the present study, two relative density retail food environment indicators (both with a 1- and 3-km buffer zone) were selected. The two relative density indicators' respective formula, extracted from Stevenson et al.'s paper (2022)⁽¹⁸⁾, are shown in Table A1 of the Additional files section and briefly described below.

The first relative density indicator pertained to the proportion of healthy food outlets (HFO) compared to *all food outlet types* within each dissemination area and its buffer zones⁽¹⁸⁾. HFO include chain supermarkets, grocery stores, as well as fruit and vegetable markets, whereas *all food outlet types* include HFO, FFO, convenience stores and convenience stores at a gas station. The second relative density indicator concerned the proportion of FFO among all full service and FFO within each dissemination area and its buffer zones. In this case, FFO are understood as 'eating places that sell pre-prepared or quickly prepared food at a counter that is likely highly processed'⁽¹⁸⁾, whereas full-service restaurants are understood as 'eating places where patrons typically order from a waiter, can be seated for dine-in, and pay after eating'⁽¹⁹⁾, (p. 5).

Stevenson et al. (2022) created HFO and FFO indicators for each dissemination area and its buffer zones by entering Statistics Canada's 2018 business register data into each indicator's respective formula⁽¹⁸⁾. Using the results obtained from each indicator's formula, a k-medians cluster approach was undertaken by the authors to form clusters (classes 0–4). A class of 0 indicates

that no targeted food outlet (e.g. HFO) is accessible in the given dissemination area and its buffer zone. As for non-zero indicators, a value of 4 represents the greatest access to the targeted food outlet, whereas a value of 1 reflects the lowest access to the targeted food outlet.

Linking datasets, recoding retail food environment variables and developing parsimonious clusters

To examine the relationships between THEPA participants' acceptability levels of RFE policies and the characteristics of their local retail food environment, several steps, conducted on SPSS version 28.0, were undertaken to link together the THEPA dataset and the Can-FED. The merging process' primary challenge pertained to the absence of congruent geographic units that would enable the direct linkage. To this effect, the smallest geographical unit of analysis in the THEPA dataset regarded postal code information, whereas the smallest unit in the Can-FED related to dissemination area information. The absence of a common geographical variable, enabling the direct merging of both datasets, called for the introduction of an intermediary dataset, that is, the November 2020 Postal Code Conversion File (PCCF)⁽²¹⁾. The latter file contains information on approximately 900 000 Canadian postal codes, including their corresponding dissemination areas.

In terms of the merging process, the initial step consisted of extracting all unique postal codes located in the seventeen targeted census metropolitan areas from the nationwide PCCF dataset. This was carried out by extracting the statistical area classification codes belonging to each census metropolitan area. The second step consisted of taking the Can-FED and merging it with the newly created seventeen census metropolitan area datasets. This merge was done based on dissemination area information and led to the creation of a dataset encompassing the postal codes, dissemination areas and Can-FED indicators of Canadians living in the specified census metropolitan areas.

To ensure sufficient representation of all FFO and HFO indicator classes (0–4) within the newly created dataset, both indicator classes were consolidated into broader categories. Based on distribution patterns of the targeted indicators within the newly created seventeen census metropolitan area datasets, all 1- and 3-km HFO and FFO indicators were recoded into the following: *no access* (encompassed of class: zero), *typical access* (encompassed of classes: one and two) and *highest access* (encompassed of classes: three and four).

Once retail food environment variables were recoded, clusters characterising the different retail food environments present within the seventeen census metropolitan areas were created. Clusters were developed via cluster analysis and equally encompassed both HFO and FFO data. Distinct clusters were created for the 1- and 3-km buffer zones, as the food environment proximally surrounding a dissemination area centroid (1 km) can differ from the characteristics observed at a more distal distance from the centroid (3 km). To be retained, established clusters had to show pronounced intra-group homogeneity and pronounced inter-group heterogeneity⁽²²⁾.

Developing retail food environment clusters first required assessing the relationship between all environmental variables (recoded HFO variables for 1- and 3-km buffer zones and recoded FFO variables for 1- and 3-km buffer zones). Spearman's rank order correlations were used to assess the extent to which environmental variables were overlapping⁽²³⁾. As the correlation coefficients remained low, it was deemed appropriate to input all

variables belonging to the same buffer zone simultaneously into a two-step clustering method.

The two-step clustering method, available on SPSS version 28.0, used an algorithm to first compress the data into subclusters and then used a hierarchical clustering method to merge the latter subclusters into larger clusters⁽²⁴⁾. The latter method was selected as, contrary to other clustering methods, it was appropriate for ordinal variables, did not require variables to be normally distributed, was adequate for a large dataset and provided information regarding cluster quality⁽²⁵⁾. Cluster quality was presented as the *silhouette coefficient*, ranging from –1.0 to 1.0⁽²⁶⁾. To be designated as final clusters, clusters had to have the greatest silhouette coefficient (i.e., signifying good cluster quality) and make qualitative sense (i.e., signifying real-life feasibility).

