

Promoting access to fresh fruits and vegetables through a local market intervention at a subway station

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Abstract

Objective: Alternative food sources (AFS) such as local markets in disadvantaged areas are promising strategies for preventing chronic disease and reducing health inequalities. The present study assessed how sociodemographic characteristics, physical access and fruit and vegetable (F&V) consumption are associated with market use in a newly opened F&V market next to a subway station in a disadvantaged neighbourhood.

Design: Two cross-sectional surveys were conducted among adults: (i) on-site, among shoppers who had just bought F&V and (ii) a telephone-based population survey among residents living within 1 km distance from the market.

Setting: One neighbourhood in Montreal (Canada) with previously limited F&V offerings.

Subjects: Respectively, 218 shoppers and 335 residents completed the on-site and telephone-based population surveys.

Results: Among shoppers, 23% were low-income, 56% did not consume enough F&V and 54% did not have access to a car. Among all participants living 1 km from the market (n 472), market usage was associated (OR; 95% CI) with adequate F&V consumption (1.86; 1.10, 3.16), living closer to the market (for distance: 0.86; 0.76, 0.97), having the market on the commute route (2.77; 1.61, 4.75) and not having access to a car (2.96; 1.67, 5.26).

Conclusions: When implemented in strategic locations such as transport hubs, AFS like F&V markets offer a promising strategy to improve F&V access among populations that may be constrained in their food acquisition practices, including low-income populations and those relying on public transportation.

Keywords
Fruits and vegetables
Food environment
Farmers' markets
Health inequalities
Local food systems

Interventions that increase the consumption of fruits and vegetables (F&V) could reduce the burden of obesity and related chronic diseases such as heart disease and diabetes^(1,2). Furthermore, disadvantaged populations are both more heavily affected by non-communicable diseases^(3–5) and show lower levels of F&V consumption^(6,7). Due to fewer financial and material resources (e.g. access to a car), disadvantaged populations are often more dependent on their immediate environment and on public transit for their food shopping^(8–14). Given these constraints, these groups use a wide variety of coping strategies to acquire foods that meet their needs and preferences (e.g. visit several stores to get the best deals, travel further, wait for a ride)^(9,10,13–17). These complex food procurement strategies do not ease the acquisition of healthy foods and may partly explain inequalities in F&V consumption.

Interventions aiming to improve local access to healthy foods may help address this issue. In some cases, the implementation of a new supermarket in a food desert (i.e. a low-income area where sources of nutritious foods are unavailable⁽¹⁸⁾) led to improved perceptions of healthy food access^(19,20), improved quality of diet⁽¹⁹⁾ and increased F&V consumption⁽²¹⁾. Yet more studies found either no change^(20,22–24), or even decreases in F&V consumption⁽¹⁹⁾ and increases in the consumption of prepared⁽²²⁾ and unhealthy foods⁽²⁵⁾. Such findings may in part be explained by an increase in exposure to both healthy and unhealthy foods related to the implementation of new supermarkets^(18,25,26). Interventions increasing healthy food offerings in convenience stores seem to be successful in terms of purchase^(27–29), but F&V consumption *per se* has only rarely been studied⁽²⁷⁾.

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Implementation of alternative food sources (AFS) such as farmers' markets or cooperative grocery stores⁽³⁰⁾ is promising for improving healthy food access and reducing inequalities in healthy food consumption^(24,30–32). AFS differ from conventional food venues like supermarkets and wholesalers because they prioritize local food products and short supply chains wherein goods flow from producer to consumer via few or no intermediaries^(30,33). AFS are often part of community (or local) food systems with larger goals; for example, not only to increase access to healthy foods but also to stimulate the local economy and promote sustainable development⁽³⁴⁾. Several studies found an association between the use of AFS and greater F&V consumption as well as better diet quality^(33,35–40). Farmers' markets are the type of AFS that has been studied the most and public health advocates and policy makers are increasingly promoting farmers' markets as a viable source of fresh F&V in low-income, urban settings. In the USA, the effects of farmers' markets have mainly been studied in contexts including individual programmes providing financial incentives for purchasing healthy foods^(41,42). Of studies on AFS intended as interventions for healthy food access, only a few considered a broader population beyond food assistance programme participants^(43–49). These studies on AFS implemented in low-income neighbourhoods have shown improved perceived access to F&V^(45,48) and perceived increase in F&V consumption^(45,47), but also increase in total F&V consumption⁽⁴⁸⁾ or in certain types of fruits or vegetables^(46,49). Few studies have been conducted in Canadian cities⁽⁴⁴⁾, which differ from the US context in that food deserts may be less prevalent in Canadian cities^(50,51). Despite interesting findings from a recent systematic review showing that the physical accessibility of farmers' markets is an important determinant of their use among low-income populations, alongside perceptions of prices and offerings⁽⁵²⁾, few studies focused on integrating such food venues within public transport hubs, even though these are physically accessible locations that consider daily activity patterns⁽⁵³⁾.

