Catalogue no. 82-003-X
ISSN 1209-1367

Health Reports

A pan-Canadian dataset of neighbourhood retail food environment measures using Statistics Canada's Business Register

by Andrew C. Stevenson, Clara Kaufmann, Rachel C. Colley, Leia M. Minaker, Michael J. Widener, Thomas Burgoine, Claudia Sanmartin and Nancy A. Ross

Release date: February 16, 2022

Statistics Canada Statistique Canada

Canada

How to obtain more information

For information about this product or the wide range of services and data available from Statistics Canada, visit our website, www.statcan.gc.ca.

You can also contact us by

Email at infostats@statcan.gc.ca

Telephone, from Monday to Friday, 8:30 a.m. to 4:30 p.m., at the following numbers:

- Statistical Information Service 1-800-263-1136
- National telecommunications device for the hearing impaired 1-800-363-7629
- Fax line 1-514-283-9350

Standards of service to the public

Statistics Canada is committed to serving its clients in a prompt, reliable and courteous manner. To this end, Statistics Canada has developed standards of service that its employees observe. To obtain a copy of these service standards, please contact Statistics Canada toll-free at 1-800-263-1136. The service standards are also published on www.statcan.gc.ca under "Contact us" > "Standards of service to the public."

Note of appreciation

Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued co-operation and goodwill.

A pan-Canadian dataset of neighbourhood retail food environment measures using Statistics Canada's Business Register

by Andrew C. Stevenson, Clara Kaufmann, Rachel C. Colley, Leia M. Minaker, Michael J. Widener, Thomas Burgoine, Claudia Sanmartin and Nancy A. Ross

DOI: https://www.doi.org/10.25318/82-003-x202200200001-eng

ABSTRACT

Background

The objective of this study was to create the Canadian Food Environment Dataset (Can-FED) and to demonstrate its validity.

Data and methods

Food outlet data were extracted from Statistics Canada's Business Register (BR) in 2018. Retail food environment access measures (both absolute and relative measures) were calculated using network buffers around the centroid of 56,589 dissemination areas in Canada. A k-medians clustering approach was used to create categorical food environment variables that were easy to use and amenable to dissemination. Validity of the measures was assessed by comparing the food environment measures from Can-FED with measures created using Enhanced Points of Interest data by DMTI Spatial Inc. and data from a municipal health inspection list. Validity was also assessed by calculating the geographic variability in food environments across census metropolitan areas (CMAs) and assessing associations between CMA-level food environments and CMA-level health indicators.

Results

Two versions of Can-FED were created: a researcher file that must be accessed within a secure Statistics Canada environment and a general-use file available online. Agreement between Can-FED food environment measures and those derived from a proprietary dataset and a municipal health inspection list ranged from r_s=0.28 for convenience store density and r_s=0.53 for restaurant density. At the CMA level, there is wide geographic variation in the food environment with evidence of patterning by health indicators.

Interpretation

Can-FED is a valid and accessible dataset of pan-Canadian food environment measures that was created from the BR, a data source that has not been explored fully for health research.

Keywords

food environment, built environment, diet, accessible data, body mass index, cardiometabolic health, geography, epidemiology

AUTHORS

Andrew C. Stevenson (andrew.stevenson@mail.mcgill.ca) and Clara Kaufmann are with the Department of Geography, McGill University, Montréal, Quebec. Rachel C. Colley and Claudia Sanmartin are with the Health Analysis Division, Statistics Canada, Ottawa, Ontario. Leia M. Minaker is with the School of Planning, University of Waterloo, Waterloo, Ontario. Michael J. Widener is with the Department of Geography and Planning, University of Toronto, Toronto, Ontario. Thomas Burgoine is with the UK Clinical Research Collaboration Centre for Diet and Activity Research, MRC Epidemiology Unit, University of Cambridge School of Clinical Medicine, Cambridge, United Kingdom. Nancy A. Ross (Nancy.ross@mcgill.ca) with Queen's University as Vice-President (Research) and work was carried out when Nancy A. Ross was with the Department of Geography, McGill University, Montréal, Quebec, and the Department of Epidemiology, Biostatistics and Occupational Health, McGill University, Montréal, Quebec.

What is already known on this subject?

- Unfavourable food environments, characterized as neighbourhoods with high access to fast food and low access to healthy food, contribute to poor diet quality.
- Previous Canadian research indicates that neighbourhoods with good access to healthy food are associated with healthier diets, lower body mass index and lower risk of type 2 diabetes.
- Canadian food environment research to-date has been limited to certain regions of Canada as no pan-Canadian food environment dataset was available.

What does this study add?

- This paper describes the development and validation of the Canadian Food Environment Dataset (Can-FED): a pan-Canadian dataset of retail food environment measures.
- The Can-FED includes the densities of 19 different food store types for all dissemination areas in Canada. Two relative food environment measures are also included in the database.
- Comparisons to secondary food environment datasets and the geographic variability of food environments in Canada are presented.

The retail food environment is a modifiable component of the built environment with the potential to contribute to improvements in the diets of Canadians at the population level. The retail food environment is defined by geographic access to different types of retail food sources, including restaurants and food stores. Unfavourable neighbourhood retail food environments, characterized by neighbourhoods with an overabundance of less healthy food stores or a scarcity of healthier food stores, are a target for intervention because they can be a contributing factor to poor diet quality.[1] In Canada, neighbourhoods with easy access to healthier food options or limited access to less healthy food options have been associated with healthier diets,[2–4] lower body mass index (BMI)[5] and lower risks of Type 2 diabetes.[6] However, measurement error regarding both food environments and either diet or health outcomes has generated inconsistent findings.[5,7,8]

Researchers typically use secondary business datasets or government sources to identify and locate food outlets to measure retail food environments.[5] However, validation studies of these types of secondary datasets have identified substantial errors that arise from problems such as misclassification of food outlets, incomplete coverage and inaccurate geocoding.[8–10] These errors have been shown to underestimate or overestimate food access compared with ground validation.[8] Random error could mask true associations, and systematic error could lead researchers to inaccurate findings. Additionally, measures created from proprietary sources cannot be made available to other researchers or the public. Measures created from government sources are often specific to a local region, therefore limiting the ability of researchers to measure retail food environments across Canada and compare retail food environments across regions. Self-reported diet and health outcomes can also have substantial error from recall bias, social desirability bias, interviewer bias, or inaccurate translation of self-reported statements into the relevant measure of diet or health, which can also generate inconclusive or unexpected findings.[11,12]

A high-quality and accessible Canada-wide dataset of businesses that can be used to create food environment measures has not been identified. Accessible and valid national food environment measures would contribute to a stronger evidence base with increased accuracy and reusability of exposure data. Additionally, a dataset that allows for Canada-wide analyses may be an improvement over regional studies that may suffer from a lack of heterogeneity in exposure to food environments. This is a problem because if everyone within the study has a similar level of exposure to the retail food environment, the retail food environment will have a limited influence on the distribution of the outcome, potentially masking a true association. National and valid retail food environment measures would facilitate data linkage with national health surveys, health administrative data and investigator-led cohort studies. They are intended to be made available to public health stakeholders in Canada who wish to adopt and monitor food environment interventions.