Once all postal codes located in Canada's seventeen most densely populated census metropolitan areas were attributed respective clusters, the latter data were merged with the THEPA dataset via postal code linkage. Of the 27 162 participants of the THEPA study, 4696 participants were not attributed cluster information. On the one hand, this was partially due to the fact that not all participants provided postal code information (only forward sortation area information was minimally required to participate). On the other hand, a slight misalignment was noticed between the broader sampling frame of the THEPA survey study, which included participants residing just beyond the targeted census metropolitan areas, and the narrower geographical data extracted from the PCCF (based on statistical area classification codes). In all, 22 466 THEPA participants were attributed cluster information.

Addressing missing data in the newly merged Targeting Healthy Eating and Physical Activity dataset

Whether it pertains to retail food environment characteristics, sociodemographic characteristics, health-related characteristics or acceptability levels, missing data in the newly merged THEPA dataset were imputed using predictive mean matching methods. The latter method assigns a value to a missing case based on random allocation of one of the five closest participant cells⁽²⁷⁾. Comparatively to other imputation techniques, predictive mean matching methods have the distinct advantage of solely introducing plausible values to the imputed datasets⁽²⁸⁾. A total of ten imputed datasets were created.

Descriptive and statistical analyses

Descriptive analyses were used for all acceptability correlates (i.e., sociodemographic characteristics, health-related characteristics and retail food environment characteristics) and reported across select datasets. All descriptive analyses were conducted using SPSS version 28.

As for statistical analyses, multilevel logistic regression analyses were conducted using HLM 8.0 software. These analyses were performed on the weighted data derived from the pooled ten imputed datasets (n 27 162). Conducting multilevel analyses enabled the respect of the multilevel structure of the THEPA sampling frame, that is, lower-order units (individuals) nested within different higher-order units (census metropolitan areas)⁽²⁹⁾. Supporting this conceptual distinction is the work by Lambert-De Francesch *et al.* (2024)⁽⁶⁾ who found statistically significant differences in the likelihood of completely agreeing with RFE policies across the seventeen census metropolitan areas.

For each of the three policies, two statistical models were created. The first model solely examined the associations between the targeted retail food environment variables and complete agreement levels, whereas the second model adjusted for select sociodemographic and health-related characteristics. The decision to adjust for these sociodemographic and health-related variables was underpinned by their pre-established association with complete agreement levels of RFE policies^(6,16) and their ability to accurately predict access to retail food environments⁽³⁰⁾. For each model, the OR and 95 % CI were reported.

Results

Participant sociodemographic and health-related characteristics

Participant sociodemographic and health-related characteristics are presented for two datasets: one comprising only those who initially received retail food environment cluster information (*n* 22 466, further subdivided into unweighted/non-imputed data and weighted/non-imputed data) and the other dataset comprising all study participants, irrespective of initial retail food environment cluster attribution (*n* 27 162, weighted/imputed data).

According to Table 1, compared to the unweighted/non-imputed THEPA dataset consisting solely of those who were initially attributed cluster information (*n* 22 466), the weighted/non-imputed dataset mainly adjusted for the underrepresentation of those with a high school level diploma or less, compared to those with a university degree. In the full weighted/imputed dataset (*n* 27 162), the sample predominantly consisted of women (51.8 %), Canadian-born individuals (77.9 %) and non-Indigenous persons (94.5 %). The majority of participants described their health status as either good, fair or poor (55.4 %) and consumed restaurant-prepared food either a few times a week, once a week or less than once a week (77.1 %). Across the full dataset, the most prevalent age category was 55 years and over (35.4 %), the most prevalent educational attainment category was university level (29.2 %) and the most prevalent gross household income category was \$40 000–\$79 999 (31.8 %).

Stevenson *et al.*'s (2022) healthy food outlet and fast-food outlet cluster class distribution

Distribution patterns of Stevenson *et al.*'s (2022) HFO and FFO clusters (classes 0–4) are available in Table A2 in the Additional files section. These distribution patterns are presented across 1- and 3-km dissemination area buffer zones and across select datasets. A brief description regarding Table A2 is also provided in the Additional files section.

Identification of final clusters

As mentioned previously, Stevenson *et al.*'s (2022) HFO and FFO clusters (classes 0–4) were recoded into broader categories (i.e., no access, typical access and highest access), forming the basis of this study's retail food environment clusters.

1-km retail food environment access clusters were named the following way:

- 1) **proximal absence** (no HFO nor FFO)
- 2) **proximal healthiest** (highest HFO and no FFO)
- 3) **proximal least healthy** (no HFO and highest FFO)
- 4) **proximal typical** (typical HFO and typical FFO)

- 5) **proximal food swamp-like environment**¹ (typical HFO and highest FFO).

3-km retail food environment clusters were named as:

- 1) **distal absence** (no HFO nor FFO)
- 2) **distal healthiest** (highest HFO and typical FFO)
- 3) **distal greatest relative density** (highest HFO and highest FFO)
- 4) **distal typical** (typical HFO and typical FFO)
- 5) **distal food swamp-like environment** (typical HFO and highest FFO).