The present study concerns a newly opened local F&V market located next to a subway station in a disadvantaged neighbourhood in Montreal with previously limited offerings in F&V. Given the short first season of operation of the market, we were interested in characterizing early adopters and in exploring the potential effect of the market on F&V availability for vulnerable populations. Therefore, the present study was guided by two main purposes: to assess early adoption of this newly implemented AFS and to understand the determinants of its use among the neighbouring population. The specific objectives were to: (i) determine market awareness and characterize early-adopting market shoppers; (ii) compare profiles of shoppers and non-shoppers among local inhabitants; and (iii) evaluate if and how socio-demographic characteristics, measures of physical access and F&V consumption are associated with F&V market use

among the neighbouring population. The orientation of the study was determined in partnership with the Montreal Public Health Department and 'Y'a QuelQu'un l'aut'bord du mur' (YQQ), the local social economy enterprise that runs the F&V market.

Methods

Intervention context

With 1.8 million inhabitants, Montreal is the second largest city in Canada and is part of the Montreal census metropolitan area, which has a population of 3.4 million. Prevalence of poverty in Montreal is among the highest of major Canadian cities, given that 21% of its population lives under the low-income threshold⁽⁵⁴⁾. In addition, 12.7% are food insecure⁽⁵⁵⁾. Among adult Montrealers, 59% consume fewer than five portions of F&V daily, one-half are overweight and one-third have at least one chronic disease⁽⁵⁶⁾. Access to healthy foods and services is an important health equity issue and has been the target of research in the last 10 years^(57–59). Although food deserts *per se* are not common in Montreal⁽⁵⁷⁾, 34% of low-income populations still have no or negligible access to fresh F&V within walking distance from their home (500m)⁽⁶⁰⁾.

The intervention market is located outside the Cadillac subway station in Montreal. In the adjacent neighbourhoods (Louis-Riel and Longue-Pointe), about 20% of adults are living in low-income households⁽⁶¹⁾ (i.e. earn less than half of the Canadian median household income, adjusted for household size⁽⁶²⁾) and about a quarter of the low-income population has low access to fresh F&V within walking distance from their homes⁽⁶³⁾. Approximately 50% of neighbouring residents do not have access to a car⁽⁶¹⁾.

Intervention description

The intervention is a seasonal outdoor F&V market that is intended to serve the neighbouring population by offering produce that is easily accessible on people's usual travel route. The market, part of a community food system, is run by YQQ and receives financial support from the Montreal Public Health Department. Most of the F&V sold at the market are produced by YQQ in local urban gardens. Produce is sold at the lowest possible cost, after accounting for a fair production price and for the intervention's viability, resulting in a similar cost for F&V to those in chain grocery stores. Customers can pay using cash or credit card. During the period between 7 September and 28 October 2016, the market opened weekly for 8 to 12 h, Wednesday through Friday, from 13.00 or 14.00 hours to 18.00 or 19.00 hours, for a total of fourteen days.

Design and sampling

The study was conducted in accordance with the Declaration of Helsinki and the protocol was approved by

the Ethics Committee of the Centre Hospitalier de l'Université de Montréal (CHUM) in August 2016 (N.D. 16.128). Following the opening of the market, two cross-sectional surveys were conducted: (i) on-site, recruiting adults who had just bought F&V; and (ii) through a telephone-based population survey recruiting adults residing within 1 km road-network distance from the market.

Spatial dynamics of food purchase are not straightforward, meaning it is never easy to define the spatial boundaries of accessibility. While the on-site survey was used to assess early adopters regardless of their residence location, the telephone-based population survey enabled assessment of the awareness and use of the market in the neighbouring population and to identify determinants of market use among the intervention's target population.

On-site survey

On-site recruitment started two weeks after the market opening date. Between 21 September and 28 October 2016, two interviewers were on-site during all opening hours. After completing their purchases, customers were systematically approached by one of the interviewers. Prior to verbal consent, potential respondents were informed that the research project was interested in understanding F&V access in the neighbourhood, that the survey was confidential and that they retained the right to refuse to answer any question. Consenting participants were also given the main researcher's contact information.

Each transaction represented one potential respondent. If participants were shopping in groups, only those who completed purchases were considered as potential respondents. Specifically, if people were shopping together but paid separately, they were approached separately. On the other hand, if they paid together (such as in a couple or family), they were approached together and only one person would complete the survey.

Eligibility criteria included being aged 18 years or older, speaking French or English, having lived in one's current home since at least 1 July 2016 and not having already completed the survey. Interviews were administered on-site under a gazebo with a table and chairs to make respondents comfortable, and using electronic questionnaires deployed on laptop computers. Potential respondents who mentioned lacking time were offered to complete the survey through a follow-up telephone interview. If they agreed, their telephone numbers were collected at the market and they were called back. Up to six telephone contact attempts were made before being considered as a refusal to participate. Of 326 eligible shoppers approached, 68% completed the on-site survey ($n = 218$) including forty-three of fifty-four shoppers who agreed to provide their telephone number (80%).

