Mapping Access: Food Availability and Public Transit in Montreal

Hailey Roop
Department of Economics, McGill University
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Professor Babcock
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Abstract

Studies on food accessibility in Montreal have identified food deserts as low-income areas lacking in geographic proximity to large supermarkets. Consequently, the city's suburban areas are often overlooked due to their high average incomes and car dependence. In this study, non-traditional indicators like store opening hours and their distance to bus stops, car usership and population density are observed across eleven boroughs. The data is mapped using geographic information systems (GIS) to understand whether or not food is made accessible to public transit users. The food outlets studied were in close proximity to public transit stops and were made up of a variety of store types indicating that non-chain grocery stores should be considered in similar studies. Some of the highest-income boroughs were severely lacking in food access points, posing concern for the public transit-reliant residents of the borough. The results reveal that priority should be placed on improving food availability rather than transit availability and that food deserts should be studied using more than one indicator.

Introduction

The availability of healthy and affordable food options has been a growing area of interest for urban geographers and public health authorities since the late 1990s (Cummins & Macintyre, 1999; Rodier et al., 2017). Regions with poor access to these goods are now widely recognized as food deserts (Dutko et al., 2012). They tend to be more prevalent in low-income neighbourhoods, where residents are increasingly at risk of food insecurity (Raja et al., 2008). Although still important indicators, the literature on food deserts has expanded beyond income distribution and geographic proximity. Researchers have found other potentially significant contributing factors to food security, such as transit availability, car ownership, product diversification, and the temporal availability of quality food[1] (Páez et al., 2010; Rodier et al., 2017; Widener et al., 2015; Widener & Shannon, 2014). These studies, among many others, have opened new realms for analysis that should be applied in food accessibility-centred case studies.

As the city of Montreal makes development plans for population increase, the accessibility of food sources must be re-assessed. Previous studies have analyzed food deserts in Montreal, but are becoming increasingly outdated to the city's plans for urban renewal (Apparicio et al., 2007; Páez et al., 2010)). Additionally, most researchers have focused on the lowest-income neighbourhoods, which tend to be located near the city centre and have high public transport access. Since increased densification and reduced car usage are two of Montreal's goals for 2050, research focusing on the suburban areas that need to adapt to these goals should be prioritized (*2050 City Vision*, 2022). Hence, this study considers how food is or is not made available to people through public transit in the suburban areas of Montreal.

As the city moves towards urban densification and away from car dependency, how should food and public transit systems be improved in Montreal's Western and Eastern extremities?

Through a comparison of 11 boroughs in two distinct regions of Montreal, the spatial and temporal accessibility of food sources is measured. This analysis considers the number of stores, their proximity to bus routes, their opening hours, and the type of food offered. The demographic variables measured include population, average household income and car ownership. These variables are used first to understand if some boroughs have greater access to quality food than others, and if this relates to income distribution. Second, to assess if all types of grocery stores are available to public transit users. Third, how car ownership impacts food availability, and fourth, what alternatives exist for people to access food. Higher-income boroughs are predicted to have greater quantity, quality, and variety of food access points[2], including more specialty stores. Alternatives to grocery stores, such as food banks, are expected to be more common in lower-income boroughs. Additionally, car ownership in the East end may be lower than in the West, making it more important for grocery stores to be closer to public transit routes. Lastly, non-chain grocery stores are expected to be located in more areas than chain stores since the latter tend to cluster together. This would offer greater access to healthy food than what previous research has shown.

[1]Quality food refers to varied, healthy, and affordable food items.

[2]Note that food access points and food outlets are used interchangeably throughout.

Literature Review

Several studies have looked at this issue within the context of the greater Montreal region. The earliest and most well-cited of these is that of Apparicio et al., published in 2007, which aimed to identify food deserts based on the neighbourhood's proximity to various food sources. Their analysis found that the socially deprived areas of Montreal were at low risk of becoming food deserts considering their <1km proximity to chain supermarkets. Now, 16 years later, food accessibility in the city should be re-evaluated, as there is growing evidence that new areas of poverty are emerging in suburban and peri-urban areas. In Ades et al.'s (2016) cross-sectional study of Canada's three largest cities, they explain how car dependency and inefficient public transportation systems in low-density areas can compromise vulnerable populations' accessibility to quality food. Additionally, Páez et al. (2010) found that the low concentration of food outlets in peripheral locations made residents heavily reliant on vehicle ownership, compared to city centres, where public transit is already developed, and there is a high availability of food. As such, there is a need for public transit systems in underserved areas to be considered as a measure of accessibility when studying a region's food system.

A re-assessment of the city's food outlets in proximity to public transit outside the urban core is needed to understand if Montreal can achieve its development goals. As part of its *2050 City Vision* (2020) strategy, Montreal aims to "continue developing complete, compact living environments, where everything you need to grow and thrive is available within minutes of home" (19). Two main ways they plan to do this are by reducing car usage and densifying existing and future residential areas. To achieve this, public transit must be developed in a way that supports the needs of families, seniors and low-income households (*Land Use and Development Plan*, 2015). Particularly in regions where transit is limited, these groups are sometimes excluded from the transport system due to a lack of personal mobility or lack of accessibility and practicality of the system. Widener et al., 2015 found that daily mobility patterns greatly affected the ease at which people can acquire groceries. Therefore, public transit speed and availability should be studied in research on food security, not just residential proximity to grocery stores (Widener et al., 2015).

In DeWeese's *Curbing the Car* (2020), which looked at factors that shape driving behaviour (built environment, land-use patterns and transport systems), an unexpected contrast was found in low- and high-income households. He concluded that "relative to people from high-income households, people from lower-income households are more likely to travel by car for all purposes combined" (DeWeese, 2020, p. 20). This is perhaps due to the fact that public transit has primarily been developed in North American cities to facilitate movement from the peripheries to the central business district (CBD) (Lane & Beeler, 2017). Moreover, the jobs offered in the central business district, or Downtown Montreal, are generally higher paying than in areas that cannot be accessed by public transit. As such, it is possible that public transit does not serve lower-income peripheral neighbourhoods to the extent of its higher-income counterparts. This is heightened by the fact that in 2024, the relatively high-income neighbourhoods of the West Island will be gaining the Reseau Express Metropolitain (REM), which will offer a new, high-speed, affordable mode of travel to people living in that area (*2023 Work Schedule*, 2023). These trends indicate that the public transit available in the East end may be lacking, and that the city should do

more to make places of work, services, and retail more accessible for all.