The purpose of this paper is to describe the development and validation of the Canadian Food Environment Dataset (Can-FED), a pan-Canadian dataset of retail food environment measures at the dissemination area (DA) level using food outlet data from the 2018 Statistics Canada Business Register (BR).

Table 1

Overview of retail food environment measures in the researcher Canadian Food Environment Dataset and the general-use Canadian Food Environment Dataset

Absolute densities (#/km2) (continuous variable)	Definition	Assignment and method NAICS code and additional keyword or other specification (if applicable)
Researcher dataset		
Chain supermarkets	Stores that primarily sell a variety of fresh and prepared food products, have multiple locations, and are owned by large retail companies	445110 Chain supermarket brand name
Grocery stores	Stores that primarily sell a variety of fresh and prepared food products	445110 Not a chain supermarket (as defined above)
Convenience stores	Stores that primarily sell convenience goods and food products that are already prepared and packaged	445120 N/A
Convenience stores at a gas station	Stores located at a gas station that primarily sell convenience goods and food products that are already prepared and packaged	447110 N/A
Bakeries	Retail bakeries that sell fresh baked goods on the premises	311811 N/A
Fruit and vegetable markets	Stores that primarily sell fresh fruits and vegetables	445230 N/A
Meat markets	Stores that primarily sell meat and poultry	445210 N/A
Fish markets	Stores that primarily sell fish and seafood products	445220 N/A
Specialty stores	Stores that primarily sell specialty food products (e.g., coffee store, spice and herb store, dietary supplement store)	445299 N/A
Confectionery	Stores that primarily sell either packaged or ready-to-eat sweets, such as chocolates, ice cream or candy	445292 N/A
Full-service restaurants	Eating places where patrons typically order from a waiter, can be seated for dine-in and pay after eating	722511 N/A
Fast-food outlets	Eating places that sell pre-prepared or quickly prepared food at a counter that is likely highly processed	722512 Chain fast-food brand name, or businesses with a name alluding to fast-food (e.g., "burger," "pizza," "fried," "fries")
Cafés	Limited-service eating places that serve coffee and tea beverages and typically do not offer a full menu	722512 Chain café brand name, or businesses with a name alluding to cafés (e.g., "coffee," "java," "café")
Other limited-service food outlets	Eating places that typically sell pre-prepared or quickly prepared food at a counter, are not fast-food outlets and are not cafes	722512 Not a fast-food outlet or café (as defined above)
Bars	Drinking places primarily engaged in preparing and serving alcoholic beverages for immediate consumption	722410 N/A
Liquor stores	Stores that primarily sell alcoholic beverages, including liquor, beer and wine	445310 N/A
Dollar stores	Variety and dollar stores that primarily sell pre-packaged snack foods	452999 Dollar store chain name
Superstores	Large stores that sell a variety of food products and other non-food products	452910 Super or mega store chain name
Chain pharmacies	Large chain pharmacies that offer a selection of different food products	446110 Pharmacy chain name
Relative densities (continuous variable)	**Definition**	**Formula**
mRFEI	Proportion of food outlets that sell a wide selection of fresh and nutritious food	$\frac{(chain\ supermarkets + grocery\ stores + fruit\ and\ vegetable\ markets)}{(chain\ supermarkets + grocery\ stores + fruit\ and\ vegetable\ markets + fast{-}food\ outlets + convenience\ stores + convenience\ stores\ at\ a\ gas\ station)} \times 100$
Rmix	Proportion of fast-food outlets relative to fast-food outlets and full-service restaurants	$\frac{(fast{-}food\ outlets)}{(fast{-}food\ outlets + full{-}service\ restaurants)} \times 100$
Absolute densities (categorical variable)	**Definition**	**Assignment and method** **NAICS code and additional keyword or other specification (if applicable)**
General-use dataset		
Chain supermarkets	Stores that primarily sell a variety of fresh and prepared food products, have multiple locations, and are owned by large retail companies	445110 Chain supermarket brand name
Grocery stores	Stores that primarily sell a variety of fresh and prepared food products	445110 Not a chain supermarket (as defined above)
Fruit and vegetable markets	Stores that primarily sell fresh fruits and vegetables	445230 N/A
Fast-food outlets	Eating places that sell pre-prepared or quickly prepared food at a counter that is likely highly processed	722512 Chain fast-food brand name, or businesses with a name alluding to fast-food (e.g., "burger," "pizza," "fried," "fries")
All convenience stores	Stores including those located at a gas station that primarily sell convenience goods and food products that are already prepared and packaged	445120 and 47110 N/A
Full-service restaurants	Eating places where patrons typically order from a waiter, can be seated for dine-in and pay after eating	722511 N/A
Relative densities (categorical variable)	**Definition**	**Formula**
mRFEI	Proportion of food outlets that have a wide selection of fresh and nutritious food	$\frac{(chain\ supermarkets + grocery\ stores + fruit\ and\ vegetable\ markets)}{(chain\ supermarkets + grocery\ stores + fruit\ and\ vegetable\ markets + fast{-}food\ outlets + convenience\ stores + convenience\ stores\ at\ a\ gas\ station)} \times 100$
Rmix	Proportion of fast-food outlets relative to fast-food outlets and full-service restaurants	$\frac{(fast{-}food\ outlets)}{(fast{-}food\ outlets + full{-}service\ restaurants)} \times 100$

Notes: mRFEI = modified retail food environment index; Rmix = fast-food restaurant mix; NAICS = North American Industry Classification System; N/A = not applicable.
Source: Statistics Canada, 2018 researcher Canadian Food Environment Dataset.

Two versions of the dataset were developed: (1) a researcher Can-FED that includes continuous absolute and relative densities measured as counts per kilometre within a buffer, which is accessible through Statistics Canada's secure data environments of the Canadian Research Data Centre Network; and (2) a general-use Can-FED that includes categorical measures of the food environment, which is publicly available for download. The objectives of this paper are to describe the approach used to create Can-FED and to demonstrate its validity as a food environment dataset by comparing the food environment measures from Can-FED with measures derived using a secondary business dataset and a public health inspection list, calculating the geographic variability of food environments across Canada, and assessing ecological associations with health indicators at the census metropolitan area (CMA) level.

Methods

Development of the Canadian Food Environment Dataset

Food outlet data

Food outlet data come from the BR, a central repository of information on businesses operating in Canada.[13] Information on businesses is compiled from mandatory tax data collected by the Canada Revenue Agency (CRA). Responding to the survey is mandatory, and all outlets are consistently classified with a North American Industry Classification System (NAICS) code that identifies the primary function of a business. A research contract was signed with Statistics Canada to provide access to the BR at a secure site at the Statistics Canada headquarters in Ottawa.

