Neighbourhood fruit and vegetable availability and consumption: the role of small food stores in an urban environment

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Abstract

Objective: Previous studies on the relationship of dietary intake to the neighbourhood food environment have focused on access to supermarkets, quantified by geographic distance or store concentration measures. However, in-store food availability may also be an important determinant, particularly for urban neighbourhoods with a greater concentration of small food stores. This study synthesises both types of information — store access and in-store availability — to determine their potential relationship to fruit and vegetable consumption.

Design: Residents in four census tracts were surveyed in 2001 about their fruit and vegetable intake. Household distances to food stores in these and surrounding tracts were obtained using geographical information system mapping techniques. In-store fruit and vegetable availability was measured by linear shelf space. Multivariate linear regression models were used to measure the association of these neighbourhood availability measures with consumption.

Setting: Four contiguous census tracts in central-city New Orleans.

Subjects: A random sample of 102 households.

Results: Greater fresh vegetable availability within 100 m of a residence was a positive predictor of vegetable intake; each additional metre of shelf space was associated with 0.35 servings per day of increased intake. Fresh fruit availability was not associated with intake, although having a small food store within this same distance was a marginal predictor of fruit consumption.

Conclusions: The findings suggest the possible importance of small neighbourhood food stores and their fresh produce availability in affecting fruit and vegetable intake.

A growing body of research in public health and nutrition has addressed the role of environments in shaping dietary behaviour and health outcomes¹–⁴. Studies examining the neighbourhood food environment have focused mainly on access to supermarkets as an influence on consumption. For example, Morland et al. found that with each additional supermarket in a census tract, fruit and vegetable intake increased⁵. Rose and Richards showed that increased supermarket access was a positive predictor of fruit consumption among participants in the US Food Stamp Program⁶, while Laraia et al. found that pregnant women living in closer proximity to a supermarket consumed higher-quality diets⁷.

The ‘in-store environment’ and its effect on consumption has also been the subject of considerable research, but has been confined almost exclusively to the field of marketing. This literature provides a number of studies that have shown how in-store availability can affect consumers’ purchasing behaviours⁸–¹⁰. Curhan found that increasing the amount of space dedicated to fresh produce items in a supermarket resulted in higher sales of fresh fruit and vegetable items¹⁰. Additional papers have found a correlation between the availability of particular foods in the surrounding neighbourhood and the reported consumption of such foods¹¹–¹³.

Underlying the hypothesis that improved access to stores improves consumption of certain products is the assumption that such stores contain these products. Researchers interested in fruit and vegetable consumption have studied access to supermarkets, since these stores...
typically have well-stocked produce departments. Smaller
neighbourhood food stores have more limited produce
availability and their selection varies considerably
between stores. But such stores may play an important
role in the consumption patterns of low-income con-
sumers with limited access to transportation and could be
particularly important for small fill-in shopping for per-
ishable items, like produce. To further the understanding
of the impact of the neighbourhood environment on
consumption, in particular the influence of small food
stores, the present exploratory study integrates two types
of information – access to food stores and in-store avail-
ability of specific products – into the same predictive
model of consumption.

This research was conducted in 2001 in New Orleans.
The study site was selected in an area of the city that is
typical of older urban areas throughout the country in
which stores are within walking distances of residences.
The study focused on the consumption of fruits and
vegetables, which is appropriate given their documented
importance for health and because of the inadequacy
of their consumption, especially among low-income
populations. In New Orleans, only 19% of individuals
met the US ‘5-a-day’ recommendation. Of 105 metropo-
lar areas in the country, the New Orleans area ranked
92nd on this statistic.