Recent studies identify measures other than public transit that should also be considered when studying accessibility. Widener & Shannon (2014) find that research on food deserts that use only a place of residence as a proxy for food access is limiting in that it does not consider other key features. For instance, food stores that are open for a longer period, particularly in the evenings and on weekends, become more accessible to people who work long hours. For this reason, the opening hours of grocery stores are considered in the study. Rodier et al. (2017) analyze the buying behaviour of residents living in two of Montreal's food deserts in the Mercier-Hochelaga-Maisonneuve borough. They find that product diversification and food education are more significant in purchasing healthy foods than geographical access to supermarkets. Categorizing grocery stores by type to estimate the availability of quality food options is therefore equally needed in the study of food-related health outcomes. This is especially important because much of the well-cited literature on food deserts has failed to include non-chain grocery stores in its analysis. This tends to be credited to one study by Horowitz et al. (2004), which compared Harlem and the Upper East Side of New York City. They found that chain supermarkets offer more consistent and cheaper products than alternative vendors like depanneurs. However, as one of the aims is to understand if independent grocery stores fill any gaps where chain supermarkets are lacking, it is important also to identify their locations. Additionally, in Montreal, many non-chain grocery stores offer comparable and even cheaper prices than their counterparts. Five of the ten stores on Trylon's top 10 list of cheapest grocery stores are non-chain grocers (Reeves, 2019).

Methods

By mapping quality food access points alongside Montreal's public transit system, this study quantifies the network of accessible food outlets in two regions of Montreal. On the West end are boroughs Sainte-Anne-de-Bellevue, Baie-D'Urfé Beaconsfield, Kirkland, Pierrefonds, Dollard-des-Ormeaux and Pointe-Claire. On the East end are boroughs Montreal-Est, Montreal-Nord, Rivière-des-Prairies–Pointe-aux-Trembles and Anjou. The data gathered for these boroughs includes food access points, transit lines, population density, car ownership, and median income per household.

These boroughs were chosen first due to the need to move beyond existing research on food deserts located near the city centre. Second, the West and East end offer similar public transit levels, making for a more even comparison. Third, they have significantly different median household incomes, making them interesting locations to identify income-based challenges. The population count in 2016 for the West and East ends were 237,623 and 237,122, respectively. Hence, the food access points in either area should serve roughly the same number of people. Although adjacent to Sainte-Anne-de-Bellevue and Pierrefonds-Roxboro, Senneville was excluded from the list of West end boroughs because it offers no public transit stops.

The addresses and opening hours of food access points are obtained through Google Maps and crosschecked through Yellow Pages. Food outlets are geocoded to the x, y, coordinate-level using GeoApify and plugged into QGIS. They are tagged by type, using food outlet definitions from a Statistics Canada health report (Government of Canada, 2022). Each type is colour-coded to be quickly identifiable on the map, as seen in the table below.

Type	Definition	Colour
Chain supermarket	Stores that primarily sell a variety of fresh and prepared food products, have multiple locations, and are owned by large retail companies. This also included superstores, like Walmart and Costco, which sell a variety of other non-food products.	
Grocery store	Stores that primarily sell a variety of fresh and prepared food products.	
Depanneur / convenience store	Stores that primarily sell convenience goods and food products that are already prepared and packaged, occasionally offering small selection of fresh options.	
Bakery	Retail bakeries that sell fresh baked goods on the premises.	
Fruit and vegetable store	Stores that primarily sell fresh fruits and vegetables.	
Meat and fish store	Stores that primarily sell meat, poultry, and/or fish and seafood.	
Specialty store	Stores that primarily sell specialty food products (e.g., coffee store, spice and herb store, dietary supplement store)	

Depanneur / Convenience store includes dollar stores but leaves out pharmacies as the latter is inconsistent with their variety of food options depending on the store. Both dine-in and takeaway restaurants were excluded from the study, as were bars, cafes, and confectionery stores.

Each store's opening hours were tagged as follows: Early (E) if open for fewer than five days a week and closed before 8:00 PM; Late (L) if open at least five days a week until 8:00 PM or later for at least three of the days.

The data set containing the geospatial information of the routes and stops of the bus and metro lines is taken from the Société de Transport de Montréal (STM, 2016). The distance matrix feature in Quantum Geographic Information System (QGIS) calculates the average distances from food outlets to bus stops. Given an origin (food outlet) and destination (bus stop), this algorithm computes the distance between each food outlet and its five closest bus stops.

The Canadian Population Census is used for the data on population, median household income and car ownership by neighbourhood (Canada, 2021). Multiple boroughs were missing data from the 2021 census tract, hence why 2016 census data was used. This also allowed for census results that were collected at a time when the COVID-19 vaccine was only just being released to be mitigated. The median total income was taken by household rather than by person. This is because earnings include only wages, salaries, and income from self-employment for individual workers. Whereas household income includes earnings for each household member as well as income from social security, interest and dividends, creating a more representative figure of aggregate wealth in a borough (Canada, 2021). Car ownership statistics were gathered by taking the % of the population >15 years old that uses a vehicle (car, truck or van) as their primary mode of transport.

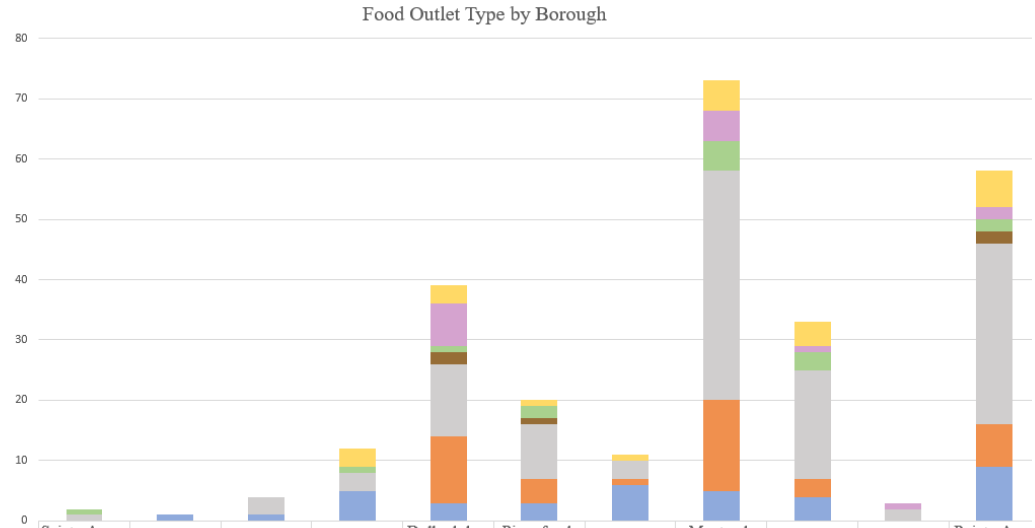
All of this is compiled into a map in QGIS, which is used to demonstrate the food-related similarities and differences between the West and East ends.