Population-based survey

Three weeks after the end of the market season, a professional surveying firm conducted a random landline

telephone survey (22 November to 18 December 2016) among residents of all six-digit postal codes located within 1 km of the market. This distance, roughly a 15 min walk, was considered reasonable for pedestrian accessibility, given the need to carry market purchases home. It is also the same distance used in previous studies on residential food environments⁽⁶⁴⁾. The research team trained the firm's investigators to administer the questionnaire and listened to several interviews to ensure their quality. To be eligible, respondents needed to not have completed the on-site survey, be aged 18 years or older, speak French or English, have lived in their current homes since at least 1 July 2016, as well as be in charge of the household's food shopping at least half of the time. Respondents were offered to complete the survey either online or by telephone, but none chose the online option. Up to ten attempts were made for reaching potential respondents at various times and on different days. The response rate for the population-based survey was 41%.

Measures

The on-site and population-based survey questionnaires included thirty-eight and fifty-one closed-ended questions, respectively, taking on average 8 and 12 min to complete. The questions used for the purposes of the present study were identical between the two surveys. Questions were mainly taken or adapted from previous studies^(47,65–70). The final versions of the questionnaires were reviewed by the partners and pre-tested among eligible participants at the beginning of each of the data collection phases. The dichotomous outcome of interest was market usage, separated according to participants who bought fruits or vegetables at the market at least once and those who did not. A similar definition of market shoppers has been used in previous studies^(44,46,71). Determinants of market usage included sociodemographic characteristics such as age, sex, ethnicity, household income category (before taxes and deductions), household main source of income, education, access to a car for food shopping (either as a driver or a passenger) and road-network distance between home (six-digit postal code) and the market. In the Montreal metropolitan area, there are over 50 000 unique residential postal codes, with an average of roughly sixty inhabitants per unique postal code, thus providing good geographical precision for distance estimations. Usual F&V consumption was measured with the six-item F&V module of the Short Diet Questionnaire, which has been validated among a French-speaking population⁽⁶⁹⁾. To account for outliers, for each item from the F&V consumption module, values exceeding the maximum acceptable value as defined by the National Cancer Institute⁽⁷²⁾ were capped. Perceived access to F&V in the neighbourhood was measured by the degree of agreement to four statements assessing physical access, availability, quality and price (see Table 1). Low internal consistency prevented the

creation of a combined score, meaning each dimension of perceived access was treated separately. As several studies suggested that the location of food venues on usual travel routes was a determinant of their use^(16,17,73–75), participants were asked to report if the F&V market was along their usual travel route (yes/no). Participants were also asked to report on their market shopping habits between May and October (farmers' markets, farm stands, mobile markets, other than Cadillac market; times per week/month) as a control variable. Respondents were further classified as living in a household under the low-income threshold or not, using the upper limit of self-reported income category and adjusting for household size. The use of the upper limit of income strata underestimated the number of respondents classified as living under the low-income measure. The road-network distance between each participant's postal code and the market was computed using ArcGIS version 10.3.

Statistical analyses

Descriptive analyses are presented for both samples. Shoppers recruited on-site who were residing up to 1 km from the F&V market were pooled with the population-based sample to create a sample of local inhabitant shoppers and non-shoppers. Figure 1 illustrates data sources used for analyses. The profiles of these two groups were compared using χ^2 and Mann–Whitney tests.

Determinants of the F&V market usage were identified using multivariate logistic regression. Only respondents living within 1 km of the market were included in the final analyses since the market intervention targeted the neighbouring population. The variable related to household income included 122 missing values (26%) and ten other independent variables included one to eleven missing values. In total, 30% of observations had a missing value. To handle the missing values, multiple imputation analyses were performed in R version 3.3.2 with the package 'mice'⁽⁷⁶⁾, generating five data sets. Categorical variables were imputed with logistic regressions (binary) or polytomous regressions (three or more categories); the continuous variable 'household size' was imputed with predictive mean matching⁽⁷⁷⁾. All variables included in the analyses (including the dependent variable) were included in the multiple imputation procedure.

Given the exploratory nature of the study, all variables in Table 1 (exceptions: responsibility level for household food shopping, mode of transportation to and from the market, F&V market awareness and use) were tested for inclusion in the final model using univariate models ($P < 0.20$) and a backward conditional model. Ethnicity, household's main source of income and perceived access to affordable F&V were excluded from the model. A few basic predictors of interest were forced into the model, including sex, education, low-income status and F&V consumption. Linearity in the logit of the dependent

variable was evaluated with the Box–Tidwell procedure⁽⁷⁸⁾. Bonferroni correction was applied, resulting in a significance level of $P < 0.002$ ⁽⁷⁹⁾. Variance inflation factors were all below 2, indicating limited collinearity among variables. Mahalanobis' test identified one outlier at $P < 0.001$, which was kept in the analyses given that it did not change the model. The final model included the whole sample of respondents residing within 1 km of the market ($n = 472$), i.e. the target population. The level of significance was set at $\alpha = 0.05$, except if another criterion was specified. Analyses were run with the statistical software package IBM SPSS Statistics version 24, except for multiple imputation done in R.

