

Classifying Neighbourhoods by Level of Access to Stores Selling Fresh Fruit and Vegetables and Groceries: Identifying Problematic Areas in the City of Gatineau, Quebec

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ABSTRACT

Objectives: Physical access to stores selling groceries, fresh fruit and vegetables (FV) is essential for urban dwellers. In Canadian cities where low-density development practices are common, social and material deprivation may be compounded by poor geographic access to healthy food. This case study examines access to food stores selling fresh FV in Gatineau, Quebec, to identify areas where poor access is coincident with high deprivation.

Method: Food retailers were identified using two secondary sources and each store was visited to establish the total surface area devoted to the sale of fresh FV. Four population-weighted accessibility measures were then calculated for each dissemination area (DA) using road network distances. A deprivation index was created using variables from the 2006 Statistics Canada census, also at the scale of the DA. Finally, six classes of accessibility to a healthy diet were constructed using a k-means classification procedure. These were mapped and superimposed over high deprivation areas.

Results: Overall, deprivation is positively correlated with better accessibility. However, more than 18,000 residents (7.5% of the population) live in high deprivation areas characterized by large distances to the nearest retail food store (means of 1.4 km or greater) and virtually no access to fresh FV within walking distance (radius of 1 km).

Conclusion: In this research, we identified areas where poor geographic access may introduce an additional constraint for residents already dealing with the challenges of limited financial and social resources. Our results may help guide local food security policies and initiatives.

Key words: Geographic mapping; spatial analysis; poverty areas; socioeconomic factors; geographic information systems

La traduction du résumé se trouve à la fin de l'article.

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The complex relationship between social and material deprivation and health status is well documented in Canada.^{1,2} Diet, and in particular, the lack of access to an adequate diet, is just one among the numerous factors associated with social inequalities in health.³ In light of the relationship between diet and health, much research has concentrated on the different elements that affect access to food. Disposable income is the primary factor determining whether a household has access to a sufficient quality and quantity of food to meet the dietary needs of its members.⁴ Informational constraints also play an important role in determining whether all members of a household have access to a healthy diet.⁵ Finally, having "physical" access to a source of food (referred to as geographic access) has also been the subject of much research. While there is some evidence showing that place of residence does not affect one's food security status,⁶ the impact that poor geographic access may have on unhealthy eating patterns should not be underestimated.

Although there is much debate surrounding the exact pathways, geographic access to food is considered by researchers in the United States (US) as a risk factor for excess weight and obesity and for some chronic diseases linked to diet.⁷⁻⁹ While some argue that proximity to a source of fresh fruit and vegetables (FV) is not a factor determining their consumption,¹⁰ studies in the United Kingdom (UK) and the US have found that coping with poor geographic access to food may affect the type and quality of food purchased by households with limited means.^{11,12}

A decade of research examining geographic accessibility and food access was summed up by Beaulac and colleagues in 2009:¹³ food deserts are consistently found in American cities, yet Canada, the UK and other Western countries show no systematic evidence of a correlation between poverty and poor geographic access to food. On the contrary, several Canadian studies conclude that lower income areas tend to have better accessibility than higher income areas.¹⁴⁻¹⁶ Despite this evidence of overall better geographic access to food for the underprivileged in Canada, some neighbourhoods where access to food is poor and deprivation is high have been identified in cities such as Edmonton (AB) and London (ON). In addition, recent work linking poor food access with certain urban forms¹⁷ and municipal zoning practices,¹⁸ coupled with a growing concern over the decentralization of poverty in Canada,¹⁹ establish the need for more empirical research into disparities in food access. Accordingly, this paper presents the results of a case study undertaken in Gatineau, Québec, to establish whether there are areas where high deprivation coincides with poor geographic access to food stores.