Last, alternative methods of accessing and acquiring food are considered by comparing how the derived map relates to Dawson College's food map, and to Communauto's car-sharing map. In 2021, the Food Justice & Sustainability hub at Dawson College created a database of 14,000 food-related points across Montreal (Dawson College). Part of the database consists of community food assets such as gardens, fresh food drop-off points and food bank services. These are compared to the derived map to understand how alternative food sources fill gaps where conventional food sources are lacking. Communauto's network of shared cars allows non-car owners to make trips at affordable prices at the time of their choosing (Communauto, n.d.). Although this form of transport is not considered public transit because it has a higher price barrier and serves individuals, it is included in the study to investigate if some boroughs benefit from more means of accessing groceries than others.

Results

A total of 256 food outlets are found in the studied boroughs. The quantity and types per borough are compiled in Figure 1, showing how some boroughs, such as Rivière-des-Prairies–Pointe-aux-Trembles and Montreal Nord, have significantly more food access points than Sainte-Anne-de-Bellevue and Baie D'Urfé. The boroughs in the West end account for only 89 food access points compared to the East's 167.

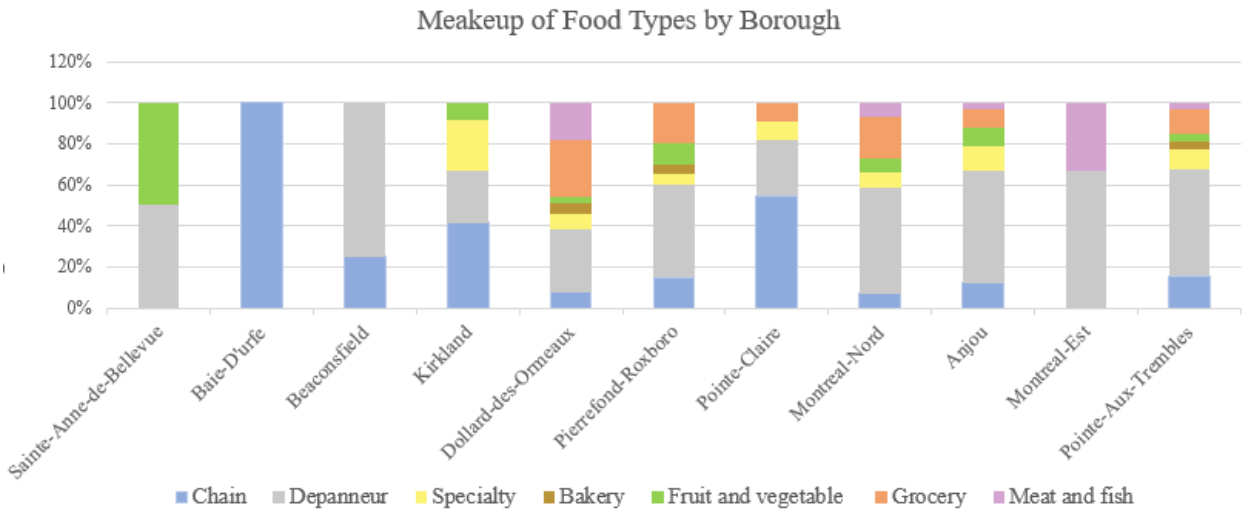
Figure 1: Food Outlet Type by Borough



	Sainte-Anne-de-Bellevue	Baie-D'urfe	Beaconsfield	Kirkland	Dollard-des-Ormeaux	Pierrefond-Roxboro	Pointe-Claire	Montreal-Nord	Anjou	Montreal-Est	Pointe-Aux-Trembles
Specialty store	0	0	0	3	3	1	1	5	4	0	6
Meat and fish store	0	0	0	0	7	0	0	5	1	1	2
Fruit and vegetable store	1	0	0	1	1	2	0	5	3	0	2
Bakery	0	0	0	0	2	1	0	0	0	0	2
Depanneur / convenience store	1	0	3	3	12	9	3	38	18	2	30
Grocery store	0	0	0	0	11	4	1	15	3	0	7
Chain Supermarket	0	1	1	5	3	3	6	5	4	0	9

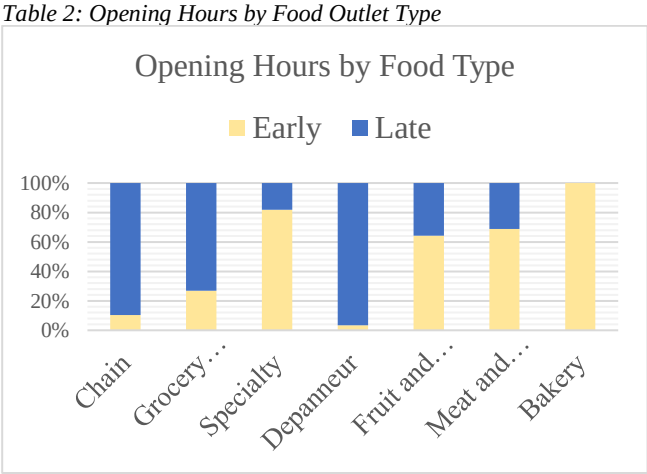
The ratios of food outlet types are shown in Table 1. The ratio of chain supermarkets to all other types of food outlets was higher in the West end than in the East. In all boroughs, except for Baie D'Urfé, which has no depanneurs, depanneurs and convenience stores make up at least 25% of the food access points. Specialty stores are present in 7 of the 11 boroughs, ranging from 7% to 25%. Bakeries make up very few of the food access points, representing only 3% to 5% in 3 of the 11 boroughs. Fruit and vegetable stores are present in 7 of the 11 boroughs, ranging between 3% and 10%, except in Sainte-Anne-de-Bellevue, where they represent 50% of food outlets since there are only two food outlets. Grocery stores are present in 6 of the 11 boroughs, ranging from 9% to 28%. Meat and fish stores are present in 5 of the 11 boroughs, ranging between 3% and 18%, except in Montreal-Est, which reaches a high of 33% because only three food outlets are present.

Table 1: Makeup of Food Outlet Type by Borough



The opening hours by food type are shown in Table 2. Chain supermarkets, grocery stores and Depanneurs are mostly open late. Specialty stores, fruit and vegetable markets, meat & fish stores, and bakeries have limited opening hours. Little variation was found in the opening hours between regions; the East and West ends displayed similar ratios of late to early stores. The similar ratio of late to early stores in the East and West end was partly due to chain supermarkets' consistent hours across their stores and depanneurs being intended for late-night shopping.