Results

Market awareness and characteristics of fruit and vegetable market shoppers

Table 1 describes the samples of the two surveys. Among the population-based survey respondents, 43.6% were aware of the new F&V market and 8.7% had actually used it ($n = 29$). Among shoppers recruited on-site, 79.8% were women, 78.4% were born in Canada, 39.0% lived alone and 63.8% reported salary or self-employment as their household's main source of income. Shoppers' income levels covered a broad range and almost a quarter lived under the low-income measure. Two-thirds lived within 1 km of the F&V market. Half did not have access to a car and 80.7% reported that the F&V market was located on their usual travel route. Subway and walking were the two most used modes of transportation to get to the F&V market, while walking was mostly used when leaving the F&V market. The majority of shoppers recruited on-site had insufficient F&V consumption (< 5 F&V/d; 56.4%). Nearly half of participants shopped frequently at markets, almost all were responsible for their household's food purchases at least half of the time (94.0%) and the majority were visiting the F&V market for the first time (62.4%).

Profiles of shoppers and non-shoppers among local residents

Table 2 presents the profiles of shoppers and non-shoppers residing within 1 km of the market, according to the variables included in the final model. Within the pooled sample of shoppers living within 1 km of the market ($n = 166$), the twenty-nine shoppers from the neighbourhood survey shared similar characteristics to the 137 shoppers from the on-site survey but were more prone to report a positive perception of F&V access of good quality (69.0 v. 39.7% agree), to report F&V access along their usual travel route (89.7 v. 57.7% agree) and to declare F&V access within walking distance from home (69.0 v. 39.4% agree). Shoppers from the on-site survey were younger than their counterparts (46.7 v. 13.8% aged

Table 1 Descriptive statistics of participants recruited through the on-site survey (21 September–28 October 2016) and the population-based survey (22 November–18 December 2016) about a newly opened local F&V market located next to a subway station in a disadvantaged neighbourhood in Montreal, Canada

Variable	On-site survey (<i>n</i> 218)		Population-based survey (<i>n</i> 335)	
	% or Mean	SD	% or Mean	SD
Sociodemographic characteristics				
Age (%)				
18–44 years	45.4	–	14.3	–
45–64 years	34.9	–	42.4	–
≥ 65 years	19.7	–	42.7	–
Missing	0.0	–	0.6	–
Sex (%)				
Male	19.3	–	28.7	–
Female	79.8	–	71.3	–
Missing	0.9	–	0.0	–
Born in Canada (%)				
Yes	78.4	–	84.5	–
No	21.6	–	15.2	–
Missing	0.0	–	0.3	–
Household size (mean and SD)	2.1	1.1	2.2	1.3
Missing	0.0	–	1.2	–
Education (%)				
High school or less	23.8	–	32.9	–
Trade school or pre-university college	37.6	–	22.4	–
University	38.1	–	43.9	–
Missing	0.5	–	0.9	–
Household income (%)				
< \$CAN 20 000	14.2	–	8.1	–
\$CAN 20 000–29 999	17.4	–	12.5	–
\$CAN 30 000–39 999	9.6	–	6.6	–
\$CAN 40 000–49 999	11.5	–	10.4	–
\$CAN 50 000–59 999	9.2	–	5.1	–
\$CAN 60 000–79 999	6.9	–	10.1	–
\$CAN 80 000–99 999	5.0	–	7.2	–
≥ \$CAN 100 000	10.1	–	10.7	–
Missing	16.1	–	29.3	–
Household under the LIM (%)				
Yes	23.4	–	13.1	–
No	60.6	–	57.3	–
Missing	16.1	–	29.6	–
Household's main source of income (%)				
Salary or self-employment	63.8	–	44.8	–
Retirement income	19.3	–	34.6	–
Other†	14.3	–	11.9	–
Missing	2.8	–	8.7	–
Car access (%)				
Yes	45.9	–	71.6	–
No	54.1	–	28.4	–
Missing	0.0	–	0.0	–
Geographic and mobility variables				
Distance home–market (100 m; mean and SD)	20.9‡	36.1	6.1	1.9
Missing	0.03	–	0.0	–
Residing ≤1 km from the market (%)				
Yes	62.8	–	100.0	–
No	33.9	–	–	–
Missing	3.2	–	–	–
Market on usual travel route (%)				
Yes	80.7	–	56.7	–
No	19.3	–	42.7	–
Missing	0.0	–	0.6	–
Transport to the market (%)			(<i>n</i> 29)	
Metro	49.5	–	6.9	–
Bus	5.0	–	0.0	–
Car	2.3	–	10.3	–
Bike	1.8	–	3.4	–
Walk	41.3	–	79.3	–
Missing	0.0	–	0.0	–
Transport from the market (%)			(<i>n</i> 29)	
Metro	14.2	–	3.4	–
Bus	10.1	–	0.0	–