Methods

Study sample

This study was conducted in June and July of 2001. Four
contiguous census tracts were selected in central-city New
Orleans, Louisiana. Nearly 6000 people resided in these
tracts; 65.2% of the population was African American and
39.5% lived below the poverty line. These tracts were
chosen because they contained a diversity of socio-eco-
nomic and racial/ethnic groups and exhibited high levels
of land-use mix, with small neighbourhood stores inter-
mingled with residences. The relatively close proximity
of residences to stores found in these tracts is common to
many urban neighbourhoods in the country, and made this
geographic area especially conducive to the study of small
food stores and their potential impact on consumption. A
random sample of household phone numbers was sys-
tematically selected from this area. The phone numbers
were obtained from Powerfinder, version 1.3 (InfoUSA,
Inc., 2001). Telephone interviews were conducted with a
respondent from each household, by the US 2001 poverty
line. Respondents identified their annual household
income as being in one of seven ranges (e.g. $0–$4999,
$5000–$9999, etc.). A poverty-index ratio (PIR) was cal-
culated by dividing the midpoint of the income range,
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$5000–$9999, etc.). A poverty-index ratio (PIR) was cal-
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$5000–$9999, etc.). A poverty-index ratio (PIR) was cal-
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$5000–$9999, etc.). A poverty-index ratio (PIR) was cal-
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$5000–$9999, etc.). A poverty-index ratio (PIR) was cal-
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$5000–$9999, etc.). A poverty-index ratio (PIR) was cal-
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https://doi.org/10.1017/S1368980007000493

Fruit and vegetable intake

Fruit and vegetable intake was determined using an
instrument to elicit recall of fruit and vegetable con-
sumption in the previous 24 hours. This instrument was
incorporated into the telephone-administered ques-
tionnaire and listed a set of commonly consumed fruits
(specifically apples, bananas, oranges and grapes) and
vegetables (specifically lettuce, dark leafy greens, toma-
toes, carrots, green beans and cabbage). Respondents
were asked to indicate whether or not each of these
specific fruit and vegetable items were consumed during
the previous 24 hours and the number of servings they
had consumed. A serving was defined as a single fruit or
vegetable item or the approximate size of a hand made
into a fist. The respondents were also prompted to indi-
cate up to two ‘other’ fruits and two ‘other’ vegetables
they had consumed that were not one of those listed
above. The instrument did not take into account fruits or
vegetables from mixed dishes. Our intake variables were
determined by summing the number of servings of fruits
and the number of servings of vegetables. Fruit and
vegetable intakes were examined separately since pre-
vious research has found that food access predictors may
affect the intake of these foods differently.

Household demographics

Information on the demographic characteristics of the
household and car ownership was also collected in the
household survey. This included the gender, age and
race/ethnicity of the respondent, and the household size
and income. Race/ethnicity was categorised into African
American, White, Latino, Asian, or other. Since only a
small number of Latino and Asian respondents were
found in the sample, they were combined into the ‘other’
category. Respondents identified their annual household
income as being in one of seven ranges (e.g. $0–$4999,
$5000–$9999, etc.). A poverty-index ratio (PIR) was cal-
culated by dividing the midpoint of the income range,
selected by the respondent, by the US 2001 poverty
threshold for the size of their household. Households
were divided into three income groups: those in poverty
(PIR<1); those with incomes above the poverty line but
still qualifying for some food assistance programmes,
like WIC (Special Supplemental Nutrition Program for
Women, Infants, and Children) or School Lunch (1≤PIR<1.85); and those with a PIR of 1.85 or above.
Respondents were also asked whether anyone in the
household received food stamps, participated in the WIC
programme, or received some other form of food assis-
tance. In addition, information was collected on whether
someone in the household owned a car.

Food store access

All of the food stores listed for 2001 in the Louisiana
Office of Public Health’s (OPH) list of food retailers
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within or bordering the study’s four census tracts, along
with supermarkets that were within 5 km of the tract
borders, were included in our analysis \((n = 24)\) of store
access. No supermarkets were located within the study
tracts. To be comprehensive in our description of store
access, it was necessary to include supermarkets beyond
the tract borders, since previous research has indicated
the importance of supermarkets for consumption5–7,26.
The completeness of the OPH database was verified by
driving around the study neighbourhoods and visually
locating all of the food retailers. Stores were categorised
into two groups – small food stores and supermarkets,
based on codes in the OPH database for annual gross
sales. Stores with a code indicating sales greater than
$5 000 000 were classified as supermarkets, while stores
with sales less than $1 000 000 were classified as small
food stores. None of the food retailers in our study area
had codes indicating annual sales between $1 000 000 and
$5 000 000. All stores and household residences were
g eo c ode d using ArcGIS, version 8.3 (ESRI, Inc., 2003) and
straight-line distances from each household to each store
were calculated.