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Table 1. Mean Values of Deprivation-related Variables and Deprivation Index According to Population Quartile

	Population Quartile (Mean Value)				All Dissemination Areas
	Q1 (Low Deprivation)	Q2	Q3	Q4 (High Deprivation)	
Proportion of separated, divorced or widowed persons (%)	12.5	16.8	19.8	24.8	19.1
Proportion of single-parent families (%)	10.7	15.9	21.6	30.2	20.6
Proportion of individuals aged 24 to 65 without a high school diploma (%)	6.0	11.6	18.2	29.9	17.6
Employment rate (%)	76.1	71.5	64.2	54.9	65.6
Median household income before taxes (\$)	\$80,388	\$58,383	\$44,917	\$32,534	\$51,283
Deprivation index	1.05	1.59	2.10	2.81	1.98

The study area: Gatineau, Québec

Since the 1960s, the city of Gatineau has developed as a low-density bedroom suburb of Ottawa (ON). It has a population of approximately 243,000 clustered around five formerly independent municipalities. In the past decade, Gatineau has expanded in a form typical of Canadian cities with populations under a million inhabitants: low-density suburban sprawl.²⁰ In 1999, the only supermarket in the central neighbourhood of Hull closed down. Supermarket closure in the city core is cited as one of the main processes leading to the formation of food deserts.^{15,16} This observation raised the question: are there problematic areas in Gatineau and if so, can they be described based on their level of geographic accessibility?

METHODS

The three main components of the study are as follows: 1) the characterization of the local food environment; 2) the creation of a local deprivation index; and 3) the measurement of geographic accessibility to the food environment. These components are brought together using a k-means cluster analysis and an overlay technique.

Local food environment

As in the study by Bertrand and colleagues,²¹ the retail food stores included in this study have a minimum of seven square metres (75 sq. ft.) of shelf and floor space devoted to the sale of fresh FV. This excludes convenience and other small stores selling lemons and onions but not representing a substantial source of fresh FV. A list of food retailers was obtained from the *Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec* (MAPAQ) and cross-validated using the Yellow pages. Each store was visited to measure the FV surface area and a handheld GPS was used to locate the stores on the map. Forty-five food retailers were retained for this study: 30 supermarkets, 8 grocery stores, 5 non-traditional food retailers, and 2 health food stores.

Deprivation index

Deprivation indices are common in public health research as they bring together a number of variables capturing a complex socio-economic portrait. The present study combines five variables from

Table 2. Mean Values for Each Accessibility Measure According to Accessibility Class

Accessibility Class (Number of DA)	Nearest Supermarket*	Nearest Store†	Store Variety‡	FV Shelf Space§
Very poor (n=13)	5371	5329	0.00	0.00
Poor II (n=63)	2802	2637	0.00	0.00
Poor I (n=140)	1443	1358	0.00	0.00
Intermediate (n=46)	2038	632	1.00	16.00
Good (n=94)	820	777	1.00	80.50
Excellent (n=36)	627	597	2.36	224.00
All classes (n=392)	1637	1401	0.33	10.50

* The mean distance to the nearest supermarket (metres).
 † The mean distance to the nearest food store of any type (metres).
 ‡ The median number of stores within a walkable distance of 1000 m.
 § The median FV shelf space in stores within a distance of 1000 m (m²).

the 2006 Canadian census into a composite index of social and material deprivation (see Table 1). The selection of these variables is inspired by the work of Pampalon and Raymond,²² who validated the relationship between these variables and deprivation. Similar indices have been used in previous work examining geographic access to food stores in Canada.^{14,16} The dissemination area (DA) was chosen as the unit of measurement since it is the finest scale at which socio-economic data are provided by Statistics Canada. The proportions for each variable were scaled between 0 and 1 and then summed to create the index. The values for the employment rate and household income were inverted to insure that they vary in accordance to deprivation; i.e., as income decreases, deprivation increases. The resulting composite index was divided into population quartiles; i.e., each quartile contains areas comprising 25% of the population of the study area (Table 1).