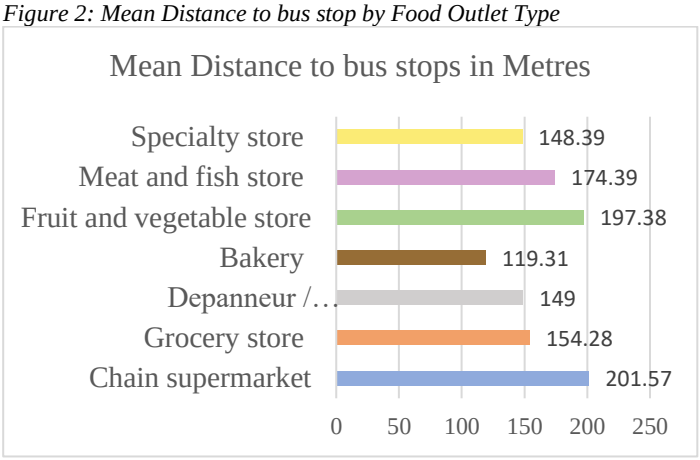
Table 2: Opening Hours by Food Outlet Type



The distance from each food outlet to its five closest bus stops was derived using QGIS' distance matrix. These distances are then compiled and averaged by food outlet type to test if some food categories are closer to public transit services than others. The mean distances by type in metres are shown in Figure 2. Chain supermarkets and fruit and vegetable stores tend to be located the farthest away from public transit, at approximately a 200-metre distance. Bakeries are found to be the closest at just under 120 metres.

The following standard and choropleth maps are built in QGIS, and are used to display the distribution of food access points, population, income and car ownership. These maps are then used for analysis in the discussion.

Figure 2: Mean Distance to bus stop by Food Outlet Type



The distribution of food outlets is shown along the STM bus lines in Figures 3a and 3b. Even without the mean distance calculations, it is evident that food outlets are located along bus lines in most cases.

Figure 3a. Distribution of food outlets - East End

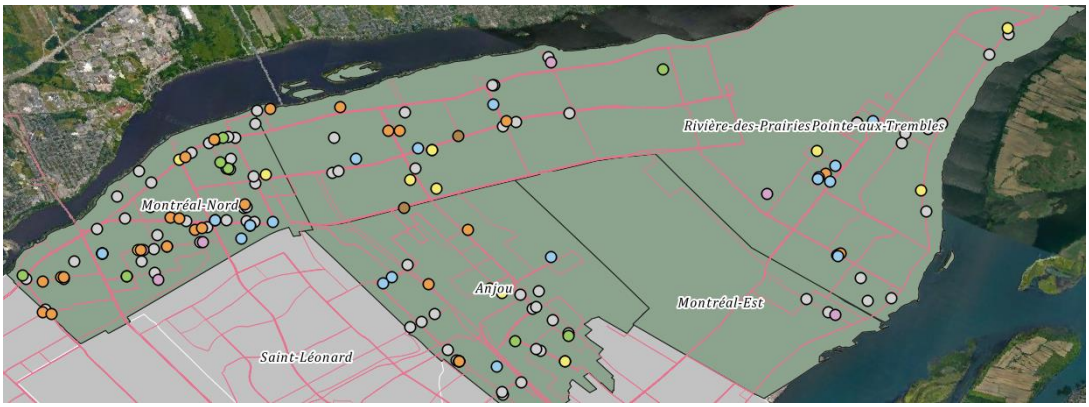
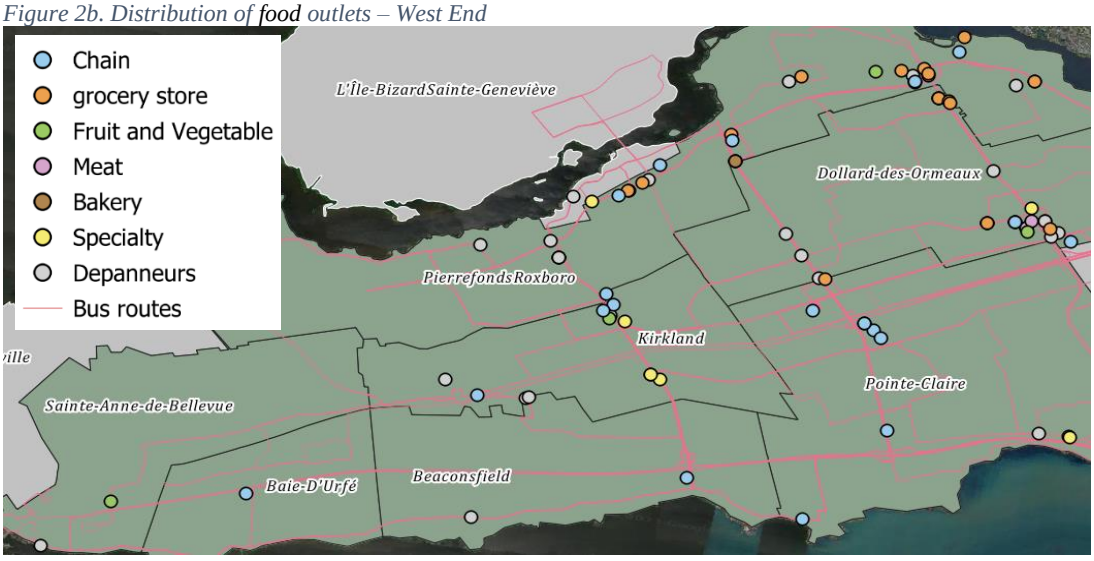


Figure 2b. Distribution of food outlets – West End



Figures 4a and 4b show how population density affects food distribution. The population distribution varied significantly in either region, with some boroughs like Pierrefonds-Roxboro and Rivière-des-Prairies–Pointe-aux-Trembles home to more than 100,000 people.

It is noted that a significant portion of Sainte-Anne-de-Bellevue is made up of farmland, decreasing its size for residential use. Similarly, Montreal-Est is in the lowest population range since most land is used for industrial purposes. Montreal-Nord's high concentration of stores can be attributed to its relatively large population despite its small area.

Average annual household income differs widely between the two regions. As seen in Figures 5a and 5b, most boroughs in the West end show considerably darker shades, indicating a higher average income than those in the East.