Cluster centre homogeneity and distribution of clusters

The level of homogeneity within the retail food environment cluster centres is available in Table A3 in the Additional files section. The distribution patterns of the clusters across select datasets are also available in Table A3. A brief description of both cluster centre homogeneity and cluster distribution is provided alongside Table A3 in the Additional files section.

Results of multilevel logistic regression analyses

Table 2 illustrates the OR and 95 % CI for being in complete agreement with the three RFE policies according to THEPA participants' residential retail food environment clusters (based on weighted/imputed dataset, *n* 27 162). Reference categories were **proximal typical** (typical HFO and typical FFO) for the 1-km buffer zone and **distal typical** (typical HFO and typical FFO) for the 3-km buffer zone. Results are shown for unadjusted and adjusted models (i.e., adjusted for sociodemographic and health-related characteristics).

For the default choice policy, irrespective of the targeted buffer zone, no significant association was detected between complete agreement levels and environmental variables.

For the zoning policy, for analyses conducted using only 1-km data, in the unadjusted model, participants surrounded by the **proximal least healthy food environment** (no HFO and highest relative density of FFO) were less likely to be in complete agreement with the policy than those with **typical** relative densities of HFO and FFO (OR: 0.90, 95 % CI: 0.82, 0.98). The statistical significance observed in the latter association became non-significant in the adjusted model (OR: 0.92, 95 % CI: 0.83, 1.02). As for analyses conducted using only 3-km data, we observed that participants not only exposed to the highest relative density of FFO but also the highest relative density of HFO (cluster: **distal greatest relative food outlet density**) were less likely to be in complete agreement with the zoning policy than those in the reference category, and this for both unadjusted and adjusted models (OR_{unadjusted}: 0.85, 95 % CI: 0.74, 0.98; OR_{adjusted}: 0.86, 95 % CI: 0.74, 0.99). Tying in with the latter observation are results derived from the combined 1- and 3-km retail food environment clusters. According to the latter examination, participants whose food environment was categorised as **distal greatest relative food outlet density** were also less likely to be in complete agreement with the policy. This was, however, only observed in the adjusted model (OR: 0.86, 95 % CI: 0.75, 0.99).

¹Food swamps are "food environments where access to food of low nutritional value is so important that it "drowns" access to healthy food of high nutritional value"⁽⁴³⁾.

Table 1. Sociodemographic and health-related characteristics of *Targeting Healthy Eating and Physical Activity* (THEPA) survey study participants

Individual characteristics	Survey participants whose postal code was initially linked to cluster information (n 22 466, unweighted/non-imputed dataset)		Survey participants whose postal code was initially linked to cluster information (n 22 466, weighted/non-imputed dataset)	All survey participants, irrespective of initial cluster linkage (n 27 162, weighted/imputed dataset)
	n	%	%	%
Gender				
Male	9942	44.3 %	48.3 %	48.2 %
Female	12 393	55.2 %	51.1 %	51.8 %
Other	57	0.3 %	0.3 %	–
Missing	75	0.3 %	0.3 %	–
Age				
18–34 years	5721	25.5 %	27.5 %	29.5 %
35–54 years	7630	34.0 %	35.5 %	35.1 %
55 years or older	8713	38.8 %	35.3 %	35.4 %
Missing	402	1.8 %	1.8 %	–
Education				
High school or less	4548	20.2 %	39.8 %	41.2 %
Trade school or junior college	7278	32.4 %	29.6 %	29.6 %
University	10 420	46.4 %	29.6 %	29.2 %
Missing	220	1.0 %	1.0 %	–
Annual family income before taxes				
Less than \$40 000	4395	19.6 %	23.0 %	25.7 %
Between \$40 000 and \$79 999	6678	29.7 %	29.8 %	31.8 %
Between \$80 000 and \$119 999	5009	22.3 %	20.9 %	23.5 %
\$120 000 and over	4089	18.2 %	15.7 %	18.9 %
Missing	2295	10.2 %	10.6 %	–
Country of birth				
Canada	17 183	76.5 %	74.7 %	77.9 %
High-income country outside of Canada	1361	6.1 %	6.4 %	7.2 %
Low- or middle-income country	3010	13.4 %	14.5 %	14.9 %
Missing	912	4.1 %	4.4 %	–
Self-reported Indigenous status				
Non-Indigenous	21 173	94.2 %	93.0 %	94.5 %
Indigenous	935	4.2 %	5.0 %	5.5 %
Missing	358	1.6 %	2.0 %	–
Perceived health status				
Excellent or very good	10 412	46.3 %	44.7 %	44.6 %
Good, fair or poor	11 892	52.9 %	54.6 %	55.4 %
Missing	162	0.7 %	0.7 %	–
Average frequency of consuming foods in restaurants				
Everyday	340	1.5 %	1.8 %	2.3 %
A few times a week, once a week or less than once a week	17 402	77.5 %	75.9 %	77.1 %
Never	4356	19.4 %	20.3 %	20.7 %
Missing	368	1.6 %	2.0 %	–

Characteristics are presented for the partial dataset (exclusively consisting of those whose postal code was initially linked to cluster information, n 22 466) and according to the full dataset (consisting of all participants, irrespective of initial cluster linkage, n 27 162). The partial dataset consists of both unweighted/non-imputed and weighted/non-imputed data, whereas the full dataset consists of weighted and imputed data. Survey data were collected between October and December 2020.