Previous research on food store access and consump-
tion has used either distance to store6,7 or density
measures5. Our analyses included both types of measures
by using the geographical information system (GIS)-
generated distances to construct two variables describing
small food store access: distance to the nearest small food
store in kilometres and a dichotomous variable indicating
the existence of a small food store within 100 metres of
the household residence. This latter access variable can
be seen as a measure of small food store density, i.e.
the number of stores within a specified radius of the
respondent’s residence. The distance of 100 metres
was selected because it represented the approximate size
of a city block. Even though the primary focus of this
study was to examine small food store access, similar
supermarket access measures were also created con-
sidering that prior studies have indicated their impor-
tance. Two variables were constructed to represent
supermarket access: distance to nearest supermarket in
kilometres and a dichotomous variable indicating the
existence of a supermarket within 1000 metres of the
household. Since supermarkets were located outside the
study tracts, their density measure necessitated a larger
radius. We used dichotomous expressions for all of the
density variables both for simplicity and because most
cases took on values of zero or one.

**In-store availability**

Store surveys were performed to determine in-store fruit
and vegetable availability. Information on linear shelf
space devoted to fruits and vegetables and the number of
fresh produce varieties available within each store was
obtained for 15 small food stores and three supermarkets.

Trained observers used measuring wheels to determine
shelf space lengths. This measurement was done sepa-
ately for fresh, canned and frozen fruits and vegetables.
Information on fresh produce varieties was gathered by
counting the number of varieties available for individual
fruits items (specifically apples, bananas, grapes and
oranges) and individual vegetable items (specifically let-
ttle, dark leafy greens, cabbage, green beans, tomatoes
and carrots). Data from the surveyed small food stores
were used to impute availability values for one small food
store for which we did not have in-store data. The
imputed values for this store were calculated by taking
the average of the fruit and vegetable availability mea-
surements for all the other small food stores.

**Neighbourhood availability**

The neighbourhood availability measures synthesised
information on food store access and in-store availability.
These measures were constructed by summing all of the
shelf space devoted to fresh fruits or fresh vegetables in
all small food stores within 100 m of the household resi-
dence. Thus, one variable reflected availability of fresh
fruits within a block distance of a household and the
other variable represented fresh vegetable availability
within the same distance. Similar neighbourhood avail-
ability variables were created for total fruit and total
vegetable shelf space, i.e. the sum of fresh, canned and
frozen shelf space lengths, and fresh fruit and fresh
vegetable varieties within 100 m. These neighbourhood
availability measures were an adaptation of the ‘cumula-
tive accessibility potential’, a GIS modelling concept that
measures the magnitude of availability (e.g. amount of
shelf space) while accounting for the travel distance to
each source27. Only small food store fruit and vegetable
availability data were used to create these measures.
Since the immediate neighbourhood environment around
the household was the focus of our study, we did not
include shelf space from supermarkets in these avail-
ability measures, as the nearest supermarket to any
resident was 0.8 km.

**Statistical analysis**

Differences in mean fruit and vegetable intake by various
demographic, socio-economic and access variables were
assessed using \(t\)-tests for dichotomous variables, with a
type I error rate of \(\alpha \leq 0.05\). Analysis of variance was used
for variables with more than two categories (i.e. age,
race/ethnicity and income). Post hoc testing using the
least significant difference was used to determine differ-
ences in intake with the reference category of these
variables (Table 3) when the main effect was significant.