Table 1 Continued

Variable	On-site survey (n 218)		Population-based survey (n 335)	
	% or Mean	SD	% or Mean	SD
Car	6.0	–	13.8	–
Bike	1.4	–	6.7	–
Walk	68.3	–	72.4	–
Missing	0.0	–	3.4	–
F&V consumption, perceived access and shopping habits				
Eats 5 F&V/d (%)				
Yes	42.2	–	30.1	–
No	56.4	–	67.2	–
Missing	1.4	–	2.7	–
Easy to find fresh F&V of good quality in own neighbourhood (%)				
Agree	47.2	–	72.2	–
More or less agree	18.3	–	18.8	–
Disagree	33.5	–	8.4	–
Missing	0.9	–	0.6	–
Easy to find affordable fresh F&V in own neighbourhood (%)				
Agree	33.5	–	26.6	–
More or less agree	15.6	–	30.7	–
Disagree	47.7	–	41.8	–
Missing	3.2	–	0.9	–
Easy to purchase fresh F&V within walking distance from home (%)				
Agree	64.2	–	69.0	–
More or less agree	5.5	–	15.2	–
Disagree	29.8	–	15.5	–
Missing	0.5	–	0.3	–
Easy to purchase fresh F&V on usual travel route (%)				
Agree	64.7	–	78.8	–
More or less agree	3.7	–	9.6	–
Disagree	30.7	–	11.0	–
Missing	0.9	–	0.6	–
Responsibility level for household food shopping (%)				
Mainly responsible	69.7	–	75.2	–
Sharing responsibility (50–50)	24.3	–	24.5	–
Occasionally responsible	5.0	–	–	–
Not responsible	0.5	–	–	–
Missing	0.0	–	0.3	–
Market shopping habits (%)				
Less than once/month	27.5	–	26.3	–
1–3 times/month	26.1	–	24.5	–
Once/week or more	45.4	–	47.5	–
Missing	0.9	–	1.8	–
F&V market awareness and use				
Cadillac FV market awareness (%)				
Yes	100.0	–	43.6	–
No	–	–	56.4	–
Missing	–	–	0.0	–
Cadillac F&V market usage (%)				
Yes	100.0	–	8.7	–
No	–	–	91.3	–
Missing	–	–	0.0	–
First visit to Cadillac F&V market (%)			(n 29)	
Yes	62.4	–	13.8	–
No	37.6	–	83.2	–
Missing	0.0	–	3.0	–

F&V, fruits and vegetables; LIM, low-income measure.

†Includes employment insurance, Old Age Security, social assistance or welfare, no income and other (e.g. rental income, scholarship).

‡This result is explained by the fact that nearly 34% of shoppers recruited at the market were living further than 1 km from the market.

<44 years) and had a higher proportion of respondents who ate 5 F&V/d (46.7 v. 24.1%; data not shown).

As shown in Table 2, shoppers were younger than non-shoppers. Even though both groups had similar

proportions of university degrees, non-shoppers had otherwise lower educational attainment. The proportion of respondents under the low-income threshold was also similar in the two groups, but non-shoppers had more