Table 2. OR and 95 % CI for being in complete agreement with each policy

Buffer zones	Retail food environment clusters	Default policy				Zoning policy				Eliminate policy			
		Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted	
		OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
1 km	Proximal absence	0.99	0.90, 1.08	0.99	0.90, 1.10	0.94	0.87, 1.03	0.98	0.90, 1.08	0.96	0.88, 1.05	0.99	0.90, 1.10
	Proximal healthiest	0.93	0.84, 1.04	0.93	0.83, 1.05	1.00	0.90, 1.12	1.03	0.91, 1.15	0.97	0.87, 1.09	0.99	0.88, 1.12
	Proximal least healthy	0.92	0.84, 1.01	0.93	0.84, 1.03	0.90[†]	0.82, 0.98	0.92	0.83, 1.02	0.83[†]	0.75, 0.92	0.85[†]	0.75, 0.95
	Proximal typical	1.00		1.00		1.00		1.00		1.00		1.00	
	Proximal food swamp-like environment	0.98	0.90, 1.07	0.98	0.90, 1.07	0.92	0.84, 1.00	0.92	0.84, 1.01	0.94	0.85, 1.05	0.95	0.86, 1.06
3 km	Distal absence	1.09	0.97, 1.23	1.08	0.93, 1.25	1.02	0.88, 1.19	1.08	0.90, 1.29	0.93	0.79, 1.09	0.95	0.78, 1.15
	Distal healthiest	1.05	0.96, 1.14	1.03	0.94, 1.12	1.06	0.98, 1.15	1.04	0.96, 1.13	0.99	0.88, 1.11	0.96	0.86, 1.08
	Distal greatest relative food outlet density	0.94	0.81, 1.10	0.94	0.81, 1.09	0.85[†]	0.74, 0.98	0.86[†]	0.74, 0.99	0.88	0.77, 1.02	0.89	0.77, 1.02
	Distal typical	1.00		1.00		1.00		1.00		1.00		1.00	
	Distal food swamp-like environment	1.05	0.96, 1.15	1.03	0.94, 1.14	1.02	0.94, 1.12	1.02	0.93, 1.13	0.95	0.86, 1.04	0.94	0.86, 1.04
1 km + 3 km	Proximal absence	0.97	0.88, 1.07	0.99	0.90, 1.09	0.95	0.87, 1.03	0.96	0.88, 1.04	0.98	0.88, 1.09	1.00	0.90, 1.11
	Proximal healthiest	0.93	0.84, 1.04	0.94	0.84, 1.05	1.00	0.90, 1.13	1.02	0.91, 1.14	0.98	0.87, 1.10	1.00	0.89, 1.12
	Proximal least healthy	0.91	0.83, 1.01	0.93	0.84, 1.03	0.90	0.82, 1.00	0.91	0.83, 1.01	0.84[†]	0.75, 0.94	0.85[†]	0.76, 0.96
	Proximal food swamp-like environment	0.98	0.90, 1.07	0.98	0.90, 1.07	0.92	0.84, 1.00	0.92	0.84, 1.01	0.95	0.86, 1.06	0.96	0.86, 1.07
	Proximal typical and distal typical	1.00		1.00		1.00		1.00		1.00		1.00	
	Distal absence	1.09	0.96, 1.25	1.07	0.93, 1.22	1.04	0.89, 1.21	1.02	0.87, 1.19	0.93	0.78, 1.11	0.92	0.77, 1.10
	Distal healthiest	1.05	0.97, 1.15	1.03	0.95, 1.12	1.06	0.9, 1.15	1.04	0.96, 1.12	0.99	0.88, 1.11	0.96	0.86, 1.08
	Distal greatest relative outlet density	0.96	0.82, 1.12	0.95	0.82, 1.11	0.87	0.76, 1.00	0.86[†]	0.75, 0.99	0.91	0.79, 1.05	0.90	0.78, 1.05
	Distal food swamp-like environment	1.06	0.97, 1.17	1.05	0.95, 1.15	1.05	0.96, 1.15	1.04	0.95, 1.14	0.97	0.89, 1.07	0.96	0.87, 1.06

OR and 95 % CI are presented according to retail food environment clusters present within 1- and 3-km buffer zones from the residential dissemination area centroids of those partaking in the *Targeting Healthy Eating and Physical Activity* (THEPA) survey study. Data are presented according to unadjusted and adjusted results. Adjusted results account for participants' sociodemographic and health-related characteristics. The sociodemographic reference categories were Canadian-born male individual, aged 55 years or older, holding a university degree, reporting an annual household income of \$40 000–\$79 999 and not identifying as Indigenous. Health-related reference categories were as follows: reporting excellent or very good perceived health, and consuming restaurant-prepared foods a few times per week, once per week or less than once a week. All acceptability levels stem from the full dataset (weighted and imputed data, *n* 27 162), where data collection occurred between October and December 2020. Retail food environment data were extracted from the *Canadian Food Environment Dataset* (Can-FED). Bolded results with [†]symbol are statistically significant.