Multivariate linear regression analysis was used to
assess the association of consumption with neighbour-
hood store access and food availability variables, while
controlling for household demographic factors. Separate equations were estimated for fruits and for vegetables. Because previous research on access and consumption is so limited, the literature gives little guidance concerning which dimensions of access are important. For example, although studies have documented the importance of supermarket density and distance to the nearest supermarket, there is no indication as to whether or not shelf space of all fruits, shelf space of fresh fruits, or the number of different varieties of fresh fruits are important dimensions of neighbourhood availability. Thus, we tested hypotheses concerning each of these dimensions of access and availability in separate, but equivalent, models that controlled for the same set of demographic and socio-economic variables. This set included gender, ethnicity and age of the individual, as well as car ownership, income of the household and food assistance programme participation. Our models on neighbourhood fruit and vegetable availability also controlled for distance to the nearest supermarket. Data management and statistical analyses were performed using SPSS, version 12.0 (SPSS, Inc., 2003).

### Results

The socio-economic characteristics of the study sample are shown in Table 1. The majority of the respondents were female and over half of the sample was African American. Thirty-one per cent of households had annual incomes below the poverty threshold, and 19% had someone in their household who received some form of governmental food assistance. Over 70% of respondents owned a car or had someone in their household who owned one.

Information on fruit and vegetable availability in the neighbourhood food stores is shown in Table 2. Mean fruit and vegetable shelf space was considerably larger for supermarkets (174 m) than for small food stores (11 m). This discrepancy was especially apparent for fresh produce items, in which supermarkets had greater amounts of shelf space than small food stores, 121 m of shelf space vs. 4 m. It was also seen in relative terms; 70% of fruit and vegetable shelf space was allocated to fresh produce in supermarkets, as opposed to 32% in small food stores. Supermarkets also offered a considerably larger number of varieties of fresh produce than did small food stores (36 vs. 4).

Mean fruit and vegetable intake by socio-economic characteristics and neighbourhood access measures are shown in Table 3. In most cases, socio-economic characteristics were not related to fruit and vegetable consumption. One exception was for female respondents, who consumed 3.1 servings of vegetables per day, significantly higher than the 2.2 servings consumed by male respondents. Associations of consumption with food assistance and car ownership were marginally significant. For example, respondents whose households received food assistance consumed, on average, 2.8 servings of fruits per day compared with 1.9 for those whose households did not (P = 0.055). Those who owned a car consumed, on average, 3.0 servings of vegetables per day, while those who did not consumed 2.3 servings (P = 0.088).

Respondents who had a small food store within 100 m had a significantly higher mean intake of vegetables and a marginally significant higher mean intake of fruits (P = 0.083). Having a supermarket within 1000 m did not significantly affect intake. Respondents with no fresh vegetable shelf space available within a block of their residence had the lowest mean intake of vegetables (2.4 servings per day), those who had up to 3 m of fresh

### Table 1 Socio-economic characteristics of the study sample (n = 102)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>74</td>
<td>73.3</td>
</tr>
<tr>
<td>Male</td>
<td>27</td>
<td>26.7</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16–30</td>
<td>18</td>
<td>18.2</td>
</tr>
<tr>
<td>31–50</td>
<td>41</td>
<td>41.4</td>
</tr>
<tr>
<td>≥51</td>
<td>40</td>
<td>40.4</td>
</tr>
<tr>
<td><strong>Race/ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>37</td>
<td>37.4</td>
</tr>
<tr>
<td>Black</td>
<td>53</td>
<td>53.5</td>
</tr>
<tr>
<td>Other</td>
<td>9</td>
<td>9.1</td>
</tr>
<tr>
<td><strong>Poverty-index ratio</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1.00</td>
<td>26</td>
<td>26.1</td>
</tr>
<tr>
<td>1.00–1.84</td>
<td>16</td>
<td>16.0</td>
</tr>
<tr>
<td>≥1.85</td>
<td>42</td>
<td>41.6</td>
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<tr>
<td><strong>Household receives food assistance</strong></td>
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<tr>
<td>Yes</td>
<td>19</td>
<td>19.0</td>
</tr>
<tr>
<td>No</td>
<td>81</td>
<td>81.0</td>
</tr>
<tr>
<td><strong>Owns a car</strong></td>
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<td></td>
</tr>
<tr>
<td>Yes</td>
<td>74</td>
<td>72.5</td>
</tr>
<tr>
<td>No</td>
<td>28</td>
<td>27.5</td>
</tr>
</tbody>
</table>