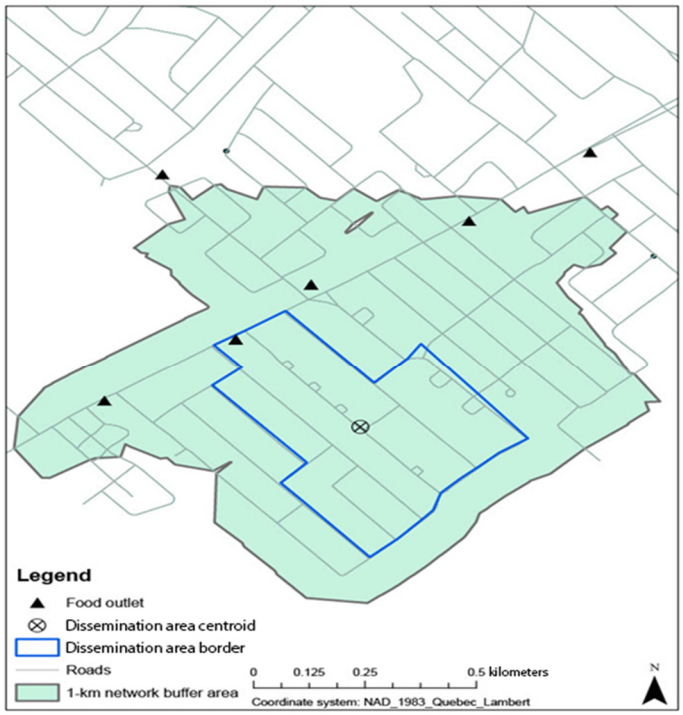
Food outlet classification

Detailed classification of food outlets was based on a level 5 NAICS code, augmented with a name-based assignment method. Businesses that needed to be further defined from their assigned NAICS code were extracted by querying that NAICS code, then categorized based on the outlet name. For example, outlets with NAICS code 722512 ("limited-service eating places") were extracted from the BR. Then, keyword searches indicating a fast-food outlet (e.g., the name of a chain or the word "burger") were conducted on the outlet name to further define "fast-food outlets." In total, 19 food outlet types were derived from NAICS codes and name-based assignments (Table 1).

Access metrics: Researcher dataset

Retail food environment measures were calculated in ArcMap (version 10.7.1, ESRI) using network buffers (created from Statistics Canada's 2016 Census Road Network File[14]) around the population-weighted centroid (calculated by Statistics Canada[15]) of all 56,589 DAs in Canada. DAs are the smallest standard geographic area for which census data are disseminated across Canada—they have populations of 400 to

Figure 1
Example of a 1-km buffer around the centroid of a dissemination area



Sources: Data comes from 2016 Statistics Canada Road Network Files, 2016 Statistics Canada Administrative Area Boundary Files, 2016 Statistics Canada Representative Points file; and the 2013 Enhanced Points of Interest file Distributed by DMTI Spatial Inc.

700 people.[16] Two network buffer sizes (1 km and 3 km) were calculated from the population-weighted centroid of each DA (Figure 1). The 1-km network buffers represent an approximate 10- to 15-minute walk from the centroid to the edge and are useful for researchers to assess food and how people access food stores in their immediate neighbourhood or by foot.[17] The 3-km buffers were included in this study because they may more accurately capture how people access food in areas that are less densely populated and where people are more likely to drive to stores.

Each food outlet was spatially joined to the buffer or buffers that it falls within. Nineteen absolute measures were calculated by summing the total number of each outlet type that fell within a buffer and dividing the sum of each outlet type by the total area of the buffer, represented by the following equation:

$$(1)\ Density_{Outlet\ type} = \frac{Count_{Outlet\ type}}{km^2}$$

Several of the absolute measures, such as fast-food density and supermarket density, have been commonly employed in food environment studies,[5,7] while others, such as pharmacy density and superstore density, are new additions. Two relative measures were calculated using the counts of selected outlet types within each buffer: the modified retail food environment index (mRFEI)[18] and the fast-food restaurant mix (Rmix).[3] Measures that capture the relative mix of different types of outlets that people are exposed to were used in past research.[6,19,20] The mRFEI calculates the proportion of outlets that offer a wide range of fresh and nutritious options within each buffer, and it is defined as:

$$(2) mRFEI = \frac{(chain\ supermarkets + grocery\ stores + fruit\ and\ vegetable\ markets)}{(chain\ supermarkets + grocery\ stores + fruit\ and\ vegetable\ markets + fast\text{-}food\ outlets + convenience\ stores + convenience\ stores\ at\ a\ gas\ station)} x\ 100$$

Rmix calculates the proportion of fast-food restaurants relative to fast-food and full-service restaurants within each buffer, defined as:

$$(3)\ Rmix = \frac{(fast\text{-}food\ outlets)}{(fast\text{-}food\ outlets + full\text{-}service\ restaurants)}\ \text{x}100$$

Statistical methods

Agreement with other secondary food outlet datasets

The neighbourhood-level food environment measures in the researcher Can-FED were compared with measures created from the 2013 Enhanced Points of Interest file developed by DMTI and the 2020 public health inspection list compiled in Peel, Ontario. The DMTI file is a proprietary dataset that contains over 1 million businesses and points of interest in Canada. These data are made available to researchers at Canadian universities for research purposes, and several Canadian food environment association studies have used DMTI data to calculate food environment exposure measures.[5] A Data Release Agreement was signed at McGill University. The Peel public health inspection list is maintained by the local public health authority, and it is freely available to download online (https://data.peelregion.ca/data-categories/food-check/food-check-peel.aspx). Outlets in the secondary datasets were categorized in different ways, such as by facility type or Standard Industrial Classification code rather than by NAICS code. The data were recoded based on the Can-FED food outlet types using keywords and the classification attributes in the DMTI dataset or the Peel public health inspection list.

Food outlet data from the Peel public health inspection list and from the DMTI file were mapped in ArcMap (10.7.1). Food outlet density measures were created using the same 1-km buffers as those used to create Can-FED measures. Spearman's correlation coefficients were calculated to assess the association between the measures from the DMTI file, the Peel public health inspection list and Can-FED. Associations were assessed for chain supermarkets, grocery plus fruit and vegetable stores, restaurants, fast-food outlets, convenience stores, the mRFEI and the Rmix. These types of outlets were included in the general-use file because proximity to them is likely to determine whether people use them, and they have been shown to be associated with diet and health in previous studies.[5,6] Additionally, the attributes included for each outlet in the Peel public health inspection list did not allow for a more extensive list of food outlet categories.

Census metropolitan area-level food environments and correlations with health outcomes

Descriptive statistics (mean and 95% confidence interval [CI], standard deviation, and interquartile range) were generated from DA measures in the researcher version of Can-FED. Two relative food environment measures, the mRFEI and the Rmix, were calculated for each CMA in Canada (n=35) by aggregating the DA-level relative measures across each CMA boundary. A CMA is formed by one or more adjacent municipalities centred on a population centre, and it must have a population of at least 100,000, of which 50,000 or more live in an urban core.[21]

Tests of association using Pearson correlation coefficients were run between the two relative food environment variables and five CMA-level indicators of health for 35 CMAs in Canada: the percentage of the population living with diabetes, the percentage of the population living with high blood pressure,

the percentage of the population who consumed fruits and vegetables five or more times per day, the percentage of the population with a BMI considered overweight or obese, and the percentage of households in the population that are considered food insecure. Health data were derived by Statistics Canada from the 2017 and 2018 Canadian Community Health Survey (CCHS) based on self-reports from respondents aged 12 and older on having been diagnosed with high blood pressure, having been diagnosed with Type 1 or Type 2 diabetes, and their height and weight.[22] The number of times that respondents reported eating fruits and vegetables per day came from the 2015 and 2016 CCHS reference period. Food insecurity data were obtained from a PROOF report[23] that used the 2017 and 2018 CCHS.