The most consistent links between environmental variables and complete agreement levels were observed for the eliminate choice policy. Unlike most associations reported for the previous policy, links remained statistically significant before and after adjustments were made for sociodemographic and health-related variables. Indeed, for all analyses conducted with 1-km buffer data (i.e., analyses with only 1-km data and analyses with both 1- and 3-km data), those surrounded by the **least healthy** food environments were consistently less likely to be in complete agreement with the eliminate choice policy compared to the reference category (i.e., $OR_{unadjusted}$ 1 km: 0.83, 95 % CI: 0.75, 0.92; $OR_{adjusted}$ 1 km: 0.85, 95 % CI: 0.75, 0.95; $OR_{unadjusted}$ 1 and 3 km: 0.84, 95 % CI: 0.75, 0.94; $OR_{adjusted}$ 1 and 3 km: 0.85, 95 % CI: 0.76, 0.96).

Results showcasing complete analyses, that is, those including the OR and 95 % CI for sociodemographic characteristics, health-related characteristics and 1- and 3-km clusters combined, are available in Table A4 in Additional files.

Discussion

This study examined the associations between urban Canadians' retail food environment characteristics and their acceptability levels of three distinct RFE policies. Our findings indicated that likelihood of being in complete agreement with the healthier default choice policy was independent of examined environmental variables. Statistically significant associations were, however, observed for the other two RFE policies. For the policy restricting the establishment of fast-foods near schools, according to analyses jointly examining 1- and 3-km data, after adjustments, it was shown that residing in dissemination areas where there was the **greatest relative density of HFO and FFO** within a 3-km buffer zone was linked to a lower likelihood of expressing complete agreement with the policy. As for the policy aiming to eliminate unhealthy foods in selected settings, according to analyses jointly examining 1- and 3-km data, both before and after adjustments, individuals whose retail food environment was exempt from HFO and had the highest relative density of FFO (i.e., **least healthy** food environment cluster) in a 1-km buffer zone were also less likely to be in complete agreement with the policy.

Although the literature on retail food environment characteristics and RFE policy acceptability is extremely limited, some comparisons regarding the FFO zoning policy can be drawn from Keeble *et al.*'s (2024) study⁽³¹⁾. These authors examined the association between support for a regulation stopping new FFO from opening near schools and neighbourhood food outlet access. Despite not finding any statistically significant association, many differences limit its comparability with the present study, notably the level of intrusiveness of the proposed policy ('stop' v. 'limit' FFO), the measurement instrument used and the target population.

Given the dearth of research on environmental exposures and FFO zoning policy acceptability, comparing this study's results to previous work requires drawing insights from other fields. One anchor for comparison may be studies assessing the determinants of pro-environmental public attitudes. In this research area, it has, for example, been shown that those who are most exposed to nature tend to hold more positive attitudes towards the natural environment^(32,33). Somewhat mirroring the latter observation are our results regarding fast-food zoning policies, where higher exposure to FFO translated into a lower likelihood of being in complete agreement with a policy aimed at limiting FFO availability. More research is, however, needed to comprehend why the

simultaneous exposure to a high relative density of both FFO and HFO is linked to a lower likelihood of being in complete agreement with the zoning policy.

As for the eliminate unhealthy food policy, our results also tie in with observations derived from pro-environmental attitude studies^(32,33), as greater exposure to unhealthy food environments in a 1-km buffer zone correlated with less favourable attitudes towards policies aiming to ban unhealthy foods. Other than mirroring trends observed in a different field of study, our results regarding the eliminate choice policy are intuitively coherent. To this effect, it could be hypothesised that in areas where FFO are the predominant food source and where healthy food options are not readily available, the elimination of unhealthy food offerings in selected settings may cut or significantly reduce food supply options. Food availability-related challenges may thus help explain the observed less favourable opinions towards this policy. Additional research would be needed to validate the latter hypothesis.

The findings from this study have significant policy implications, particularly for the enactment of RFE policies in urban Canada. The associations between specific retail food environment clusters and policy acceptability may offer insights as to a potential phased approach to policy enactment. Given that higher levels of acceptability are likely to facilitate policy enactment, urban planners and policymakers may find it advantageous to initially introduce evidence-based RFE policies in residential areas where attitudinal barriers are lower. Policy implementation may thus contribute to rendering the RFE healthier, ultimately having a positive impact on eating behaviours. In this regard, much like modifying individual food behaviours, shifting the focus from interventions targeting individuals to those aimed at transforming the retail food environment could be a much more effective strategy to attain nutrition public health goals⁽³⁴⁾.