### Table 2 Fruit and vegetable availability in neighbourhood food stores

<table>
<thead>
<tr>
<th>Product</th>
<th>Small food stores (n = 15)</th>
<th>Supermarkets (n = 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean shelf space in metres (SD)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh</td>
<td>1.6 (1.9)</td>
<td>64.8 (14.4)</td>
</tr>
<tr>
<td>Canned</td>
<td>1.4 (0.8)</td>
<td>8.1 (2.8)</td>
</tr>
<tr>
<td>Frozen</td>
<td>0.0 (0.1)</td>
<td>1.8 (0.7)</td>
</tr>
<tr>
<td>Total</td>
<td>3.1 (2.4)</td>
<td>74.7 (13.8)</td>
</tr>
<tr>
<td>Vegetables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh</td>
<td>1.9 (1.8)</td>
<td>56.3 (5.3)</td>
</tr>
<tr>
<td>Canned</td>
<td>4.8 (2.8)</td>
<td>30.5 (17.9)</td>
</tr>
<tr>
<td>Frozen</td>
<td>1.0 (1.1)</td>
<td>12.2 (3.8)</td>
</tr>
<tr>
<td>Total</td>
<td>7.7 (4.5)</td>
<td>99.1 (22.8)</td>
</tr>
<tr>
<td><strong>Mean number of fresh varieties (SD)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruits</td>
<td>1.9 (2.4)</td>
<td>15.7 (2.5)</td>
</tr>
<tr>
<td>Vegetables</td>
<td>2.0 (2.1)</td>
<td>20.3 (6.5)</td>
</tr>
</tbody>
</table>

SD – standard deviation.
Fruit and vegetable availability and consumption

Table 3 Mean fruit and vegetable intake by socio-economic characteristics, food store access and neighbourhood availability

<table>
<thead>
<tr>
<th>Socio-economic characteristic or access/availability measure</th>
<th>Mean consumption in servings per day (SD)</th>
<th>Fruits</th>
<th>Vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>2.1 (1.9)</td>
<td>3.1 (2.1)**</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1.8 (1.6)</td>
<td>2.2 (1.7)**</td>
<td></td>
</tr>
<tr>
<td>Age (years)†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16–30</td>
<td>1.4 (1.4)</td>
<td>2.7 (1.8)</td>
<td></td>
</tr>
<tr>
<td>31–50</td>
<td>2.4 (2.1)</td>
<td>2.8 (1.8)</td>
<td></td>
</tr>
<tr>
<td>≥51</td>
<td>2.1 (1.5)</td>
<td>3.0 (2.3)</td>
<td></td>
</tr>
<tr>
<td>Race/ethnicity†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>1.9 (1.6)</td>
<td>2.9 (2.3)</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>2.2 (2.0)</td>
<td>2.8 (1.9)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2.0 (1.6)</td>
<td>3.0 (1.8)</td>
<td></td>
</tr>
<tr>
<td>Poverty-index ratio‡</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>&lt;1.00</td>
<td>2.5 (2.1)</td>
<td>2.5 (1.4)</td>
<td></td>
</tr>
<tr>
<td>1.00–1.84</td>
<td>2.5 (2.1)</td>
<td>2.6 (1.7)</td>
<td></td>
</tr>
<tr>
<td>≥1.85‡</td>
<td>1.9 (1.6)</td>
<td>3.2 (2.3)</td>
<td></td>
</tr>
<tr>
<td>Receives food assistance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.9 (1.7)</td>
<td>2.8 (2.0)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2.8 (2.1)**</td>
<td>3.2 (2.1)</td>
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<tr>
<td>Owns a car</td>
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<tr>
<td>No</td>
<td>2.0 (2.2)</td>
<td>2.3 (1.5)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2.1 (1.6)</td>
<td>3.0 (2.1)**</td>
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</tr>
<tr>
<td>Small food store within 100 m</td>
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<td></td>
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</tr>
<tr>
<td>No</td>
<td>1.8 (1.4)</td>
<td>2.4 (1.6)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2.4 (2.1)**</td>
<td>3.3 (2.3)**</td>
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<tr>
<td>Supermarket within 1000 m</td>
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<td>No</td>
<td>2.1 (1.9)</td>
<td>2.9 (2.1)</td>
<td></td>
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<tr>
<td>Yes</td>
<td>2.0 (1.4)</td>
<td>2.5 (1.5)</td>
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</tr>
<tr>
<td>Fresh fruit shelf space within 100 m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>2.0 (1.7)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>0–3 m</td>
<td>1.8 (1.3)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>&gt;3 m</td>
<td>2.3 (2.2)</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Fresh vegetable shelf space within 100 m</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>None</td>
<td>–</td>
<td>2.4 (1.6)</td>
<td></td>
</tr>
<tr>
<td>0–3 m</td>
<td>–</td>
<td>3.3 (2.4)**</td>
<td></td>
</tr>
<tr>
<td>&gt;3 m</td>
<td>–</td>
<td>4.5 (2.4)**</td>
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</table>