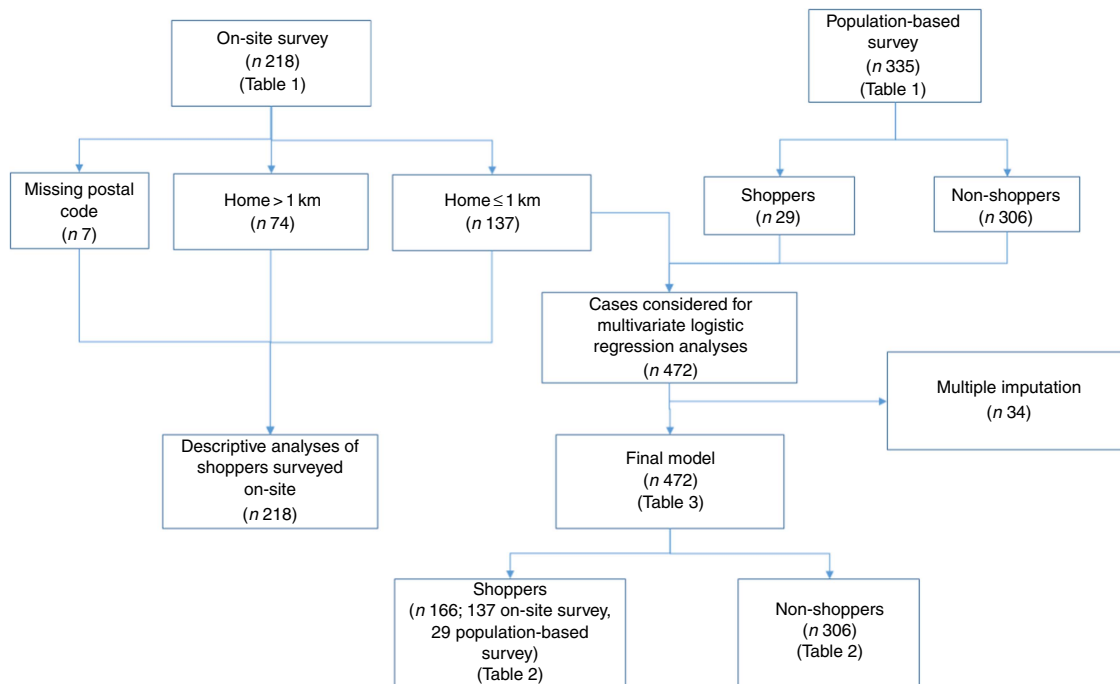


Fig. 1 (colour online) Sources of data for the statistical analyses

missing values for this variable. Shoppers were less likely to have access to a car, lived slightly closer to the F&V market and were more prone to report the F&V market to be on their usual travel route. Shoppers were more likely to have sufficient F&V consumption, yet the two groups had similar market shopping habits. Shoppers perceived their physical access to good-quality fresh F&V in their neighbourhood more negatively than non-shoppers.

Correlates of fruit and vegetable market usage

Geographic and mobility-related variables were strongly related to F&V market usage. Relevant variables included distance to the F&V market (OR for distance = 0.86; 95% CI 0.76, 0.97), F&V market on usual travel route (OR = 2.77; 95% CI 1.61, 4.75) and lack of access to a car (OR = 2.96; 95% CI 1.67, 5.26; Table 3). Consuming at least 5 F&V/d was also associated with F&V market usage (OR = 1.86; 95% CI 1.10, 3.16), whereas market shopping habits were not. Neither income nor education was associated with F&V market usage. More positive perceptions of access to fresh F&V within walking distance from home were associated with F&V market usage, as were more negative perceptions of access to fresh F&V on usual travel route.

Discussion

This intervention research is among the first studies to assess the scope of a new AFS implemented next to a transport hub in a disadvantaged area. A first objective was

to characterize early F&V market adopters and determine market awareness among the neighbouring population. Even after a short first season of operation, nearly half of respondents of the population-based survey had knowledge of the market's existence and one out of ten had been a customer. The market also seemed to reach populations that often face constraints in their food acquisition practices, including low-income populations and those who lack access to a car. A similar proportion of market shoppers lived under the low-income measure compared with that of adjacent areas (23.4% of shoppers from on-site survey and 20.5% shoppers living 1 km from the market, *v.* 20.1% (Louis-Riel) and 22.3% (Longue-Pointe)⁽⁶¹⁾). About half of the shoppers did not have access to a car, similarly to the target neighbourhoods (53.4% (Louis-Riel); 46.2% (Longue-Pointe)). In addition, one-third of shoppers recruited on-site were living beyond 1 km of the F&V market. This is probably due to the location of the market in a transport hub that attracts customers passing by who are not necessarily living nearby.

The other study objectives were to compare shoppers and non-shoppers within the neighbouring population and to identify the determinants of F&V market use. Besides being younger, shoppers had less access to a car, lived closer to the market and reported more frequently that the market was located on their usual travel route. One salient result is that the geography and mobility variables remained strongly related with the F&V market use in multivariate analysis. Hence, the strategic location of the market – in a transport hub – seemed to be a key determinant of its use. This is highly relevant for

Table 2 Descriptive statistics of shoppers and non-shoppers (*n* 472) living within 1 km of the newly opened local F&V market located next to a subway station in a disadvantaged neighbourhood in Montreal, Canada, according to variables included in the final model