Despite the importance of modifying the RFE in the realm of RFE policy enactment, it is important to highlight that curbing the growth of FFO, such as is the case with fast-food zoning policies, may come with certain challenges, as international food corporations, which are at the basis of many fast-food chains, exert substantial power and influence on governments^(35,36). Through a multitude of actions, these corporations ensure that policies do not unduly influence their commercial endeavours. The case of the Côte-des-Neiges-Notre-Dame-de-Grâce borough in Montreal, Canada, is a prime example of the big food industry's determination to not let public policy limit its expansion⁽³⁷⁾. In 2016, a bylaw, prohibiting the opening of new FFO in certain locations, was adopted by the borough. Much opposition was shown by the targeted restaurant food industry, as, in 2022, this bylaw was made the object of a dispute presented before Canada's highest court. Despite possible resistance, across the country, municipalities are nonetheless slowly adopting measures to limit FFO establishment⁽³⁸⁾.

In terms of novel contributions, this study is among the first to demonstrate links between retail food environment characteristics and RFE policy acceptability. Methodological strong points include the unique development of retail food environment clusters which include both HFO and FFO indicators. The incorporation of both healthy and less HFO data into clusters enables a more holistic understanding of how different spatial contexts are associated with RFE policy acceptability. Including both HFO and FFO indicators into clusters is also an innovative approach, as few studies have created clusters composed of multiple retail food outlets⁽³⁹⁾. Other study strong points include the weighting procedure used in this study (attenuating selection biases), the conduction of analyses on imputed data (mitigating missing data biases) and the utilisation of

multilevel analyses (decreasing the risk of biases which could have been introduced by the conduction of flat analyses on a nested data structure).

Despite the innovative and methodologically robust features of this study, several limitations are to be noted. A first limitation regards the assignment of retail food environment indicators to THEPA participants. On the one hand, the assignment process entailed linking datasets which did not have identical data collection periods, leading to a potential mismatch of data. Mismatching of data may have especially concerned Can-FED indicators, as the 2020 Covid pandemic resulted in significant shifts in the opening and closing of local businesses⁽⁴⁰⁾. On the other hand, certain assignment inaccuracies may have happened when a single postal code straddled across more than one dissemination area with different HFO and FFO indicators. The impact of this limit was however mitigated by the fact that the PCCF allocated the most probable dissemination area for each postal code based on population size⁽²¹⁾.

A second methodological limitation relates to the complexities of accurately capturing the retail food environment in a context of increased use of food delivery services leading to food purchases outside one's residential area⁽⁴¹⁾. As individuals may consume food from outlets many kilometres away from their home, additional exploration is needed regarding consumer habits and the personal variability influencing these habits, such as financial situation, disability status and contextual factors. In regard to the last element, as the THEPA survey was distributed during the pandemic, this event contributed to many consumers' even greater uptake of food delivery services⁽⁴²⁾, augmenting uncertainty about which retail food environment characteristics apply.

A third important limitation is the lack of full alignment between the geospatial delimitations employed in the Can-FED and the THEPA dataset. In the THEPA dataset, participants rated the acceptability of policies implemented within their *residential neighbourhood*, defined as the area reachable within a 15-min walk from their home. Can-FED, by contrast, notably relied on a 1-km buffer around the centroid of the dissemination area. These two units, which represent ground coverage in different ways, may therefore not align perfectly. Nonetheless, a 15-min walk can approximate 1 km depending on walking speed and walking networks, suggesting that the two measures may overlap to some extent.

As this study is among the first to examine the links between RFE policy acceptability and environmental factors, replication and extension of results are essential. Indeed, future research ought to utilise different samples and study designs to replicate and extend research findings. For example, future work could involve longitudinal studies. By following the same participants over time, researchers could reassess acceptability levels and examine whether acceptability levels shift when individuals move to dissemination areas with different retail food environment characteristics.

Conclusion

This study addresses a current gap in the literature by assessing the associations between retail food environment characteristics and RFE policy acceptability in urban Canada. Findings suggest that being surrounded by select retail food environment clusters, in particular those with the **greatest distal relative density of both HFO and FFO** and those deemed as being the **proximal least healthy**, was associated with a lower likelihood of being in

complete agreement with select RFE policies. The new evidence provided by this study may help orient development efforts promoting healthier RFE. Future important steps include replication and extension of results.

Supplementary material. For supplementary material accompanying this paper visit <https://doi.org/10.1017/S1368980026102341>

Financial support. This work was supported by Canadian Institutes of Health Research Grants (#148919 and #IP2-150710). This funding source had no role in the design, analysis or writing of this article.

Competing interests. There are no conflicts of interest.