Cluster analysis for the general-use Canadian Food Environment Dataset

A k-medians clustering approach was used to create cluster groupings for all absolute and relative densities above zero. A k-medians approach finds k-number of cluster centres to minimize within-group variation of observations (DAs) and to maximize between-group variation. K-medians are more resistant to outliers than k-means.[24] Zeros were isolated and put into their own category because zero is a unique and meaningful value for the food environment measures, representing no access to an outlet type. Any value above zero indicates that there is some access to that outlet type in the buffer. This dichotomy can represent two types of different food environments that would not have been captured if zero was not removed from the k-median groupings. A general-use file was created for all of Canada and for each province and territory using 1-km and 3-km buffers around the centroid of each DA.

Results

Researcher and general-use Canadian Food Environment Dataset

In the researcher Can-FED, 19 continuous absolute density measures (count/km^2) and 2 continuous relative density measures (mRFEI and Rmix) were calculated within 1-km and 3-km network buffers of 56,312 DAs across Canada (Table 1). In the general-use Can-FED, six categorical absolute density measures and two categorical relative density measures were calculated within 1-km and 3-km network buffers of 56,312 DAs (Table 1). Five grouping clusters were created for each variable in the general-use Can-FED: zero, class 1, class 2, class 3 and class 4. Class 1 represents the DAs with the lowest

Table 2
Spearman's correlation measures between food environment measures (1-km network buffer)

	Peel region, Ontario		
	DMTI	PHL	Can-FED
Convenience store density			
DMTI	...	...	...
PHL	0.59	...	...
Can-FED	0.28	0.34	...
Chain supermarket density			
DMTI	...	...	...
PHL	0.42	...	...
Can-FED	0.34	0.45	...
Restaurant density			
DMTI	...	...	...
PHL	0.71	...	...
Can-FED	0.49	0.53	...
Fast-food density			
DMTI	...	...	...
PHL	0.68	...	...
Can-FED	0.48	0.49	...
Grocery and fruit and vegetable store density			
DMTI	...	...	...
PHL	0.46	...	...
Can-FED	0.33	0.38	...
Rmix			
DMTI	...	...	...
PHL	0.53	...	...
Can-FED	0.27	0.26	...
mRFEI			
DMTI	...	...	...
PHL	0.42	...	...
Can-FED	0.28	0.31	...

... not applicable
Notes: DMTI = 2013 DMTI Enhanced Points of Interest file; PHL = public health list; Can-FED = Canadian Food Environment Dataset; Rmix = fast-food restaurant mix; mRFEI = modified retail food environment index.
Sources: Statistics Canada, 2018 researcher Canadian Food Environment Dataset; DMTI Spatial Inc., 2013 Enhanced Points of Interest file; and 2020 Peel public health food outlet list.

food environment variable densities, and class 4 represents the DAs with the highest food environment variable densities, as determined from the k-medians cluster analysis.

Agreement with other secondary datasets

Across both the DMTI file and the Peel public health inspection list, the absolute density measures at the DA level were generally modestly (r=0.20 to 0.39) to moderately (r=0.40 to 0.59) correlated with measures from Can-FED (Table 2). Spearman's correlation coefficients between the DMTI file or the Peel public health inspection list and Can-FED ranged from r_s=0.28 for convenience store density derived from the DMTI file to r_s=0.53 for full-service restaurant density derived from the Peel public health inspection list. Relative density measures at the DA level were generally less strongly correlated with measures from Can-FED, ranging from r_s=0.26 for the Rmix derived from the Peel public health inspection list to r_s=0.31 for the mRFEI derived from the Peel public health inspection list.

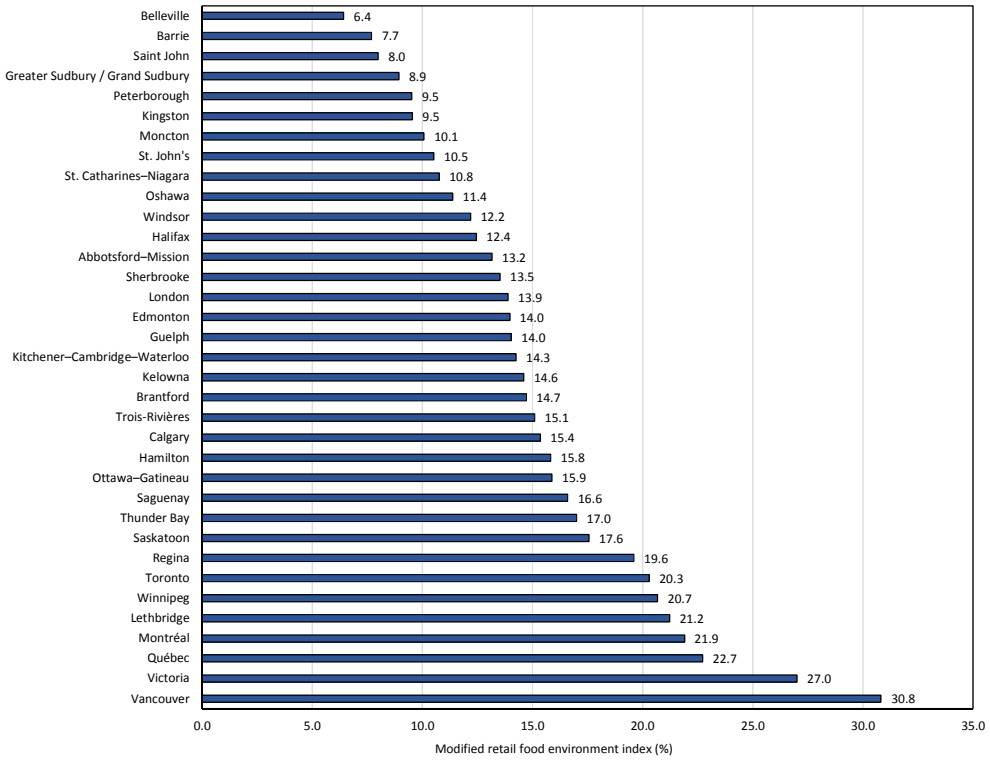
Census metropolitan area-level food environments and correlations with health outcomes

The mean mRFEI using the 1-km buffer size across the CMAs was 15.1% (95% CI: 13.3%, 16.9%), which indicates about 15% of food establishments, on average, provide fresh and nutritious food. Vancouver (30.8%; 95% CI: 29.9%, 31.7%), Victoria (27.0%; 95% CI: 24.6%, 29.4%) and Québec (22.7%; 95% CI: 21.3%, 24.2%) had the highest mRFEI scores, while Saint John (8.0%; 95% CI: 5.6%, 10.3%), Barrie (7.7%; 95% CI: 6.0%, 8.5%) and Belleville (6.4%; 95% CI: 4.3%, 8.5%) had the lowest (Figure 2; Appendix 1).

The mean Rmix across the CMAs using the 1-km buffer size was 46.6% (95% CI: 43.8%, 49.4%), meaning that, on average, almost half of all food establishments are fast-food outlets. St. John's (62.4%; 95% CI: 57.8%, 67.0%), Brantford (59.6%; 95% CI: 55.0%, 64.2%) and Moncton (58.9%; 95% CI: 53.7%, 64.2%) had the highest Rmix scores, while Victoria (33.3%; 95% CI: 30.8%, 35.9%), Montréal (28.8%; 95% CI: 28.1%, 29.4%) and Vancouver (26.4%; 95% CI: 25.6%, 27.3%) had the lowest (Figure 3; Appendix 2).

