

## Comparison of Two Indices of Availability of Fruits/ Vegetable and Fast Food Outlets

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**ABSTRACT** *Studies of food environment often examine single dimensions of areas that may not account for complexity of exposure to all food sources. With respect to the deprivation amplification hypothesis, particular needs are to assess whether relative or absolute measures of the food environment are related to characteristics of social environment. The objective of this study was to compare absolute availability (AA) of fast food outlets (FFO) and stores selling fresh fruits and vegetables (FVS) with the relative availability (RA) of the same food sources in relation to area-level poverty and ethnic diversity in 248 selected census tracts (CT) in Montreal, Canada. AA of FFO and FVS were expressed as areal densities of food sources within CTs. RA indices were calculated as the proportion of FVSs relative to total food stores and the proportion of FFOs relative to all restaurants within CTs, respectively. Whereas the AA of FFO was positively associated with area-level poverty and ethnic diversity, the RA of FFO was inversely associated with area-level poverty and not associated with ethnic diversity. Both measures of FVS were positively associated with area-level poverty and ethnic diversity. These findings do not support a model of deprivation amplification. Furthermore, results of FFO suggest that the alternate measure of RA can complement information based on AA indicators of the food environment, with potential utility in predicting eating practices.*

**KEYWORDS** *Food environment, Neighborhood, Geographical information system, Accessibility*

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### INTRODUCTION

Access to healthful and affordable food from neighborhood retail food sources may support individuals' ability to adopt a healthful diet.<sup>1</sup> The deprivation amplification

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hypothesis<sup>2</sup> posits that compared to residents living in more affluent areas, residents in deprived neighborhoods are more likely to be exposed to energy-dense foods available at convenience stores and fast food outlets (FFO) while having poor access to supermarkets offering healthier foods. This situation then reflects and perpetuates structural inequalities in access to healthful food. Evidence to this effect exists in the United States for residents of low-income and minority neighborhoods, but results from other westernized countries are sparse and inconclusive.<sup>3,4</sup> For Montreal, Canada, access to stores selling fresh fruits and vegetables (FVS) are not associated with neighborhood socioeconomic status but associated with presence of ethno-cultural diversity.<sup>5-7</sup> FFO are also more concentrated in ethnically diverse neighborhoods.<sup>5</sup>

The above ecological studies tend to be limited in that most examined a single dimension of the food environment. Estimates of the concentration of FFO or supermarkets alone may not account for the complexity of exposure to all food sources.<sup>3,8</sup> Few researchers have used other metrics to characterize unhealthful or healthful food sources relative to each other or relative to all food sources in residential areas.<sup>9-12</sup> Complementary measures may provide additional, more nuanced information about the food environment and its impact. For instance, the Retail Food Environment Index, the ratio of the number of FFO and convenience stores to supermarkets and specialty food stores, is correlated with obesity.<sup>11,12</sup> Empirical representations of the food environment require further validation.<sup>13</sup> With respect to the deprivation amplification hypothesis, particular needs are to assess whether different dimensions of the food environment are better related to measures of the social environment.

This study evaluated measures of the absolute availability (AA) of FFO and FVS (expressed as areal densities) with the relative availability (RA) of FFO and FVS (expressed against a representation of most food sources) in relation to area-level variation in poverty and ethnic diversity.

## METHODS

The area included in this study covered 248 census tracts (CT) of a total of 862 in the Montreal metropolitan area in which participants in a study of environmental determinants of healthful aging were residing.<sup>14,15</sup> Information on food stores and restaurants was obtained in May 2005 from Tamec, Inc. and geocoded at the address and postal code levels. Convergent and criterion validity of this database have been established for food sources.<sup>16</sup> Food stores and restaurants were then categorized according to a methodology already described.<sup>17</sup> Areal densities of food outlets within CTs (i.e., number of services per CT) were calculated for FVS (including groceries and supermarkets, fruits and vegetables stores, and farmer's markets), FFO (including major chains and nonchain local fast food), convenience stores, and full-service restaurants using the kernel density method.<sup>18</sup> Given skewed data, outliers were capped at the average plus 3.29 standard deviations.<sup>19</sup>

Two types of measures of availability were considered: (1) a measure of AA represented by the densities of FFO and FVS and (2) the RA of FFO and FVS expressed against a representation of most food sources in the CT. To estimate RA indices, food outlets were classified a priori into two categories of more healthful (FVS and full-service restaurants) or unhealthful (FFO and convenience stores). A RA index for FVS was calculated as the proportion of FVSs relative to total food stores with that for FFO calculated as the proportion of FFOs relative to all

restaurants in the CT. The resulting scores ranged from 0 to 100, with scores closer to 100 indicating a higher proportion of specific food sources.