Authorship. J.L.-D.F.: conceptualisation, data curation, formal analysis, investigation, methodology, software, validation, visualisation, writing – original draft and writing – review and editing. K.S.-O.: investigation and writing – review and editing. N.M.: funding acquisition, investigation, project administration and writing – review and editing. R.B.: writing – review and editing. L.G.: conceptualisation, funding acquisition, investigation, methodology, project administration, supervision, validation and writing – review and editing.

Ethics of human subject participation. This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving research study participants were approved by the Ethics Committee of the Centre Hospitalier de l'Université de Montréal on 28 November 2019 (protocol no.: 19.258). Written (online survey) or verbal (telephone survey) informed consent was obtained from all subjects/patients. Verbal consent was witnessed and formally recorded.

References

1. Vanderlee L, McLaughlin A, Vaillancourt C, *et al.* (2023) Actions to Cultivate Healthier Food Environments in Canada: Federal Government Policies and Progress. https://informacanada.com/fileadmin/Fichiers/Default/PDF-Food-EPI2023/FoodEPI_Report-2023-FEDERAL-FINAL-Web.pdf (accessed August 2025).
2. Yang Y, Weippert M, Ahmed M, *et al.* (2023) Cross-sectional nutritional information and quality of Canadian chain restaurant menu items in 2020. *Am J Prev Med* **64**, 42–50.
3. Kwon J, Cameron AJ, Hammond D, *et al.* (2019) A multi-country survey of public support for food policies to promote healthy diets: findings from the International Food Policy Study. *BMC Public Health* **19**, 1205.
4. Grelle S & Hofmann W (2023) When and why do people accept public-policy interventions? An integrative public-policy-acceptance framework. *Perspect Psychol Sci* **19**, 258–279.
5. Proctor E, Silmere H, Raghavan R, *et al.* (2010) Outcomes for implementation research: conceptual distinctions, measurement challenges, and research agenda. *Adm Policy Ment Health* **38**, 65–76.
6. Lambert-De Francesch J, Saint-Onge K, Muhajarine N, *et al.* (2024) Sociodemographic characteristics help predict Canadian urbanites' acceptability of restaurant food environment policies. *Front Nutr* **11**, 1360360.
7. Scheidmeir M, Kubiak T, Luszczynska A, *et al.* (2022) Acceptability of policies targeting dietary behaviours and physical activity: a systematic review of tools and outcomes. *Eur J Public Health* **32**, iv32–iv49.
8. Diepeveen S, Ling T, Suhrcke M, *et al.* (2013) Public acceptability of government intervention to change health-related behaviours: a systematic review and narrative synthesis. *BMC Public Health* **13**, 756.
9. Bhawra J, Reid JL, White CM, *et al.* (2018) Are young Canadians supportive of proposed nutrition policies and regulations? An overview of policy support and the impact of socio-demographic factors on public opinion. *Can J Public Health* **109**, 498–505.
10. Cranney L, Thomas M, Cobcroft M, *et al.* (2022) Community support for policy interventions targeting unhealthy food environments in public institutions. *Health Promot J Austr* **33**, 618–630.
11. Ramamoorthy S, Gauvin L & Muhajarine N (2024) Acceptability of built environment interventions to improve healthy eating and physical activity