Beaconsfield has the highest, at $124,492, nearly three times more than Montreal-Nord's average of $42,548 per household. Although studying the household income mitigates for young adults who live at home and only work part-time (bringing the average down), it does not consider that some boroughs have a greater number of people living alone, influencing the mean household income.

Figure 4a & 4b: Population Distribution - East End & West End

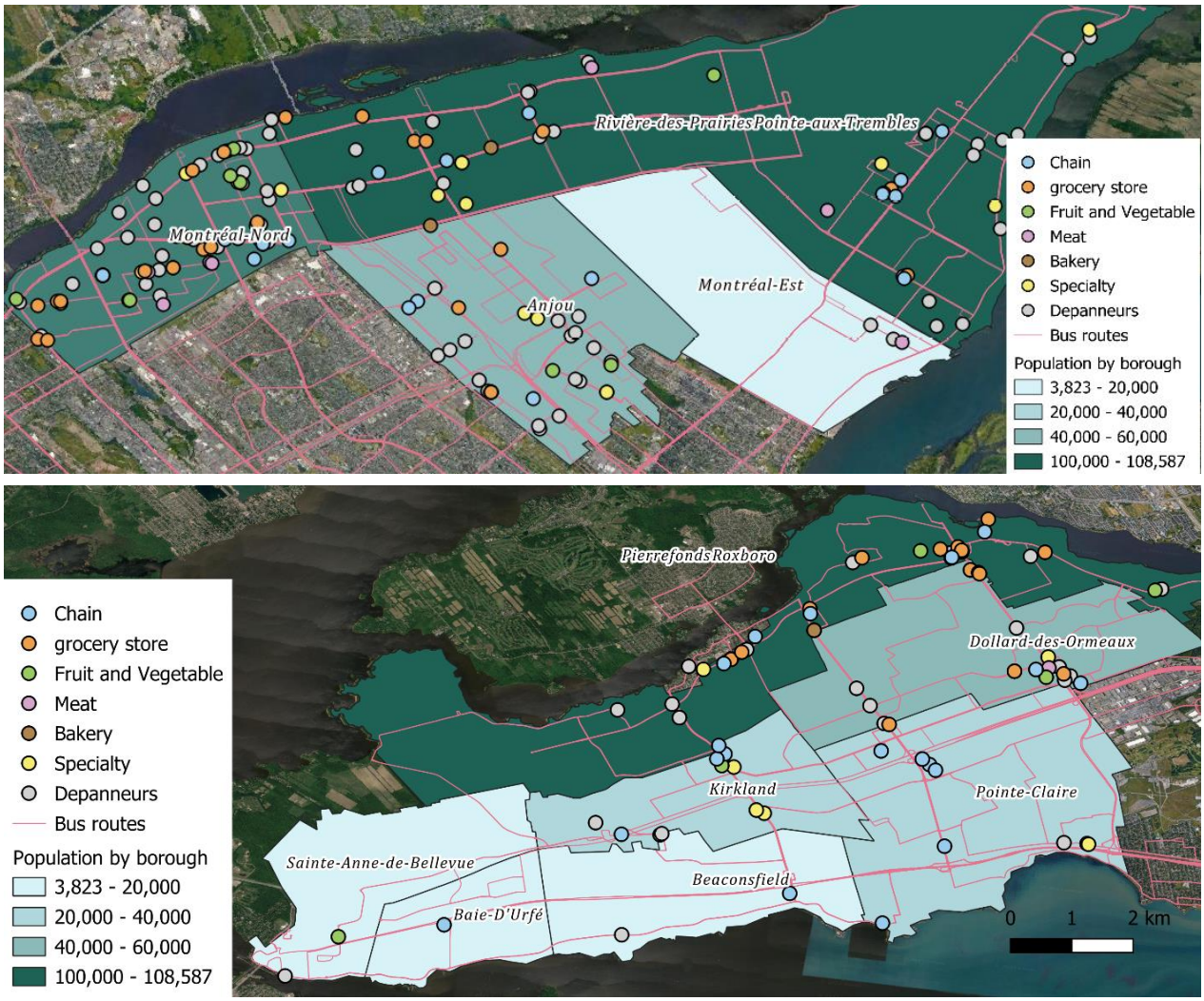


Figure 5a:Average Annual Household Income - East End

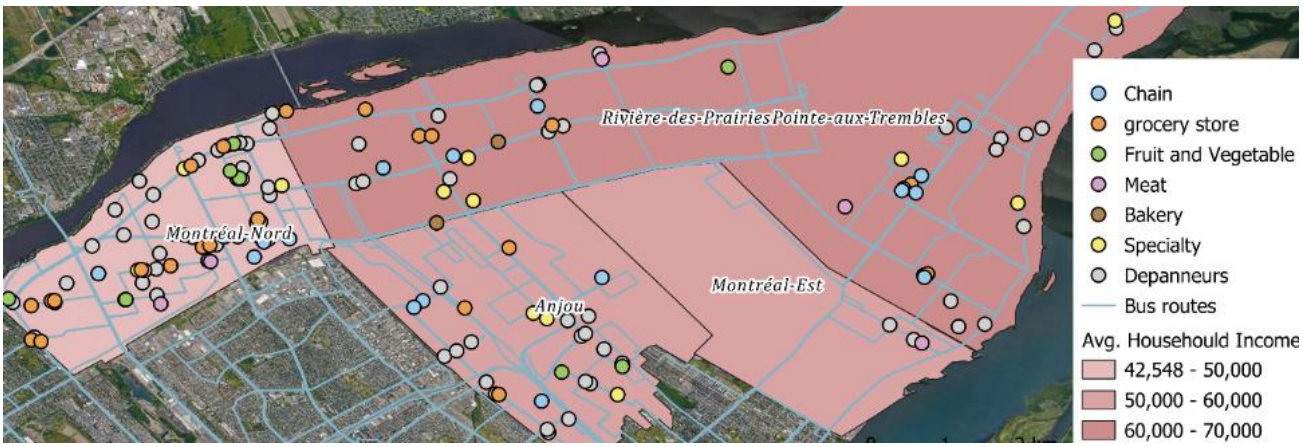
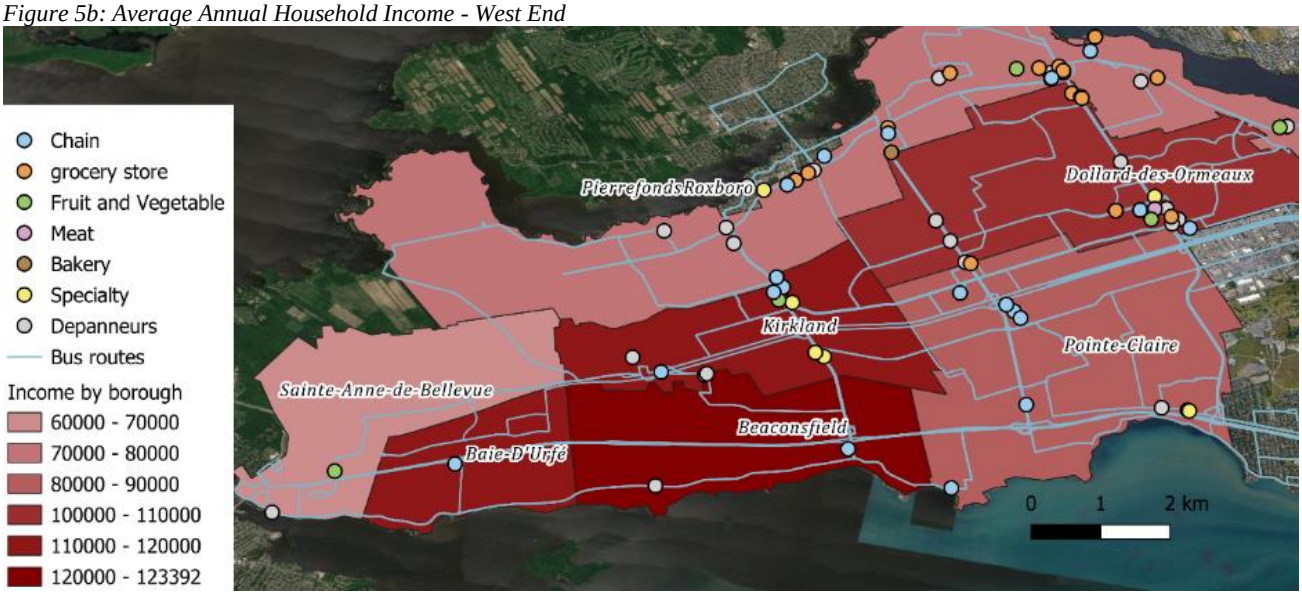