Accessibility measures

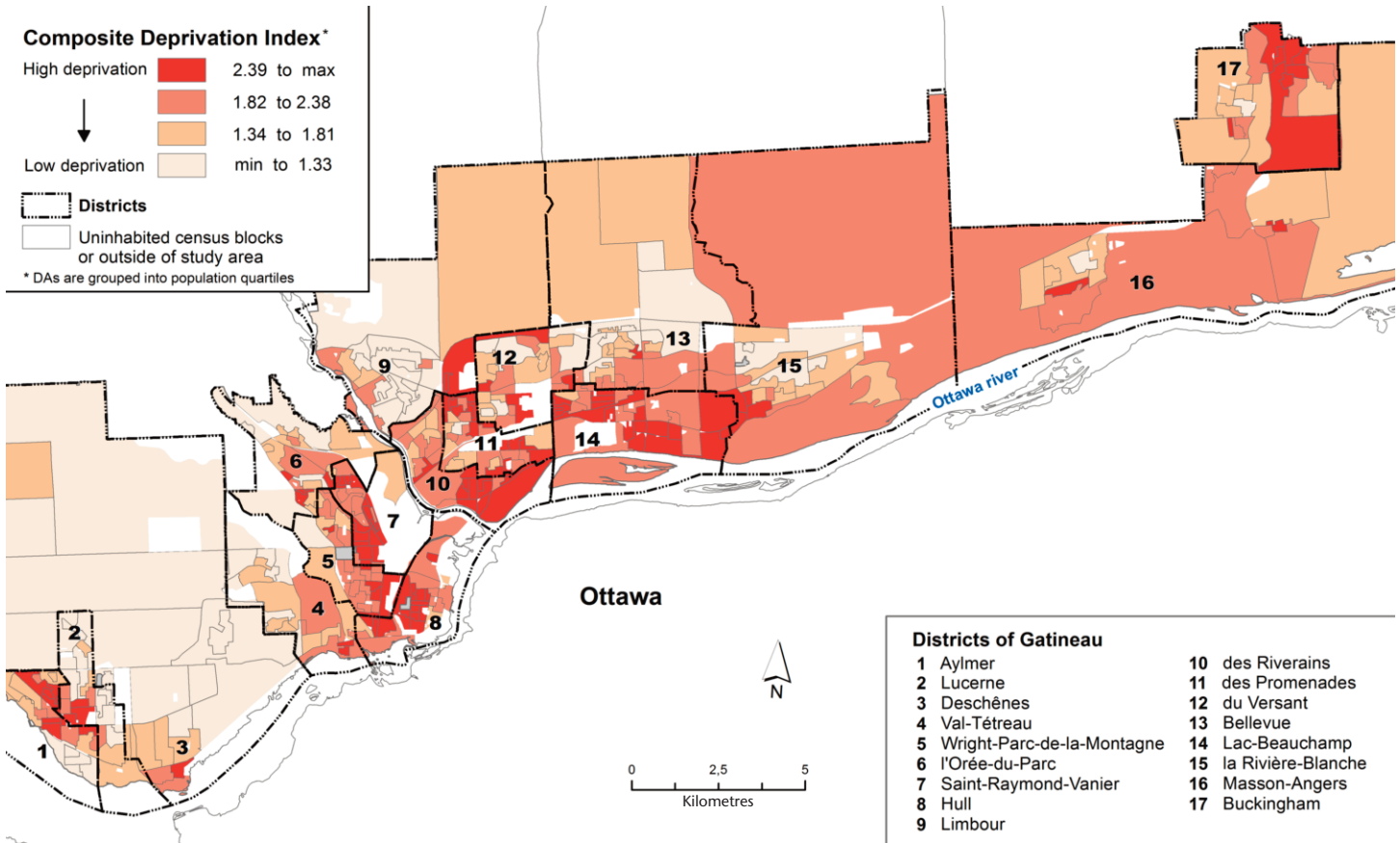
Potential geographic accessibility is measured to determine to what extent individuals residing in a specific DA have access to a given set of retailers. From the literature, we selected two measures representing *proximity* to a source of healthy food: a) the distance (in metres) to the nearest supermarket and b) the distance to the nearest food store of any type, including supermarkets. Two other measures representing *variety* of food offered within a walkable distance were also selected: c) the number of retail food stores and d) the total area devoted to the sale of fresh FV (in m²), both calculated for