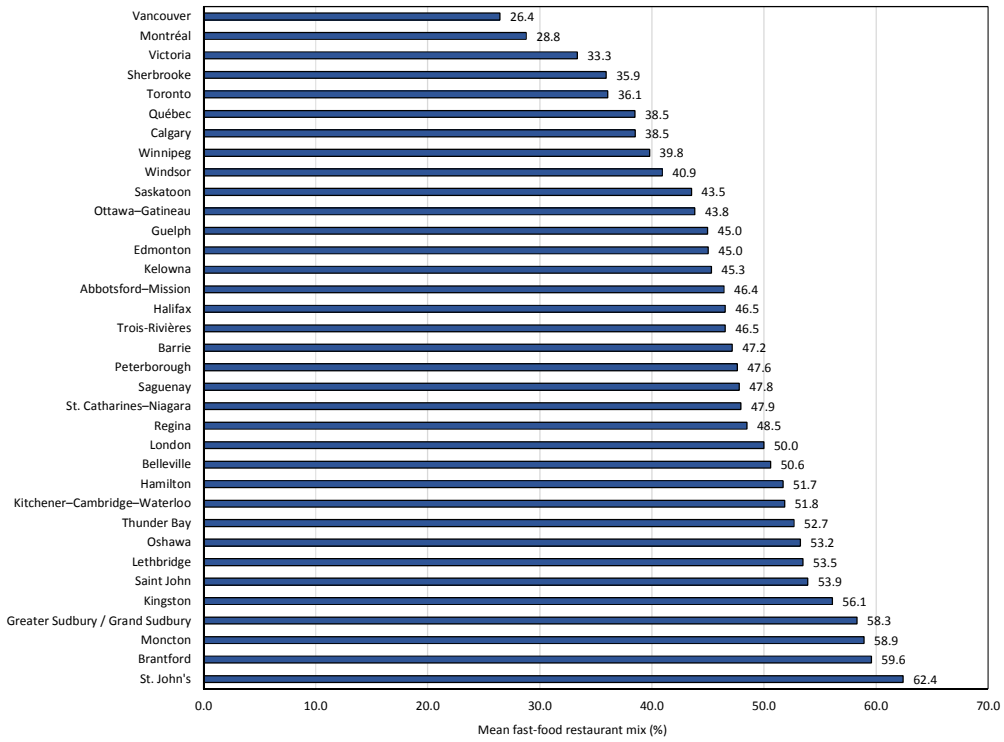
The mRFEI showed a strong negative correlation with the percentage of the population reporting overweight or obese categories of BMI, r_p=-0.65 (95% CI: -0.90, -0.40); a moderate negative correlation with the percentage of the population who reported living with diabetes, r_p=-0.44 (95% CI: -0.67, -0.12), and high blood pressure, r_p=-0.46 (95% CI: -0.69, -0.16); a modest negative correlation with households experiencing food insecurity, r_p=-0.34 (95% CI: -0.60, -0.01); and a modest positive (but not statistically significant) correlation with the percentage of the population who reported eating fruits and

Figure 2
Mean census metropolitan area-level modified retail food environment index scores using the 1-km buffer size around each dissemination area



Note: A higher modified retail food environment index score indicates a higher proportion of outlets that offer a wide selection of fresh and nutritious food.
Source: Statistics Canada, 2018 researcher Canadian Food Environment Dataset.

Figure 3
Mean census metropolitan area-level fast-food restaurant mix scores using the 1-km buffer around dissemination areas with one or more fast-food outlets



Note: A lower score indicates a lower proportion of overall fast-food outlets relative to fast-food outlets and full-service restaurants.
Source: Statistics Canada, 2018 researcher Canadian Food Environment Dataset.

vegetables five times or more per day, r_p=0.32 (95% CI: -0.02, 0.60).

The Rmix showed a strong positive correlation with the percentage of the population who reported overweight or obese categories of BMI, r_p=0.74 (95% CI: 0.54, 0.86); a moderate positive correlation with the percentage of the population who reported living with high blood pressure, r_p=0.50 (95% CI: 0.19, 0.71); a moderate negative correlation with the percentage of the population who reported eating fruits and vegetables five times or more per day, r_p=-0.46 (95% CI: -0.69, -0.14); and a modest positive association with the percentage of the population who reported living with diabetes, r_p=0.36 (95% CI: 0.05, 0.63) (Table 3).

Discussion

This study was motivated by the desire to create a pan-Canadian dataset of food environment measures with high accuracy that is accessible to researchers and the public health community. Two versions of Can-FED were created using geo-coded food outlet data from the 2018 Statistics Canada BR—a researcher file and a general-use file. The researcher file contains a wide range of continuous variables that must be accessed in a secure Statistics Canada environment. The general-use file contains a more limited number of categorical variables and is publicly available for download. Results show that there was generally modest to moderate agreement between Can-FED and food environment measures derived using the DMTI proprietary dataset and the Peel public health inspection list. At the CMA level, there is wide geographic variation in the retail food environment, and the food environment measures are correlated with several CMA-level and health indicators.

The researcher Can-FED contains 19 absolute density variables and 2 relative density variables. Several food outlet categories were created so that researchers could address a broad range of research questions. Relative density measures were provided alongside absolute density measures because they account for different types of food outlets that operate in a neighbourhood.[25] Additional relative measures can be calculated by researchers using the absolute densities. A recent review from Canada and a review from the United States determined that relative measures were more consistently associated with health-related outcomes.[5,7]

Variables were created by calculating the density of outlets within 1-km and 3-km network buffers around the centroids of each DA in Canada. Network buffers represent the routes people can take to access outlets. In Canada, food environment research has generally used a buffer size of 0.4 km to 1.6 km.[5] A study of adults from five American cities (Chapel Hill,

Table 3
Pearson correlation coefficients between the census metropolitan area-level relative food environment variables and health

		95% confidence interval			95% confidence interval	
Variable	mRFEI	Lower	Upper	FFRM	Lower	Upper
mRFEI	...	...	...	-0.67 ‡	-0.82 ‡	-0.44 ‡
Rmix	-0.67 ‡	-0.82 ‡	-0.44 ‡	...	...	...
Percentage overweight or obese	-0.65 ‡	-0.8 ‡	-0.4 ‡	0.74 ‡	0.54 ‡	0.86 ‡
Percentage diabetic	-0.44 ‡	-0.67 ‡	-0.12 ‡	0.36 ‡	0.05 ‡	0.63 ‡
Percentage with high blood pressure	-0.46 ‡	-0.69 ‡	-0.16 ‡	0.5 ‡	0.19 ‡	0.71 ‡
Percentage who consumed F/V >= 5 times per day	0.32	-0.02	0.6	-0.46 ‡	-0.69 ‡	-0.14 ‡
Percentage food insecure	-0.34 ‡	-0.6 ‡	-0.01 ‡	0.2	-0.13	0.51

... not applicable

‡ represent significant associations at $p < 0.05$

Notes: mRFEI = modified retail food environment index; Rmix = fast-food restaurant mix; F/V = fruits and vegetables; Can-FED = Canadian Food Environment Dataset.