Figure 5b: Average Annual Household Income - West End



Car ownership, displayed in Figures 6a and 6b, varied between boroughs, ranging from 57% to 80%.

Figure 6a: Car usage by Borough – East End

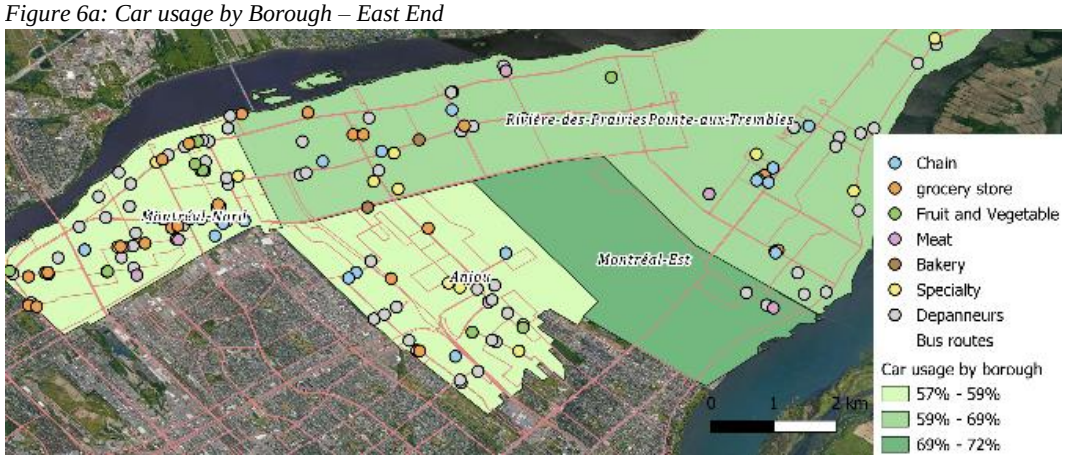
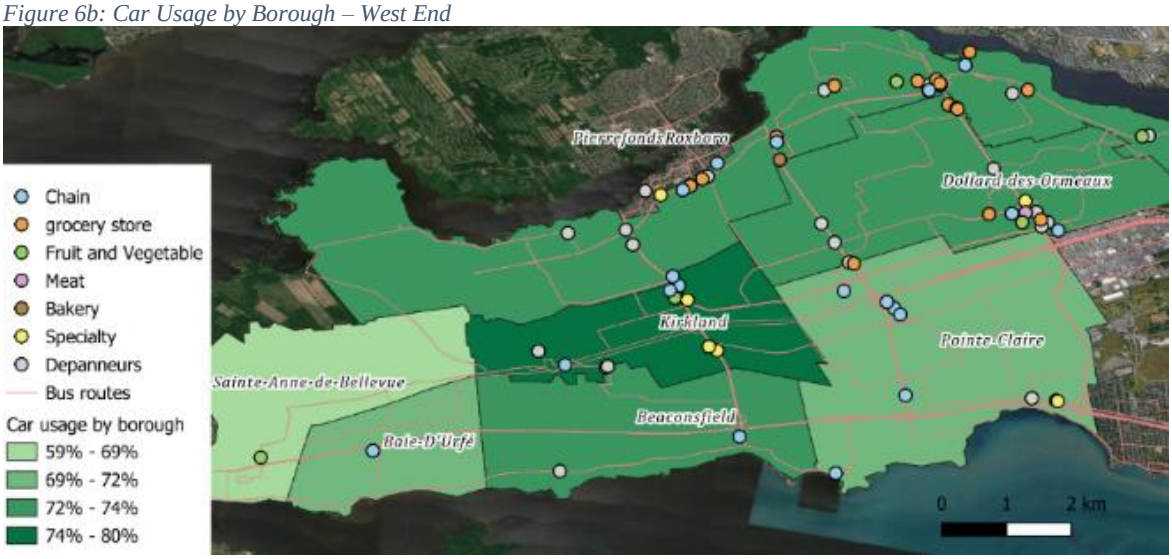


Figure 6b: Car Usage by Borough – West End



The alternative shopping methods studied showed that while several alternatives exist for acquiring food other than stores, few city-wide car-sharing options exist.

Dawson College's food map is separated into five types of alternative food access: Community services, food banks and food aid, gardens, fresh food drop-off points and Farmer's Markets. As shown in Table 3, alternative food options are most available in Montreal-Nord, Anjou and Pointe-aux-Trembles. Community gardens and food banks are the most common alternatives in the East, whereas Lufa drop-off points are the most common in the West.