SD = standard deviation.

*P < 0.10; **P < 0.05.
† The first category is the reference group.

vegetable shelf space within a block had a higher intake (3.3 servings), while those who had greater than 3 m of fresh vegetable shelf space within a block had the highest intake (4.5 servings). A similar dose–response relationship was not seen for fruits.

Multivariates estimates of consumption were made using separate linear regression models for fruits and vegetables and for each of our neighbourhood access measures (Table 4). All of the models controlled for the basic set of household variables. Distance to the nearest small food store or distance to the nearest supermarket was not associated with fruit or vegetable consumption. Our density measure of small food store access, i.e. having a small food store within 100 m, was a marginally significant positive predictor of fruit consumption (P = 0.090); but none of the measures of neighbourhood fruit availability – i.e. those that considered the amount of fruit shelf space, or the number of varieties near the residence – were significant predictors of fruit intake. Conversely, the amount of fresh vegetable shelf space near the residence was a significant positive predictor of vegetable intake; each extra metre of shelf space was associated with an additional intake of 0.35 servings per day. Other measures of neighbourhood vegetable availability, including total vegetable shelf space and number of fresh vegetable varieties, were positive marginally significant predictors of intake.

Discussion

The main objective in this paper was to explore the relationship between neighbourhood food availability and consumption through the use of more refined measures of availability, specifically measures that combine information on both store access and in-store contents. Our study investigated the immediate neighbourhood of households in central-city New Orleans, surveying fruit and vegetable availability within 100 m, or about one city block, of their residences. Our analysis shows a positive association of neighbourhood vegetable availability, measured in linear shelf space, with reported vegetable intake. A positive association was not seen for fruit shelf space with fruit intake, although access to a small food store within 100 m of the residence was marginally associated with an increased fruit intake.

Interestingly, no association was found between intake and access to supermarkets, which differs with prior research in this area5–7. The null finding may be related to the specific context of this study. Although there was not a supermarket located within any of the four census tracts studied here, supermarkets were not far away. Moreover, there was little variability in the distance to the nearest supermarket. The average distance that each household needed to travel to reach their closest supermarket was 1.3 km, while the furthest anyone had to travel was 1.7 km. Even though over a quarter of respondents did not own a car, it is possible that most households were able to get to a supermarket for large food shopping trips and then relied on their neighbourhood small food stores for ‘fill-in’ shopping trips. Prior research has found that a significant proportion of low-income households who report supermarkets as their main source for food also shop at smaller neighbourhood stores26. Among our study participants, the nearness of a small food store and the availability of fresh vegetables in these stores may have been important factors when they needed to replenish smaller amounts of perishable foods between their opportunities to go to a supermarket.