Sources: Statistics Canada, 2018 researcher Canadian Food Environment Dataset, 2017 and 2018 Canadian Community Health Survey, and 2015 and 2016 Canadian Community Health Survey. Tarasuk V, Mitchell A, 2020 Household Food Insecurity in Canada, 2017-18. Research to identify policy options to reduce food insecurity Toronto (PROOF).

Albuquerque, Columbus, Philadelphia and Los Angeles) determined that the average distance travelled to a food establishment was 4.2 km and that a 1.6 km buffer covered 64% of food establishments visited by participants.[26] These findings indicate that employing a larger buffer size may result in more consistent and significant associations with the diet and health outcomes of residents in certain regions. Providing multiple buffers allows users to choose the best conceptual fit for their application.[27] Densities (count divided by the area) were calculated to standardize the access measures because network buffer areas varied in size based on the density of the road network.

Can-FED measures tended to have modest to moderate agreement with measures derived from the DMTI file and the Peel public health inspection list. Some agreement is lost because of year mismatch, which may be especially important in quickly growing regions like Peel, Ontario. Importantly, the DMTI file and the Peel public health inspection list did not contain the same classification attributes, so individual outlets had to be categorized differently in each dataset to create the food environment categories, leading to possible misclassification. Many duplicates needed to be removed. For example, about 25% of the food outlets in the categories had to be removed because they were listed twice. The records may have been duplicated intentionally in the dataset for inspection purposes, but they needed to be removed before calculating correlations with Can-FED to ensure they were only counted once. It also appears that differential accuracy of food environment variables exists within the datasets. For example, convenience store density derived from the DMTI file was modestly correlated with convenience store density from Can-FED (r_s=0.28), while restaurant density derived from the DMTI file was moderately correlated with restaurant density from Can-FED (r_s=0.49). These results align with previous research that assessed the validity of secondary datasets. A systematic review and meta-analysis of 20 validation studies of commercially available data determined that there was high variability in data quality depending on the data source assessed, with most of the data sources falling between moderate and substantial validity when compared with a gold standard.[9] Because of the advantages of the data collection process in the BR, the Can-FED data are likely to be a gold standard. This can be determined by future validation work.

Canadian cities vary in their abundance of retail food outlets offering highly processed and nutrient-poor food and those offering a wide selection of fresh and nutritious food. The mean mRFEI score ranged from 6.4% in Belleville, Ontario, to 30.8% in Vancouver, British Columbia. This score was higher than most American state-level mRFEI scores, which ranged from 4% to 16%.[18] Evidence suggests that neighbourhoods without access to outlets that are likely to offer a wide selection of fresh and nutritious food are less widespread in Canada than in the United States.[28] In Canada, areas with access to some outlets that are likely to offer a wide selection of fresh and nutritious food but an overabundance of outlets that offer highly processed and nutrient-poor food are common.[28] Additionally, state-level scores include more rural areas than CMA-level scores, and this may tend to have many zeros because of a lack in food outlet access, leading to lower mRFEI scores. The mean Rmix score among DAs with at least one fast-food outlet ranged from 26.4% in Vancouver, British Columbia, to 62.4% in St. John's, Newfoundland and Labrador. Variations in the food environment across cities could be because of differences in cultural preferences and norms that change the type of food outlets demanded. For example, cities in Quebec have a higher proportion of convenience stores (known as "dépanneurs") than other cities, which may be, in part, because they sell select alcoholic beverages and have a unique cultural importance. Additionally, differences in urban design such as density, zoning differences and walkability may favour a certain type of outlet.

At the level of CMAs, the percentage of the population living with overweight or obesity, diabetes, or high blood pressure and who experience household food insecurity was lower with higher (more favourable) mRFEI scores. Some evidence showed that the percentage of people who eat fruits and vegetables five or more times per day was higher with higher mRFEI scores. However, this association was inconclusive as the lower bound of the confidence interval fell just below zero. The percentage of the population living with overweight or obesity, diabetes, or high blood pressure was higher in CMAs with higher (less favourable) Rmix scores, and the percentage of the population who ate five or more fruits and vegetables per day decreased with higher Rmix scores. These ecological relationships suggest that food environments have modest to strong relationships with important indicators of

cardiometabolic health at the CMA level. Further exploration of using multivariate models and individual-level health data is warranted to understand the independent effect of neighbourhood retail food environments on the health of residents.

Limitations

The CMA-level health outcomes relied on self-reports that can introduce error in different ways, such as recall bias and social desirability bias.[11,12] Additionally, overweight and obesity were determined by BMI, which cannot distinguish between people with higher muscle mass and those with high fat mass. This may reduce the validity of BMI to measure overweight and obesity.[29] Furthermore, the 1-km and 3-km buffer sizes for the retail food environment measured in Can-FED may be too small to capture rural residents' food shopping behaviour. Further research is needed to determine the average distance Canadians in rural areas travel to access food outlets. An American study determined that the distance to the nearest supermarket for people in rural areas was estimated to be 2.1 km at the 20th percentile, 5.6 km at the median and 10.2 km at the 80th percentile.[30] More considerations will be needed to adapt for rural areas since distance, density and presence alone vary considerably by rural area.

Conclusion

Can-FED is a pan-Canadian dataset of food environment measures using food outlet data derived from the BR. Previous research in this field has used secondary datasets from proprietary or local government sources. There are concerns about the accuracy, accessibility, timeliness and geographic coverage of these types of secondary datasets.[8–10] The BR stores data on businesses across Canada that are identified from mandatory business tax data collected by the CRA. All establishments are coded with the most up-to-date industry classification (NAICS) codes, and Statistics Canada staff continues to perform ongoing quality evaluation. Can-FED provides new, high-quality and flexible national measures of the food environment and comes in two versions. The researcher dataset contains continuous variables that can be accessed in a secure Statistics Canada environment. The general-use file contains a selected number of easy-to-use categorical variables and is available publicly. The datasets will allow for surveillance of the spatial variation of food environments across Canada and will open up opportunities for etiological studies when linked to national or investigator-led surveys.

The neighbourhood retail food environment measures can be adapted in future versions of Can-FED based on the best new evidence on how people access food outlets and what types of food outlets are relevant to diet and health outcomes. Researchers may also wish to consider how to weigh food outlets based on their size and opening hours, and how to incorporate new statistical and geographic methods that are available to future versions. A consensus on how often the measures need to be updated is warranted.

Acknowledgements

This study is supported by a grant from the Canadian Institutes of Health Research (CIHR) (grant reference number DA2-162516) and by funding from the Canadian Urban Environmental Health Research Consortium. Research by Andrew C. Stevenson is supported by a Fonds de recherche du Québec – Santé doctoral training award. Research by Nancy A. Ross is supported through a Canada Research Chair. Research by Thomas Burgoine is funded by the Centre for Diet and Activity Research, a UK Clinical Research Collaboration Public Health Research Centre of Excellence. Funding from the British Heart Foundation, Cancer Research UK, the Economic and Social Research Council, the Medical Research Council, the National Institute for Health Research, and the Wellcome Trust (grant reference number MR/K023187/1), under the auspices of the UK Clinical Research Collaboration, is gratefully acknowledged. Research by Thomas Burgoine is also supported by the MRC Epidemiology Unit, University of Cambridge (grant reference number MC/UU/00006/7).