Table 3. The Proportion of Dissemination Areas in Each Deprivation Quartile Broken Down by Accessibility Class (% of the Number of DAs in Each Class)

Deprivation Index Population Quartile	Accessibility Class					
	Very Poor	Poor II	Poor I	Intermediate	Good	Excellent
Q4 (high deprivation)	0.0	4.6	24.8	27.5	29.4	13.8
Q3	1.8	10.6	41.6	11.5	26.5	8.0
Q2	3.2	24.5	39.4	2.1	23.4	7.4
Q1 (low deprivation)	11.1	30.6	38.9	0.0	12.5	6.9

Chi-square = 95.812 (p<0.0001); Pearson correlation = 0.359 (p<0.0001).

Figure 1. The portrait of deprivation in Gatineau



a 1 km radius from the DA centroid. To limit aggregation errors,²³ all accessibility measures were initially computed for each census block (CB) using street network distances.²⁴ Each measure was then weighted by the population of the CB and aggregated to the DA scale (see Apparicio and colleagues¹⁴ for equations).

Cluster analysis

All four measures were integrated in the calculation of a k-means classification, a procedure creating mutually exclusive classes representing different “types” of accessibility.²⁵ After standardizing the variables, the procedure attributes each DA to a class based on the similarity of its characteristics to the other DAs, while at the same time the procedure seeks to create classes that are significantly different from each other.²⁶

In addition to Spearman correlations calculated between the accessibility measures and the deprivation index, a Chi-square test was undertaken between accessibility classes and deprivation index quartiles. Finally, high deprivation areas (fourth quartile) were overlaid on a map with areas classified as having poor and intermediate accessibility.

RESULTS

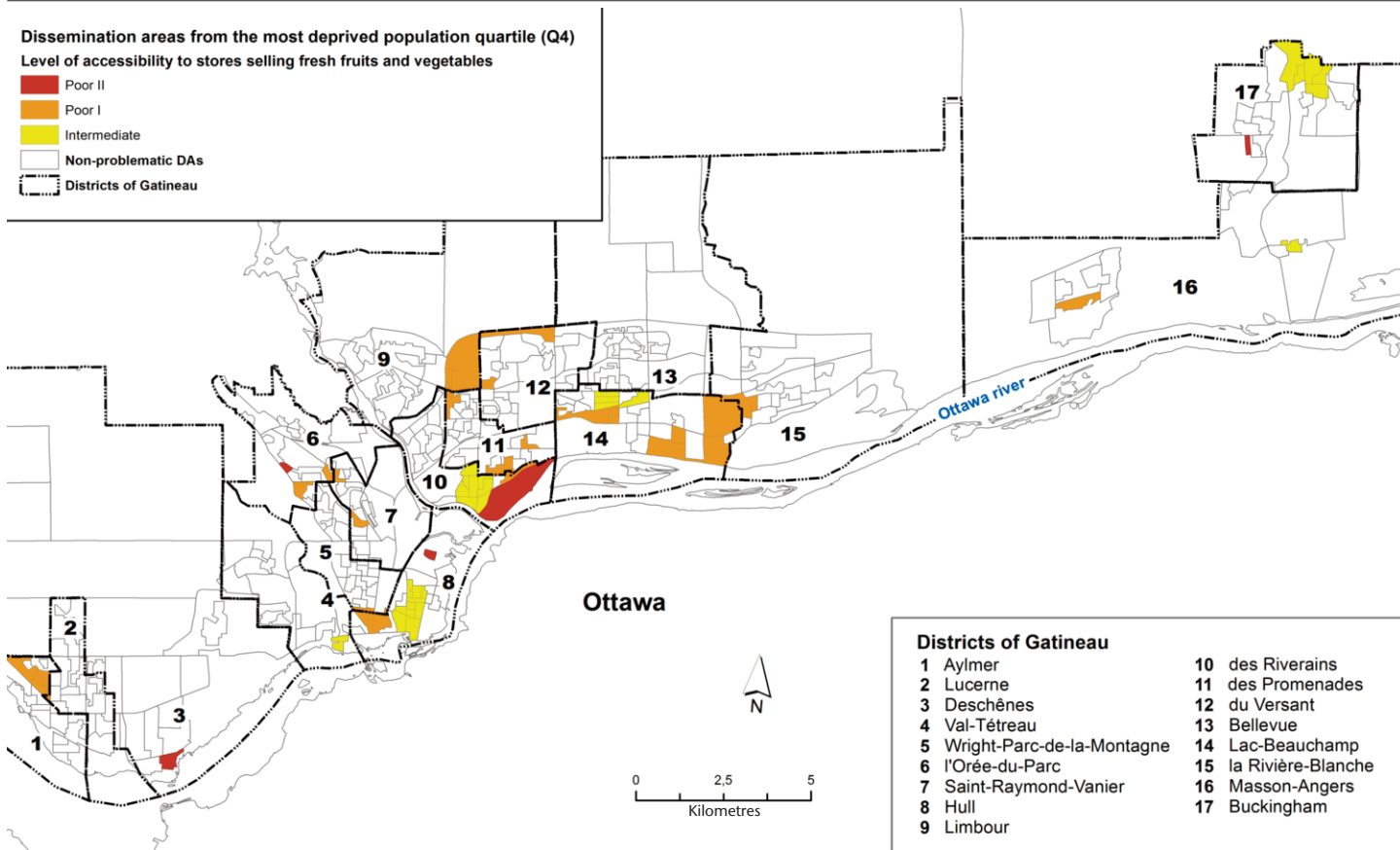
After running a series of k-means clustering procedures (4 to 15 classes), the result from the procedure with six accessibility classes was retained as it had the highest pseudo-F statistic and cubic clustering criterion.²⁵ Table 2 presents average values for each class. For the three classes defined as having *poor* accessibility, the average distance to the nearest food store, including supermarkets, is 1.4 km or greater and FV variety within 1 km is limited (median=0 for both