Two variables reflecting characteristics of populations living in the CTs were obtained from the 2001 Statistics Canada Population Census ([www12.statcan.ca/english/census01/home/index.cfm](http://www12.statcan.ca/english/census01/home/index.cfm)). The first was an estimate of poverty level, operationalized as the proportion of residents in households below the low-income threshold, and the second was the proportion of households speaking neither official language at home (i.e., French and English), reflecting ethnic diversity of the area. Both variables were categorized into quartiles.

Descriptive data (median availability and interquartile ranges) were computed. Associations between availability measures of FFO and FVS were examined with Spearman's rank order correlations, and associations with poverty level and ethnic diversity were tested with a nonparametric Jonckheere–Terpstra tests.<sup>20,21</sup> The latter procedure allowed assessment of gradients in food outlets across levels of poverty and ethnic diversity. Analyses were conducted in autumn 2010 using PASW Statistics 18.0 for Mac OS X.

## RESULTS

Data were missing for one CT. Table 1 provides median values of AA and RA indices of FFO and FVS across the sample of CTs and according to quartiles of poverty level and ethnic diversity. Correlation analyses indicated that the AA and RA of FFO and FVS were weakly and moderately correlated, respectively (Spearman's  $r = -0.14$ ,  $p = 0.032$ ,  $r = 0.44$ ,  $p < 0.001$ ). Whereas the AA of FFO was positively associated with area-level poverty and ethnic diversity, the RA of FFO was inversely associated with area-level poverty and not associated with ethnic diversity. Both the AA and RA of FVS were positively associated with area-level poverty and ethnic diversity.

## DISCUSSION

Consistent with previous work,<sup>5–7</sup> the findings show that residents of poorer and more ethnically diverse neighborhoods are more exposed to FVS but also slightly more exposed to FFO in absolute terms. For Montreal, the deprivation amplification hypothesis<sup>2</sup> seems to hold only for unhealthful eating places. However, the absence of an association between the alternate RA measure of FFO with ethnic diversity and its negative association with poverty level suggest that residents of these neighborhoods have access to nearby eating places other than fast foods. Hence, these results suggest that the deprivation amplification hypothesis might not hold for FFO, either. Given that only the central regions of the total metropolitan area was covered by this study, it is possible that poor and ethnically diverse populations are more likely to live in areas with traditional urban form characterized by greater land mix use.

The results for FFO, coupled with a weak correlation between AA and RA of FFO, suggest that the RA of FFO captures a different aspect of the food environment above and beyond absolute density as given by the AA measure.<sup>10</sup> However, the AA and RA measures of FVS showed substantial shared variance indicating that the RA of FVS may be tapping into the same construct as AA. Other urban environments should similarly evaluate and compare the utility of relative versus absolute measures of the food environment in relation to the social environment.

**TABLE 1 Availability of FFO and FVS within CTs according to poverty level and ethnic diversity (n=247)**

Food environment measure	Median Availability (IQR)	Median availability of food outlets by quartile of poverty level <sup>a</sup>				P <sup>c</sup>	Median availability of food outlets by quartile of ethnic diversity <sup>b</sup>				P <sup>c</sup>
		1 Least poverty	2	3	4 Most poverty		1 Least diversity	2	3	4 Most diversity	
FFO relative availability (%)	15.6 (11.4, 21.9)	21.1	18.3	15.7	13.2	<0.001	15.9	15.3	15.0	16.1	0.281
FFO absolute availability (n/km <sup>2</sup> )	1.1 (0.6, 1.9)	0.7	1.1	1.4	1.2	<0.001	1.0	0.9	1.2	1.2	0.005
FVS relative availability (%)	35.4 (26.7, 49.2)	32.4	35.3	33.9	41.0	0.001	27.3	33.3	40.8	45.4	<0.001
FVS absolute availability (n/km <sup>2</sup> )	1.9 (0.7, 3.7)	0.4	1.5	1.8	2.8	<0.001	1.3	1.2	2.5	2.3	<0.001

FFO fast-food outlets, FVS stores selling fresh fruits and vegetables, IQR interquartile range, CT census tract

<sup>a</sup>Cutoff points for the lowest through the highest quartile of the percentage of residents in households below the low-income threshold are 15.8 %, 24.8 %, and 36.9 %, respectively

<sup>b</sup>Cutoff points for the lowest through the highest quartile of the percentage of households speaking no official language are 12.7 %, 21.3 %, and 37.2 %

<sup>c</sup>p value of gradients in food outlets across levels

Limitations of the current study include the use of administrative units to define neighborhoods. Also, the number of CTs does not allow for inferences for the entire region. Lastly, the classification of food outlets was based on store type, not store size or the actual food supply in outlets.<sup>22</sup> Despite these shortcomings, this study shows that alternate measures of the RA of different types of food sources in residential environments can provide complementary information on the extent to which local food environments are healthful or not.<sup>8</sup> Future studies are needed to undertake investigations in different settings on the utility of relative indicators in association with diet-related outcomes and for a variety of population groups.

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