The analysis presented in this paper was conducted at the Quebec Interuniversity Centre for Social Statistics (QICSS), which is part of the Canadian Research Data Centre Network (CRDCN). The services and activities provided by the QICSS are made possible by the financial or in-kind support of the Social Sciences and Humanities Research Council, the CIHR, the Canada Foundation for Innovation, Statistics Canada, the Fonds de recherche du Québec, and Quebec universities. The views expressed in this paper are those of the authors and not necessarily those of the CRDCN, the QICSS or their partners.

We would like to thank the staff of the Data Integration Infrastructure Division and the Health Analysis Division at Statistics Canada for their ongoing support and guidance on this project. The classification of food outlets into the food environment categories were based on the subjective assessment by the research team, and not by Statistics Canada.

Appendix Table A.1

Mean census metropolitan area-level modified retail food environment index and 95% confidence interval, standard deviation, first quartile and third quartile values, interquartile range, and total number of dissemination areas scores using the 1-km buffer size

		95% confidence interval						
Census metropolitan areas	Mean mRFEI	Lower	Upper	Standard deviation	First quartile	Third quartile	Interquartile range	Number of dissemination areas
Abbotsford–Mission	13.2	10.0	16.3	26.2	0	16.7	16.7	265
Barrie	7.7	6.0	9.4	15.8	0	10.0	10.0	333
Belleville	6.4	4.3	8.5	14.3	0	0.0	0.0	178
Brantford	14.7	12.2	17.3	20.1	0	25.0	25.0	238
Calgary	15.4	14.3	16.4	22.5	0	25.0	25.0	1,759
Edmonton	14.0	12.9	15.0	22.0	0	22.2	22.2	1,688
Greater Sudbury / Grand Sudbury	8.9	6.5	11.3	20.1	0	0.0	0.0	269
Guelph	14.0	11.4	16.6	20.3	0	25.0	25.0	234
Halifax	12.4	10.7	14.2	21.9	0	20.0	20.0	601
Hamilton	15.8	14.7	17.0	20.3	0	25.0	25.0	1,199
Kelowna	14.6	11.2	18.0	27.7	0	20.0	20.0	255
Kingston	9.5	6.9	12.2	21.6	0	9.4	9.4	255
Kitchener–Cambridge–Waterloo	14.3	12.7	15.8	21.5	0	25.0	25.0	736
Lethbridge	21.2	16.6	25.9	31.4	0	33.3	33.3	175
London	13.9	12.3	15.4	21.8	0	25.0	25.0	760
Moncton	10.1	7.1	13.0	22.6	0	12.5	12.5	226
Montréal	21.9	21.4	22.4	20.5	0	33.3	33.3	6,469
Oshawa	11.4	9.9	12.9	18.4	0	20.0	20.0	580
Ottawa–Gatineau	15.9	14.8	16.9	23.6	0	25.0	25.0	1,947
Peterborough	9.5	6.8	12.2	19.4	0	14.3	14.3	198
Québec	22.7	21.3	24.2	26.6	0	37.5	37.5	1,291
Regina	19.6	16.6	22.6	29.9	0	30.0	30.0	381
Saguenay	16.6	13.3	19.9	28.9	0	25.0	25.0	295
Saint John	8.0	5.6	10.3	18.7	0	0.0	0.0	242
Saskatoon	17.6	15.2	19.9	24.8	0	28.6	28.6	428
Sherbrooke	13.5	11.4	15.6	19.4	0	25.0	25.0	327
St. Catharines–Niagara	10.8	9.2	12.3	20.6	0	16.7	16.7	678
St. John's	10.5	8.2	12.8	21.2	0	14.3	14.3	326
Thunder Bay	17.0	13.7	20.3	26.0	0	33.3	33.3	238
Toronto	20.3	19.8	20.8	22.1	0	31.3	31.3	7,525
Trois-Rivières	15.1	12.4	17.8	22.7	0	25.0	25.0	272
Vancouver	30.8	29.9	31.7	27.0	0	50.0	50.0	3,450
Victoria	27.0	24.6	29.4	29.3	0	50.0	50.0	574
Windsor	12.2	10.7	13.7	17.9	0	20.0	20.0	548
Winnipeg	20.7	19.3	22.0	24.1	0	33.3	33.3	1,229

Notes: Can-FED = Canadian Food Environment Dataset; mRFEI = modified retail food environment index; first quartile = 25th percentile; third quartile = 75th percentile.
A higher mRFEI score indicates a higher proportion of outlets that offer a wide selection fresh and nutritious food.
Source: Statistics Canada, 2018 researcher Canadian Food Environment Dataset.

Appendix Table A.2

Mean census metropolitan area-level fast-food restaurant mix scores and 95% confidence interval, standard deviation, first quartile and third quartile values, interquartile range, and total number of dissemination areas using the 1-km buffer around dissemination areas with one or more fast-food outlets

		95% confidence interval						
Census metropolitan areas	Mean Rmix	Lower	Upper	Standard deviation	First quartile	Third quartile	Interquartile range	Number of dissemination areas
Vancouver	26.4	25.6	27.3	20.3	0.0	25.0	25.0	2,183
Montréal	28.8	28.1	29.4	21.6	0.0	28.57	28.57	4,226
Victoria	33.3	30.8	35.9	21.1	0.0	33.3	33.3	263
Sherbrooke	35.9	31.8	40.0	24.8	0.0	33.3	33.3	140
Toronto	36.1	35.5	36.6	21.0	11.1	40.0	28.9	5,598
Calgary	38.5	37.1	39.9	22.4	0.0	37.5	37.5	986
Québec	38.5	36.2	40.8	28.9	0.0	33.3	33.3	605
Winnipeg	39.8	38.1	41.5	23.7	0.0	40.0	40.0	749
Windsor	40.9	38.2	43.7	25.6	10.0	40.0	30.0	332
Saskatoon	43.5	40.6	46.5	24.1	4.8	50.0	45.2	257
Ottawa–Gatineau	43.8	42.3	45.3	25.7	0.0	50.0	50.0	1,127
Edmonton	45.0	43.4	46.7	26.0	0.0	47.8	47.8	956
Guelph	45.0	40.6	49.4	26.0	0.0	50.0	50.0	134
Kelowna	45.3	39.7	50.9	27.8	0.0	40.0	40.0	95
Abbotsford–Mission	46.4	42.3	50.5	20.4	0.0	50.0	50.0	95
Halifax	46.5	43.4	49.7	26.7	9.2	50.0	40.8	277
Trois-Rivières	46.5	42.1	51.0	26.0	0.0	50.0	50.0	131
Barrie	47.2	43.8	50.5	22.3	0.0	50.0	50.0	170
Peterborough	47.6	40.8	54.4	32.0	0.0	35.7	35.7	85
Saguenay	47.8	41.1	54.5	27.3	0.0	33.3	33.3	64
St. Catharines–Niagara	47.9	45.3	50.6	26.4	0.0	50.0	50.0	382
Regina	48.5	44.7	52.2	27.1	0.0	42.9	42.9	201
London	50.0	47.6	52.4	24.9	0.0	50.0	50.0	414
Belleville	50.6	44.4	56.8	26.7	0.0	50.0	50.0	71
Hamilton	51.7	50.1	53.3	23.5	18.2	52.9	34.7	832
Kitchener–Cambridge–Waterloo	51.8	49.3	54.4	27.7	0.0	50.0	50.0	454
Thunder Bay	52.7	47.5	57.9	29.4	16.7	50.0	33.3	123
Oshawa	53.2	50.4	56.1	26.3	0.0	50.0	50.0	326
Lethbridge	53.5	47.7	59.3	25.8	0.0	50.0	50.0	76
Saint John	53.9	48.0	59.9	25.6	0.0	55.6	55.6	71
Kingston	56.1	51.1	61.1	28.4	0.0	50.0	50.0	124
Greater Sudbury / Grand Sudbury	58.3	52.9	63.7	26.3	0.0	50.0	50.0	91
Moncton	58.9	53.7	64.2	27.1	0.0	57.1	57.1	102
Brantford	59.6	55.0	64.2	27.6	0.0	57.1	57.1	138
St. John's	62.4	57.8	67.0	28.9	0.0	57.1	57.1	152