Although the amount of fresh vegetable shelf space within a short distance of the household’s residence was important in predicting vegetable intake, a similar result was not found for fruits. There are a number of possible explanations for this finding. There may have been less
variability among small food stores in the amount of shelf space dedicated to fruits, the number of fruit varieties, and/or the quality of the fruit produce as compared with vegetables. Another possibility is that residents relied on supermarkets, rather than small food stores, for the purchasing of fruits, for reasons of quality and/or price. Thus the neighbourhood fruit availability measures would not be significant predictors of intake, since no supermarket was located in the immediate neighbourhood of the study households. Finally, there could be less variability in apparent fruit intake than vegetable intake, either because of the actual behaviour of respondents or because of this study’s fruit and vegetable survey instrument.

This indicates one possible limitation of our analysis. Overall, 56% of the sample ate two or more fruits and 54% ate three or more vegetables per day, which are higher than the averages in the USA and considerably higher than the averages for poor Americans. Although it is possible that within this small sample the respondents actually had higher-than-average intakes of fruits and vegetables, it is also possible that the design of the fruit and vegetable survey instrument caused inflated intake results. If our instrument caused differential reporting by a third variable related to access, one might also be concerned about bias in our analytical results on the relationship of access and intake. For example, one might posit that higher income or higher educated respondents might overstate consumption in order to provide more ‘socially desirable’ answers to our fruit and vegetable questions. If these groups also had better access, the relationship between access and intake would have been biased upwards. However, the specific area for our neighbourhood study was very mixed, both socio-economically and racially. We tested and found no significant differences in access or availability by household income or race/ethnicity, thus making it unlikely that our instrument contributed to this type of bias in the relationship between intake and access.

A second limitation of this study is the response rate. Despite attempts to encourage respondent participation by explaining clearly in the survey script that all responses would remain confidential, about half of households chose not to participate. In comparing characteristics of our study sample with data from the 2000 Census of the same tracts, we found that the percentage of African Americans was somewhat lower in our sample (53.5%) than in the Census data (65.2%). The same was true for poverty rates (31.0% vs. 39.5%). As with many surveys, response rates were lower among the poor, which indicates that results should be interpreted with caution.

Another limitation is that data were collected from a small sample confined to a single geographic section of New Orleans. Most households experienced relatively similar exposure to food stores, particularly supermarkets. Future research in this field would benefit from a larger sample and observations on a wider geographic area with more diverse micro-environments. Additionally, respondents were not asked about their level of education and the in-store observations did not obtain information on whether food stores participated in government food assistance programmes. Continuing research in this area would benefit from data collected on these variables.

Finally, because of the cross-sectional nature of our study, causality between the association of neighbour-
hood availability and intake cannot be inferred. Research based on a longitudinal design, or on a ‘natural experiment’, could yield more conclusive results. For example, Wrigley et al. used a longitudinal design in the UK to investigate the emergence of a new supermarket in a former ‘food desert’ and found there to be significant increases in fruit and vegetable consumption. A similar design could be used to investigate the effects of increased fruit and vegetable access through the adding of more fresh produce shelf space in local food stores. Creating incentives for small storeowners to stock more fresh produce may help achieve this.

While much of the prior literature has focused on access to supermarkets and its potential influence on dietary intake, this study suggests that access to urban small food stores and their in-store availability of foods may also play a role in affecting diet, in particular vegetable intake. The potential benefits of greater local fruit and vegetable availability may be especially pronounced for poor households without private transportation, who may have a greater reliance on nearby small food stores. Despite these suggestive findings, our study was exploratory in nature; future studies involving a larger sample and covering a wider geographic area are needed. Neighbourhood availability measures similar to the ones developed for this study could be used in such future research. Additionally, research on policies to promote greater fresh produce availability in small food stores could further our understanding of how neighbourhood availability affects fruit and vegetable consumption among urban residents.

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References


28 Marcus AC, Crane LA. Telephone surveys in public health research. *Medical Care* 1986; **24**: 97–112.