The Communauto map (2023) showed that no cars in the West end and only Two cars in the East ends' Riviere-des-Prairies-Pointes-aux-Trembles were available for people to use for short trips such as grocery shopping.

Table 3: Compilation of Food Alternatives based on Dawson College's Food Map of Montreal

Type	Sainte-Anne-de-Bellevue	Baie-D'urfe	Beaconsfield	Kirkland	Dollard-des-Ormeaux	Pierrefond-Roxboro	Pointe-Claire	Montreal-Nord	Anjou	Montreal-Est	Pointe-Aux-Trembles
Community Services and Organizations in Food Security											
Collective Kitchens	-	-	-	-	-	1	1	4	2	-	1
Gardening workshops	-	-	-	-	-	-	-	-	-	-	-
Cooking workshops	-	-	-	-	-	-	-	1	-	-	-
Food buying groups	-	-	-	-	-	-	-	-	-	-	-
Food Banks and Food Aid											
food banks and food relief	1	-	-	-	-	3	1	4	1	-	4
prepared meals and meals on wheels	1	-	-	-	-	-	1	-	1	-	2
coordination of food	-	-	-	-	-	-	-	1	-	-	1
school food program	-	-	-	-	-	-	-	-	-	-	-
food vouchers	-	-	-	-	-	-	-	2	3	-	3
meals and snack service	-	-	-	-	-	-	-	1	1	-	-
self service refridgerators	-	-	-	-	-	-	-	-	-	-	-
sharing stores	-	-	-	-	-	-	-	-	-	-	-
programs for pregnant women	-	-	-	-	-	-	-	-	1	-	1
community restaurants	-	-	-	-	-	-	-	-	-	-	-
community groceries	-	-	-	-	-	-	-	-	-	-	-
Gardens											
collective gardens	-	-	-	-	-	-	-	1	2	-	4
community gardens	-	-	-	-	-	2	-	3	6	-	7
pedagogical gardens	-	-	-	-	-	-	-	-	-	-	1
urban farms	-	-	-	-	-	2	-	-	1	-	-
incredible edibles	-	-	-	-	-	-	-	-	-	-	3
enterprise gardens	-	-	-	-	-	-	-	1	1	-	-
institutional gardens	-	-	-	-	-	-	-	-	-	-	-
Fresh food drop off points											
Family Farm	1	-	1	1	-	1	3	2	-	-	4
Lufa	2	-	2	3	1	3	6	3	1	1	4
Second Life	-	-	-	-	-	-	1	-	-	-	-
Farmers market											
Public Market	-	-	2	-	2	2	1	3	6	1	1
Total	5	0	5	4	3	14	14	26	26	2	36

Discussion

The study shows that most food outlets were concentrated in the Eastern boroughs, and that non-chain grocery stores were more prevalent than chains. Food outlets were typically located along arterial roads with active bus lines, demonstrating how food sources have been situated to support the needs of both car and public transit users. Some variation was found regarding food store's mean distance from bus stops, yet all fell below a quarter of a kilometre. The assumptions made about food alternatives and car ownership were supported, yet unexpected results were shown in the distribution of stores by income.

The study's results disproved the assumptions made about food availability in that the high-income boroughs did not display greater availability or variety of food; The three wealthiest neighborhoods, Baie-D'Urfé, Beaconsfield and Kirkland, had only 17 food access points between the three of them. Most were depanneurs and chain supermarkets, and only three were specialty stores. The highest concentration of food outlets was actually found in the lowest-income neighborhood, Montreal-Nord, which had a total of 73 food outlets.

The assumptions made about store alternatives being more common in low-income boroughs, increased car use in high-income boroughs and a greater distribution of non-chain grocery stores were validated. First, alternatives to stores, like community gardens and food vouchers, were more prevalent in the lower-income neighborhoods; Montreal-Nord, Anjou and Riviere-des-prairies-Pointe-aux-trembles each had between 26 and 36 alternative spots. And in the West, boroughs Pierrefonds-Roxboro and Pointe-Claire, two of the West end's lower-income neighborhoods, each had 14 alternatives. Additionally, the alternatives covered a wide variety of potential needs, from locally grown, sustainable goods to learning programs for new mothers and pregnant women. This shows that municipalities and community groups have put effort into strengthening their food resilience by offering various affordable and healthy options, some of which teach people new food-related skills. Initiatives like these support Rodier et al.'s (2017) findings that food education is a more influential indicator in the purchase of healthy food rather than geographic proximity to healthy food options. Second, while car ownership was not drastically different in either borough, some correlation could be found between income and car usage; the latter was on average 9% higher in the Western boroughs as compared to those in the East. Households with car access have increased mobility allowing them to move further to access quality food than those relying on public transit (Páez et al., 2010). Third, in both Eastern and Western boroughs, chain stores were found to cluster together, while non-chain stores were more dispersed. This was not limited to depanneurs but also included quality food access points like grocery stores and fruit and vegetable markets. This dispersion increases store accessibility, as public transit users living far away from shopping centers can instead travel shorter distances to access healthy food.

There was a distinct contrast in store composition between the three wealthiest and three poorest boroughs. In the highest-income boroughs, all situated in the West, food access points were almost exclusively made up of chain grocery stores, depanneurs and specialty stores. In the three lowest-income boroughs, all situated in the East, grocery stores and fruit and vegetable markets comprised a greater portion of the food access points than chains. This shows that if quality food access points are made

exclusive to chain supermarkets, a significant portion of the food system is left unconsidered. This is especially important considering that these types of outlets were more prominent in low-income neighborhoods, which tend to be at higher risk of food insecurity. Hence, studies on food deserts and security should include more than just chain supermarkets, even if they offer slightly cheaper or diverse options, as the literature has shown. Bakeries, specialty stores and meat stores could be removed from future similar studies as they are less common and tend not to provide the variety of quality food that the other types do. Additionally, they tend to be open for fewer hours and on fewer days of the week, decreasing their temporal availability.

The distance matrix showed that all food outlet types were under a 250-meter average distance from the five nearest bus stops. At a walking speed of 5 kilometres an hour, the trip on foot from the store to one of the nearest bus stops would be under 3 minutes in most cases. Most stores are located along roads with active bus lines, suggesting that food outlet providers and STM bus lines have developed in a way that supports the needs of public transit users, not just private vehicle users.