measures). Consumers living in *intermediate* areas are closer to other retailers than to supermarkets (632 metres compared to 2 km, respectively) and have on average only one store within walking distance and a limited FV availability nearby (16 m²). In the *good* areas, consumers are closer to the nearest supermarket (820 metres) and even if the average FV shelf space is greater (80 m²), they still have access to only one store within 1 km. Finally, the areas with *excellent* accessibility have two or more stores nearby (mean distance close to 600 metres for both measures) and a wide variety of FV (a mean of 2.4 stores and more than 200 m² of FV within 1 km).

Gatineau’s food gaps

More than 70% of Gatineau’s poor currently live within walking distance of a retail food store selling fresh FV (Table 3). In fact, as deprivation increases, so does geographic accessibility to a healthy diet (p<0.0001 for all measures), which is illustrated by negative correlations between deprivation and the mean distances (-0.248 and -0.465 for the nearest supermarket and nearest store, respectively), and positive correlations between deprivation and the variety indicators (0.421 and 0.311 for number of stores and FV shelf space, respectively). Conversely, Table 3 shows that almost 30% of the most deprived DAs (Q4) have *poor* accessibility (*Poor I* and *Poor II* classes combined). These 32 DAs are inhabited by more than 18,000 people or 7.5% of the overall population of the city. Another 27.5% of Gatineau’s deprived DAs – representing an additional 15,000 people or 6.4% of the overall population – have *intermediate* accessibility. Furthermore, the *intermediate* class itself is characterized by its association with deprivation as two thirds of all DAs in this type of environment are classified as deprived (30 out of 45).

Figure 2. The distribution of areas in Gatineau where deprivation coincides with poor and intermediate accessibility



To illustrate these results, Figure 2 locates Gatineau’s problematic areas by superimposing deprived areas with both poor and intermediate accessibility. This map shows the dispersion of such areas throughout the urbanized sectors.