Variable	Shoppers† (<i>n</i> 166)		Non-shoppers‡ (<i>n</i> 306)		<i>P</i> value
	% or Mean	SD	% or Mean	SD	
Age (%)					
18–44 years	41.0	–	14.4	–	<0.001
45–64 years	34.3	–	42.2	–	
≥ 65 years	24.7	–	42.8	–	
Missing	0.7	–	0.0	–	
Sex (%)					
Male	19.3	–	28.8	–	<0.05
Female	79.5	–	71.2	–	
Missing	1.2	–	0.0	–	
Household size (mean and SD)	2.1	1.1	2.2	1.3	0.724
Missing (%)	0.01	–	0.0	–	
Education (%)					
High school or less	24.7	–	32.0	–	<0.05
Trade school or pre-university college	35.5	–	22.5	–	
University	39.8	–	44.4	–	
Missing	0.0	–	1.0	–	
Household under the LIM (%)					
Yes	20.5	–	13.7	–	<0.05
No	59.6	–	57.2	–	
Missing	19.9	–	29.1	–	
Car access (%)					
Yes	47.6	–	72.5	–	<0.001
No	52.4	–	27.5	–	
Missing	0.0	–	0.0	–	
Distance home–market (100 m; mean and SD)	5.6	2.3	6.1	1.9	0.01
Missing (%)	0.0	–	0.0	–	
Market on usual travel route (%)					
Yes	78.3	–	54.2	–	<0.001
No	21.7	–	45.1	–	
Missing	0.0	–	0.7	–	
Eats 5 F&V/d (%)					
Yes	42.8	–	30.7	–	<0.05
No	55.4	–	66.7	–	
Missing	1.8	–	2.6	–	
Easy to find fresh F&V of good quality in own neighbourhood (%)					
Agree	44.6	–	72.5	–	<0.001
More or less agree	21.7	–	18.6	–	
Disagree	33.1	–	8.2	–	
Missing	0.6	–	0.7	–	
Easy to purchase fresh F&V within walking distance from home (%)					
Agree	68.1	–	68.3	–	<0.01
More or less agree	6.6	–	15.0	–	
Disagree	25.3	–	16.3	–	
Missing	0.0	–	0.3	–	
Easy to purchase fresh F&V on usual travel route (%)					
Agree	63.3	–	77.8	–	<0.001
More or less agree	2.4	–	9.8	–	
Disagree	33.1	–	11.8	–	
Missing	1.2	–	0.7	–	
Market shopping habits (%)					
Less than once/month	24.7	–	26.8	–	0.264
1–3 times/month	27.7	–	24.5	–	
Once/week or more	46.4	–	46.7	–	
Missing	1.2	–	2.0	–	

F&V, fruits and vegetables; LIM, low-income measure.

†Shoppers include respondents recruited at the market who were residing within 1 km of the Cadillac market (*n* 137) and respondents recruited through the population-based survey who bought F&V at the Cadillac market at least once (*n* 29).

‡Non-shoppers include respondents recruited through the population-based survey who never bought F&V at the Cadillac market.

interventions aiming to improve healthy food access among vulnerable populations. In the light of these results, it is possible that the physical accessibility of the F&V market helped reach disadvantaged populations^(30,31,80) and helped raise awareness of the market's existence.

Even if the proportion of low-income F&V market shoppers was similar to that of the adjacent neighbourhoods, low-income status was not a predictor of market usage *per se* (Table 3) and shoppers' income levels covered a broad range. This shows that the respondents who

Table 3 Results of logistic regression analyses modelling usage of the newly opened local F&V market located next to a subway station in a disadvantaged neighbourhood in Montreal, Canada (*n* 472)

Variable	Adjusted OR	95% CI
Age		
18–44 years		Ref.
45–64 years	0.24	0.12, 0.46***
≥ 65 years	0.13	0.06, 0.30***
Sex		
Male		Ref.
Female	1.46	0.81, 2.64
Household size	0.72	0.56, 0.94*
Education		
High school or less	1.03	0.51, 2.08
Trade school or pre-university college	1.73	0.96, 3.13
University		Ref.
Household under the LIM		
Yes	0.98	0.39, 2.45
No		Ref.
Car access		
Yes		Ref.
No	2.96	1.67, 5.26***
Distance home–market (100 m)	0.86	0.76, 0.97*
Market on usual travel route		
Yes	2.77	1.61, 4.75***
No		Ref.
Eats 5 F&V/d		
Yes	1.86	1.10, 3.16*
No		Ref.
Market shopping habits		
Less than once/month	0.67	0.36, 1.25
1–3 times/month	1.07	0.59, 1.94
Once/week or more		Ref.
Easy to find fresh F&V of good quality in own neighbourhood		
Agree		Ref.
More or less agree	2.33	1.20, 4.49*
Disagree	10.48	4.59, 23.93***
Easy to purchase fresh F&V within walking distance from home		
Agree		Ref.
More or less agree	0.27	0.11, 0.68**
Disagree	0.30	0.13, 0.69**
Easy to purchase fresh F&V on usual travel route		
Agree		Ref.
More or less agree	0.23	0.07, 1.31*
Disagree	2.08	1.05, 4.12*

F&V, fruits and vegetables; LIM, low-income measure; Ref., reference category.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

already used the market had a variety of economic profiles, as was also observed in another F&V market intervention⁽⁴⁵⁾. Whereas the market primarily aimed to serve disadvantaged populations, the fact that it actually attracted a diversity of profiles including higher-income groups strengthened the intervention's economic viability and long-term sustainability in local access to fresh F&V for all. Analysing purchase-level data could help determine how much clients from higher socio-economic status contribute to the F&V market's economic viability.