There were no significant discrepancies in borough population and their respective availability of food outlets; boroughs with very few food outlets had correspondingly small population sizes. This follows Apparicio et al.'s finding that "low-density areas and highly motorized areas tend to have fewer (but on presumes larger) supermarkets" (2007). However, the distance that one may have to travel to get to the few food access points in boroughs like Sainte-Anne-de-Bellevue, Baie D'Urfé and Beaconsfield is concerning, especially if relying on public transit. These boroughs have few bus lines, indicating a longer average distance from homes to bus stops. This extends public transit users' total travel time for acquiring groceries. And while this may not be a concern for the bulk of the population in these boroughs who do own cars, there are still pockets of the population who rely on public transit. As demonstrated by Páez et al. (2010), generalizations about mean income in a region can actually exclude groups who do not have the same opportunities for acquiring quality food. For instance, in Sainte-Anne-de-Bellevue, the large student population differs from residents of single-family homes in that they typically live in denser housing and rely more heavily on public transit. The borough's only food outlet open year-round, Marche Richelieu, closed in January 2023 (Valeria Cori-Manocchio, 2023), forcing people to purchase food elsewhere. Although this grocery store had limited options and higher average prices than a chain supermarket, it was significantly more convenient for residents to get to than the next closest, Provigo Deroo in Baie D'Urfé. The latter has also since closed and will remain closed until June 2023 (Harris, 2023). Despite Sainte-Anne-de-Bellevue's high mean household income, there are severe barriers to food access for much of the population. Residents have started a petition to raise awareness on the issue and to instill action on behalf of the mayor of Ste-Anne-de-Bellevue and McGill's Mac Campus Dean. The authors of the petition write, "the absence of grocery stores nearby reinforces our dependence on cars to seek food commodities which contributes to increased greenhouse gas emissions and daily traffic" (Food Desert Mac Executive Team, 2023). In a conversation about food security, one Mac Campus student explained that people mostly rely on carpooling and home deliveries to gather their groceries (S. McSweeney, March 23rd, 2023). McSweeney has co-run a service

at MacDonald Campus called Buy Your Own Bulk that offers low-priced dried goods that can be bought in bulk on a weekly basis. Happy Belly is another initiative at MacDonald Campus that offers free, healthy lunches for students each week. While efforts like these are valuable to the student population and foster community relations, they cannot be relied upon to serve the entire population regularly. Additionally, the low accessibility of food outlets becomes worrisome for the ageing suburban population with lower mobility (Apparico et al., 2007). The case of Sainte-Anne-de-Bellevue demonstrates how income alone cannot be used to determine whether a population is or is not at risk of food insecurity, as there are always pockets of the population who do not fit the standard.

The Reseau Express Metropolitain (REM) route, shown in Figure 7, will offer residents of the West end a faster method of moving towards the city, potentially offering new ways of accessing food. Of the six stations situated in the studied boroughs, four are within walking distance from quality food access points: Fairview-Pointe-Claire station provides access to two chain grocery stores and two specialty stores; Pierrefonds-Roxboro to one chain grocery store: Sunnybrooke to three non-chain grocery stores and Des Sources to one chain grocery store. However, while this new public transit line offers new ways of getting to grocery stores, it does not improve the availability of food in boroughs that are currently underserved. Additionally, there are few stops along the peripheral branches, most of which are located adjacent to existing train and bus lines. As such, it can be argued that the REM serves principally to transport people from suburban residential areas to the CBD rather than to bring people to essential goods and services. Future studies should look at whether stores and services relocate to be in proximity of REM to facilitate the needs of REM users. Last, there are currently no plans for this light rail system to extend into the East end. This speaks to a greater trend of exclusion, beyond food security, occurring in the island's East end. The REM should be considered in future research on Montreal's socioeconomic disparities as it highlights a critical discrepancy in investment between Eastern and Western boroughs.

Figure 7: REM Map

Limitations

The analysis of food accessibility in suburban boroughs could have been made more robust by including public transit commute data. Widener et al. (2015) estimated the required time for grocery shopping when using public transit. They found that many residents had improved access to supermarkets when their grocery trip was made on the way home from work rather than departing from their home location. This allowed for daily mobility patterns to be considered, creating a more realistic view of how people acquire their groceries. In the same realm, Páez et al. (2010) estimated the distance travelled from home to store using the spatial expansion method. This could be used in tandem with bus schedules to understand how long it

would take for a household to gather groceries using public transit.

Due to incomplete borough data in the 2021 Canadian census, the 2016 census was used instead. Although this was done to reduce inconsistencies across boroughs, it does date the research by seven years, leaving room for inaccurate findings on income, car ownership and population distribution. Additionally, because no data specific to car ownership was available, it had to be assumed based on the percentage of the population that uses the car as their primary mode of transport. It is possible that significant portions of the population own cars but do not use them as their primary mode of transport. This would change the results found on food accessibility based on the car ownership variable.

Conclusion

Food access was measured alongside bus lines in eleven boroughs in Montreal's West and East ends. The number of stores, their proximity to bus routes, their opening hours, and the type of food offered. Store opening hours and their proximity to bus routes, as well as car ownership and population distribution, were included in the maps. This allowed for the consideration of more food insecurity indicators than just household income and geographical proximity.

The boroughs studied in the East end of Montreal are potentially more equipped for increased densification and lowered car usage because there are more food access points, and they tend to be more dispersed than in the West. Three of the seven Western boroughs are severely lacking in food outlets, making it difficult for public transit users in these parts to retrieve groceries. However, this may change with the expansion of the public transit network through the REM.

Non-chain grocery stores and fruit and vegetable markets were abundant and dispersed, indicating that they fill gaps in quality food access points in the absence of chain supermarkets.

Improving the public transit system and increasing the number of food outlets to reach more neighborhoods are two obvious ways of preparing boroughs for increased densification and lowered car usage. In the short term, however, there are several low-cost adaptations that the city could implement to increase the accessibility of food in peripheral neighborhoods. First, Communauto cars could be extended to boroughs like Sainte-Anne-de-Bellevue, Baie-D'Urfé and Beaconsfield to offer non-car owners a fast and reliable way of completing non-daily tasks like grocery shopping. Second, more quality food pickup points, like Lufa farms, could be implemented with little effort to fill gaps where stores are needed. This would be an effective interim solution for residents of Sainte-Anne-de-Bellevue who do not currently have alternatives nearby. Safety and convenience measures could also be implemented to improve the ease of acquiring groceries via public transit. For instance, real-time bus data at food outlets and bus stops would allow people to properly plan their trips. This might also keep people sheltered for longer to avoid uncomfortable weather conditions. Last, since most of the food access points studied are located on busy arterial roads, the construction of safe pedestrian walkways should be a priority. This includes sidewalks, adequate lighting, bus shelters, illuminated crosswalk beacons and timed crossings at intersections.

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