Notes: Rmix = fast food restaurant mix; third quartile = 75th percentile; first quartile = 25th percentile. A lower score indicates a lower proportion of overall restaurants as fast-food.
Source: Statistics Canada, 2018 researcher Canadian Food Environment Dataset.

References

1. Roberto CA, Swinburn B, Hawkes C, et al. Patchy progress on obesity prevention: emerging examples, entrenched barriers, and new thinking. *The Lancet Public Health* 2015; 385(9985): 2400-9.

2. McInerney M, Csizmadi I, Friedenreich CM, et al. Associations between the neighbourhood food environment, neighbourhood socioeconomic status, and diet quality: an observational study. *BMC Public Health* 2016; 16: 984.

3. Clary CM, Ramos Y, Shareck M, Kestens Y. Should we use absolute or relative measures when assessing foodscape exposure in relation to fruit and vegetable intake? Evidence from a wide-scale Canadian study. *Prev Med* 2015; 71: 83-7.

4. Minaker LM, Raine KD, Wild TC, et al. Objective food environments and health outcomes. *Am J Prev Med* 2013; 45(3): 289-96.

5. Stevenson AC, Brazeau A-S, Dasgupta K, Ross NA. Neighbourhood retail food outlet access, diet and body mass index in Canada: a systematic review. *Health Promot Chronic Dis Prev Can* 2019; 39(10): 261-80.

6. Polsky JY, Moineddin R, Glazier RH, et al. Relative and absolute availability of fast-food restaurants in relation to the development of diabetes: a population-based cohort study. *Can J Public Health* 2016; 107 (Suppl 1): 5312.

7. Cobb LK, Appel LJ, Franco M, et al. The relationship of the local food environment with obesity: a systematic review of methods, study quality, and results. *Obesity (Silver Spring)* 2015; 23(7): 1331-44.

8. Fleischhacker SE, Evenson KR, Sharkey J, et al. Validity of secondary retail food outlet data: a systematic review. *American Journal of Preventive Medicine* 2013; 45(4): 462-73.

9. Lebel A, Daepp MIG, Block JP, et al. Quantifying the foodscape: a systematic review and meta-analysis of the validity of commercially available business data. *PLOS ONE* 2017; 12(3): e0174417.

10. Daepp MIG, Black J. Assessing the validity of commercial and municipal food environment data sets in Vancouver, Canada. *Public Health Nutrition* 2017; 20(15): 2649-59.

11. Freedman LS, Schatzkin A, Midthune D, Kipnis V. Dealing with dietary measurement error in nutritional cohort studies. *Journal of the National Cancer Institute* 2011; 103(14): 1086-92.

12. Merrill RM, Richardson JS. Validity of self-reported height, weight, and body mass index: findings from the National Health and Nutrition Examination Survey, 2001–2006. *Prev Chronic Dis* 2009; 6(4): A121.

13. Statistics Canada. *Business Register (BR)*. 2019 2020. Available at: http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=1105.

14. Statistics Canada. *Road Network Files*. 2020. Available at: https://www12.statcan.gc.ca/census-recensement/2011/geo/RNF-FRR/index-eng.cfm.

15. Statistics Canada. *Representative Point*. 2016. Available at: https://www12.statcan.gc.ca/census-recensement/2016/ref/dict/geo040-eng.cfm.

16. Statistics Canada. *Dissemination Area: Detailed Definition*. 2018. Available at: https://www150.statcan.gc.ca/n1/pub/92-195-x/2011001/geo/da-ad/def-eng.htm.

17. Papas MA, Alberg AJ, Ewing R, et al. The built environment and obesity. *Epidemiol Rev* 2007; 29: 129-43.

18. Centers for Disease Control and Prevention. *Census Tract Level State Maps of the Modified Retail Food Environment Index (mRFEI)*. Atlanta, GA: Centers for Disease Control and Prevention, 2013.

19. Burgoine T, Sarkar C, Webster CJ, Monsivais P. Examining the interaction of fast-food outlet exposure and income on diet and obesity: evidence from 51,361 UK Biobank participants. *International Journal of Behavioral Nutrition and Physical Activity* 2018; 15(1): 71.

20. Fonge YN, Jain VD, Harrison C, et al. Examining the relationship between food environment and gestational diabetes. *American Journal of Obstetrics & Gynecology MFM* 2020; 2(4): 100204.

21. Statistics Canada. *Census Metropolitan Area (CMA) and Census Agglomeration (CA)*. 2015. Available at: https://www12.statcan.gc.ca/census-recensement/2011/ref/dict/geo009-eng.cfm.

22. Statistics Canada. *Health Characteristics, Two-year Period Estimates, Census Metropolitan Areas and Population Centres*. 2020. Available at: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1310080501.

23. Tarasuk V, Mitchell A. *Household Food Insecurity in Canada, 2017-18: Research to Identify Policy Options to Reduce Food Insecurity*. Toronto: PROOF, 2020.

24. Whelan CHG, Wang J. Understanding the k-medians problem. *International Conference of Scientific Computing*. 2015.

25. Cummins S, Clary C, Shareck M. Enduring challenges in estimating the effect of the food environment on obesity. *Am J Clin Nutr* 2017; 106(2): 445-6.

26. Liu JL, Han B, Cohen DA. Peer reviewed: beyond neighborhood food environments: distance travelled to food establishments in 5 US cities, 2009–2011. *Preventing Chronic Disease* 2015; 12.

27. Monsivais P, Burgoine T. The built environment and obesity in UK Biobank: right project, wrong data? *Lancet Public Health* 2018; 3(1): e4-e5.

28. Minaker LM, Shuh A, Olstad DL, et al. Retail food environments research in Canada: a scoping review. *Can J Public Health* 2016; 107 (Suppl 1): 5344.

29. Buss J. Limitations of body mass index to assess body fat. *Workplace Health & Safety* 2014; 62(6): 264-.

30. Ver Ploeg M, Breneman V, Farrigan T, et al. *Access to Affordable and Nutritious Food: Measuring and Understanding Food Deserts and Their Consequences: Report to Congress*. 2009.