DISCUSSION

Long-term exposure to stress and anxiety from living in an area with high levels of deprivation has been linked to deteriorating health at the individual level.²⁷ Add to this the cost and stress of coping with *poor* accessibility to a food store and the result is that those individuals living at or near the poverty line are at a greater risk of being pushed periodically (or permanently) into unhealthy eating patterns.^{3,4} If, indeed, the geography of food access makes certain individuals living in food gaps more vulnerable to external factors (e.g., rise in gasoline prices) and to changes in their personal circumstances (e.g., change in employment status), then our results indicate areas where unconventional means may be needed to address food insecurity – such as the creation of food cooperatives, initiatives to increase the shelf space devoted to the sale of FV in existing stores,²⁸ farmers’ markets²⁹ or urban gardening initiatives.

According to our results, areas with *poor* accessibility tend to be dispersed just outside the cores of the former municipalities of Gatineau; a pattern similar to that in Edmonton, AB.¹⁵ A look at the morphological characteristics of these areas shows low-density inner-ring suburban areas intermingled with higher-density residential housing projects and even a mobile home park. Furthermore, according to the hypothesis of poverty decentralization in Canadian cities, rising proportions of low-income households are settling in low-density inner-ring suburbs.¹⁹ The combination of

these two elements may lead to an increase in the number and scope of Gatineau’s food gaps and may also contribute to an increase in deprivation in existing food gaps.

The areas classified as intermediate food environments are found in the deprived areas at the centres of the original municipalities. It is difficult to predict how these areas will evolve over time; on the one hand, they appear to be at risk of becoming food gaps in the future,^{15,16} yet on the other hand, city projects to revitalize former “main streets” may improve accessibility levels in these areas over time. Either way, in the *intermediate* areas, where the nearest supermarket is more than 2 km away, any small grocery store closure (or new store opening, for that matter) or even changes in the type of food sold in them will modify the foodscape.³⁰

Finally, it should be noted that this study only considers potential geographic accessibility rather than measuring individual shopping behaviour. Further research needs to be undertaken to answer to what extent living in an area with poor geographic access actually affects food-purchasing behaviour and health and well-being. Answers to these questions, combined with our results, will help planners improve local food security policies.

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RÉSUMÉ

Objectifs : L'accès physique à des magasins qui vendent des produits d'épicerie et des fruits et légumes (FL) frais est essentiel pour les citoyens. Dans les villes canadiennes, où les pratiques d'aménagement à faible densité sont courantes, la défavorisation sociale et matérielle peut être aggravée par le manque d'accès géographique à des aliments sains. Notre étude de cas, qui porte sur l'accès aux magasins d'alimentation qui vendent des FL frais à Gatineau (Québec), vise à repérer les zones où les problèmes d'accès coïncident avec une défavorisation élevée.

Méthode : Nous avons repéré les détaillants en alimentation à l'aide de deux sources secondaires et visité chaque magasin afin de calculer la superficie totale consacrée à la vente de FL frais. Nous avons ensuite calculé quatre indicateurs de l'accessibilité pondérée selon la population pour chaque aire de diffusion (AD) à l'aide des distances du réseau routier. Nous avons créé un indice de défavorisation à l'aide des variables du Recensement 2006 de Statistique Canada, toujours à l'échelle des AD. Enfin, nous avons construit six catégories d'accessibilité aux aliments sains selon une méthode à K moyennes. Ces catégories ont été cartographiées et surimposées sur les zones à défavorisation élevée.

Résultats : Globalement, la défavorisation est positivement corrélée avec une meilleure accessibilité. Cependant, plus de 18 000 résidents (7,5 % de la population) vivent dans des zones à défavorisation élevée caractérisées par de grandes distances jusqu'au magasin d'alimentation de détail le plus proche (1,4 km ou plus en moyenne) et pratiquement aucun accès à des FL frais à distance de marche (dans un rayon de 1 km).

Conclusion : Dans cette étude, nous avons recensé les zones où l'accès géographique difficile pourrait introduire une contrainte de plus pour des résidents déjà aux prises avec des problèmes de ressources financières et sociales limitées. Nos résultats peuvent contribuer à orienter les politiques et les initiatives de sécurité alimentaire.

Mots clés : cartographie géographique; analyse spatiale; zones de pauvreté; facteurs socioéconomiques; systèmes d'information géographique