Access to a car was associated with lower market usage. Car users might use the subway less often and

consequently be less exposed. Prior research indicates that car users also tend to shop less often but in larger quantities^(11,81) while individuals without access to a car are more constrained in their food acquisition practices^(8,11–14), implying they would also benefit more from a market implemented in such a strategic transit hub.

Even though the model was restricted to participants living within 1 km of the market, each additional 100 m separating home from the market reduced the odds of usage by 14%. This underlines the role of local or very local physical accessibility to such food venues and the importance of location along regular travel routes. In short, very local access to F&V could have a positive impact on consumption⁽⁸²⁾. It may also facilitate smaller purchases at higher frequencies, providing an advantage for individuals concerned with fresh product conservation, such as individuals who live alone, those without access to a car or those with financial constraints^(12,81,83,84), which are all characteristics that were well represented in our sample of shoppers.

A younger age was associated with F&V market usage, possibly because the F&V market location and opening hours in the afternoon fit better with this population's schedules. Sadler⁽⁵³⁾ also observed that after a well-known market moved close to a bus terminal, a higher proportion of customers were aged below 44 years. However, our population-based survey included no respondents aged 25 years or younger, preventing any conclusion about this variable.

Education was not associated with F&V market usage but both surveys had a high proportion of university graduates. Selection bias is probably not at play among on-site participants because the response rate was high at 68%. However, the lower response rate in the population-based survey, and a proportion of university graduates roughly double than that of the market's neighbouring population (44.3 *v.* 25.8% (Louis-Riel) and 18.5% (Longue-Pointe)⁽⁶¹⁾, seems to point to selection bias, possibly linked to landline sampling^(85,86) and exclusion of cell-phone only households⁽⁷¹⁾. This could also partially explain why shoppers are younger than non-shoppers. A more representative sample of the surrounding population could possibly reveal a positive association between education and market usage, as was observed in other studies^(87,88). Nevertheless, conclusions on education remain unclear⁽⁸⁹⁾.

Whereas the present study did not assess change in F&V consumption, it showed that adequate F&V consumption was associated with market usage (OR = 1.86; 95% CI 1.10, 3.16). Yet, the market reached a similar proportion of shoppers with insufficient F&V consumption as is generally found in the Montreal population (56% of shoppers recruited on-site *v.* 59% of Montrealers). Food shopping habits in markets other than the Cadillac market did not differ between shoppers and non-shoppers living 1 km from the market, nor was this variable associated with

shopping at the Cadillac market. Hence, it is possible that the market also reached individuals who are not regular customers of this type of food venue. Given the positive associations between farmers' market usage and higher F&V consumption observed previously^(35–38,40,71), this result is of particular interest.

To our knowledge, the present study is the first to evaluate the early adoption of an AFS implemented next to a subway station and only the second in a transportation hub⁽⁵³⁾. In addition, few studies on AFS included both shoppers and non-shoppers. The fresh F&V market in the present study also had more opening hours than similar interventions studied previously (12 h *v.* a maximum of 4 h weekly)^(45–49,90). Besides possible selection bias already mentioned, other limitations include: (i) use of a cross-sectional design preventing determination of causal associations between market usage, F&V consumption, market shopping habits and perceived access; (ii) short exposure time, given that the population survey was conducted two weeks after initial implementation of the market and at first visit for the on-site sample (Table 1); and (iii) definition of 'shoppers' based on ever *v.* never use. Yet, conducting both an on-site survey of customers and a population-based survey of local residents made it possible to attain a sufficient number of both shoppers and non-shoppers, especially given the short exposure time to the new market. Despite its limitations, the study offers an interesting portrait of early adopters of a new local AFS and established baseline data for a follow-up study that was conducted in autumn 2017. Future studies should consider complementary strategies to recruit younger demographics, for example through online recruitment, cell phone sampling and door-to-door recruitment campaigns. The study was conducted in a predominantly French-speaking area with relatively few immigrants⁽⁶¹⁾, meaning that additional studies in other sociocultural contexts are necessary.

Conclusion

The current study suggests that AFS such as F&V markets offer a promising strategy to improve F&V access among populations that may be constrained in their food acquisition practices, including low-income populations and those who lack access to a car. The benefits of accessible F&V venues for these populations may positively impact F&V consumption, and possibly contribute to reducing diet-related health inequalities. Given the growing interest in AFS and community food systems by public health practitioners, community organizations and decision makers, the present study is timely not only for Montreal's stakeholders, but also for other Canadian and foreign initiatives where this type of intervention can be replicated and evaluated. As noted by Clary *et al.*⁽⁹¹⁾, adding a new single food venue to the foodscape is possibly insufficient

for observing population-level impacts. The F&V market in the present study is part of a developing community food system mobilizing multiple actors, with potential to foster the upscaling of local markets while preserving the authenticity of the market experience⁽⁹²⁾. Further studies should consider the broader role of community food systems on F&V access, purchase and consumption, and related health benefits.

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