- among city dwellers in Saskatchewan, Canada: THEPA findings from a local context. *Cities Health* **8**, 345–359.
12. Story M, Neumark-Sztainer D & French S (2002) Individual and environmental influences on adolescent eating behaviors. *J Am Diet Assoc* **102**, S40–S51.
 13. Kouritzin T, Spence JC & Lee K (2023) Food intake and food selection following physical relocation: a scoping review. *Public Health Rev* **44**, 1605516.
 14. Bel-Serrat S, von der Schulenburg A, Marques-Previ M, *et al.* (2022) What are the determinants of vegetable intake among adolescents from socio-economically disadvantaged urban areas? A systematic review of qualitative studies. *Int J Behav Nutr Phys Act* **19**, 158.
 15. Sharp CA, Bellis MA, Hughes K, *et al.* (2020) Public acceptability of public health policy to improve population health: a population-based survey. *Health Expect* **23**, 802–812.
 16. Lambert-De Francesch J, Saint-Onge K, Muhajarine N, *et al.* (2025) Selected health characteristics are associated with urban Canadians' acceptability of policies promoting healthier restaurant food environments. *Public Health Nutr* **28**, e15.
 17. Statistics Canada (2022) Canadian Food Environment Dataset: Data File and User Guide. <https://www150.statcan.gc.ca/n1/pub/13-20-0001/132000012022001-eng.htm> (accessed September 2025).
 18. Stevenson A, Kaufmann C, Colley RC, *et al.* (2022) A pan-Canadian dataset of neighbourhood retail food environment measures using Statistics Canada's Business Register. *Health Rep* **33**, 3–14.
 19. Statistics Canada (2021) Dissemination Area (DA). <https://www12.statcan.gc.ca/census-recensement/2021/ref/dict/az/Definition-eng.cfm?ID=geo021> (accessed September 2025).
 20. Statistics Canada (2021) Census Forward Sortation Area Boundary File, Reference Guide, Census Year 2021. <https://www150.statcan.gc.ca/n1/pub/92-179-g/92-179-g2021001-eng.htm> (accessed September 2025).
 21. Statistics Canada (2020) *Postal CodeOM Conversion File (PCCF), Reference Guide*. Ottawa, ON: Statistics Canada.
 22. Mooi E & Sarstedt M (2011) *A Concise Guide to Market Research The Process, Data, and Methods Using IBM SPSS Statistics*. Berlin: Springer.
 23. Bezerra CIM, Andrade RMC & Monteiro JM (2017) Exploring quality measures for the evaluation of feature models: a case study. *J Syst Softw* **131**, 366–385.
 24. Hu Y, Zhang Y, Zhong J, *et al.* (2024) Association between obesity phenotypes and dietary patterns: a two-step cluster analysis based on the China multi-ethnic cohort study. *Prev Med* **187**, 108100.
 25. Benassi M, Garofalo S, Ambrosini F, *et al.* (2020) Using two-step cluster analysis and latent class cluster analysis to classify the cognitive heterogeneity of cross-diagnostic psychiatric inpatients. *Front Psychol* **11**, 1085.
 26. Harantová V, Mazanec J, Štefancová V, *et al.* (2023) Two-step cluster analysis of passenger mobility segmentation during the COVID-19 pandemic. *Mathematics* **11**, 583.
 27. Austin PC & van Buuren S (2023) Logistic regression v. predictive mean matching for imputing binary covariates. *Stat Methods Med Res* **32**, 2172–2183.
 28. Allison P (2015) Imputation by Predictive Mean Matching: Promise & Peril. <https://statisticalhorizons.com/predictive-mean-matching/> (accessed April 2025).
 29. Leyland A & Groenewegen P (2020) What is multilevel modelling? In *Multilevel Modelling for Public Health and Health Services Research: Health in Context*, pp. 1–22 [AH Leyland, PP Groenewegen, editors]. Cham: Springer.
 30. Amin MD, Badruddoza S & McCluskey JJ (2021) Predicting access to healthful food retailers with machine learning. *Food Policy* **99**, 101985.
 31. Keeble M, Adams J, Amies-Cull B, *et al.* (2024) Public acceptability of proposals to manage new takeaway food outlets near schools: cross-sectional analysis of the 2021 International Food Policy Study. *Cities Health* **8**, 1094–1107.
 32. DeVille N, Tomasso L, Stoddard O, *et al.* (2021) Time spent in nature is associated with increased pro-environmental attitudes and behaviors. *Int J Environ Res Public Health* **18**, 7498.
 33. Rosa C & Collado S (2019) Experiences in nature and environmental attitudes and behaviors: setting the ground for future research. *Front Psychol* **10**, 763.
 34. Dixon BN, Ugwoaba UA, Brockmann AN, *et al.* (2021) Associations between the built environment and dietary intake, physical activity, and obesity: a scoping review of reviews. *Obes Rev* **22**, e13171.
 35. Baker P, Machado P, Santos T, *et al.* (2020) Ultra-processed foods and the nutrition transition: global, regional and national trends, food systems transformations and political economy drivers. *Obes Rev* **21**, e13126.
 36. Slater S, Lawrence M, Wood B, *et al.* (2024) Corporate interest groups and their implications for global food governance: mapping and analysing the global corporate influence network of the transnational ultra-processed food industry. *Global Health* **20**, 16.
 37. CBC News (2019) Côte-des-Neiges-NDG has the right to limit where fast food is sold, court rules. <https://www.cbc.ca/news/canada/montreal/cote-des-neiges-fast-food-restaurants-1.5352201> (accessed January 2025).
 38. Nykiforuk CIJ, Campbell EJ, Macridis S, *et al.* (2018) Adoption and diffusion of zoning bylaws banning fast food drive-through services across Canadian municipalities. *BMC Public Health* **18**, 137.
 39. Hoenink J, Eisink M, Adams J, *et al.* (2023) Who uses what food retailers? A cluster analysis of food retail usage in the Netherlands. *Health Place* **81**, 103009.
 40. Lafond-Cooke A (2021) Starting a Business in a Pandemic: The experiences of businesses created during COVID-19. <https://doi.org/10.25318/36280001202100700004-eng> (accessed July 2025).
 41. Brar K & Minaker LM (2021) Geographic reach and nutritional quality of foods available from mobile online food delivery service applications: novel opportunities for retail food environment surveillance. *BMC Public Health* **21**, 458.
 42. Kifle Abebe G, Charlebois S & Music J (2023) The impact of COVID-19 on Canadian restaurant operations and the likelihood of pivoting off-dining options post-COVID-19. *Transp Res Interdiscip Perspect* **21**, 100917.
 43. Robitaille E & Paquette M-C (2020) Development of a method to locate deserts and food swamps following the experience of a region in Quebec, Canada. *Int J Environ Res Public Health* **17**, 3359.