# Associations of Neighborhood Characteristics With the Location and Type of Food Stores

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*Objectives.* We investigated associations between local food environment and neighborhood racial/ethnic and socioeconomic composition.

*Methods.* Poisson regression was used to examine the association of food stores and liquor stores with racial/ethnic composition and income in selected census tracts in North Carolina, Maryland, and New York.

*Results.* Predominantly minority and racially mixed neighborhoods had more than twice as many grocery stores as predominantly White neighborhoods (for predominantly Black tracts, adjusted stores per population ratio [SR]=2.7; 95% confidence interval [CI]=2.2, 3.2; and for mixed tracts, SR=2.2; 95% CI=1.9, 2.7) and half as many supermarkets (for predominantly Black tracts, SR=0.5; 95% CI=0.3, 0.7; and for mixed tracts, SR=0.7; 95% CI=0.5, 1.0, respectively). Low-income neighborhoods had 4 times as many grocery stores as the wealthiest neighborhoods (SR=4.3; 95% CI=3.6, 5.2) and half as many supermarkets (SR=0.5; 95% CI=0.3, 0.8). In general, poorer areas and non-White areas also tended to have fewer fruit and vegetable markets, bakeries, specialty stores, and natural food stores. Liquor stores were more common in poorer than in richer areas (SR=1.3; 95% CI=1.0, 1.6).

*Conclusions.* Local food environments vary substantially by neighborhood racial/ethnic and socioeconomic composition and may contribute to disparities in health. (*Am J Public Health.* 2006;96:325–331. doi:10.2105/AJPH.2004.058040)

Recent evidence from epidemiological studies suggests that neighborhood characteristics are related to health after individual-level confounders are taken into account.[1,2] Many factors have been proposed to explain neighborhood health effects, including physical access to the resources necessary to develop and maintain healthy lifestyles. In particular, neighborhood factors related to healthy foods recommended by the 2005 US Department of Agriculture *Dietary Guidelines for Americans,*[3] sometimes termed the *local food environment,* have received increasing attention[4–7] in part because of the high and increasing prevalence of obesity and overweight.[8] Although scientific proof of a causal effect of the local food environment on individual diets is difficult to obtain, local food environments and residents' diets have been linked in observational studies.[5,9,10] Preliminary data from natural experiments also suggests that changes in the local food environment result in changes in people's diets.[11]

The presence of strong residential segregation by income and race/ethnicity in the United States[12,13] also suggests that the local food environment may contribute to socioeconomic and racial/ethnic differences in health. Healthy foods including whole-grain products, low-fat dairy foods, and fresh fruits and vegetables, may be less available, and relatively more costly, in poor and minority neighborhoods than in wealthier and White neighborhoods. The combination of the migration of supermarkets, which often offer nutritious foods at lower costs,[14–18] from urban to suburban areas and the lack of private or convenient transportation among the urban poor may contribute to health disparities in heart disease, obesity, and diabetes. Nevertheless, there is still limited evidence of how the local food environment varies across neighborhoods and the extent to which it is associated with features of neighborhoods such as racial/ethnic composition.[4,7] Using data from 3 large and ethnically diverse areas in the United States, we investigated differences in the local food environment across neighborhoods associated with neighborhood racial/ethnic composition. Differences by neighborhood income were also examined.

## METHODS

The study areas included 75 census tracts in Forsyth County, NC; 276 census tracts in parts of the city of Baltimore and Baltimore County, Md; and 334 census tracts in northern Manhattan and the Bronx, NY. These areas were selected for study because they correspond to neighborhoods from which participants in a large multiethnic study of atherosclerosis (the Multiethnic Study of Atherosclerosis) were sampled.[19] Information on food establishments located in the study areas was purchased from InfoUSA Inc, a proprietary information service, in November 2003.

InfoUSA offers commercial databases on businesses with information regarding business openings and closings (obtained through US Department of Labor, telephone books, county offices, national change of address listings through the postal service, and utility companies) updated on a weekly basis. Selected characteristics of the businesses are verified monthly by telephone interviews. Businesses may be excluded from the directory on their request, and refusal rates average 12% (M. Dinarte, InfoUSA representative, personal communication, September 2004). InfoUSA used standardized criteria and information obtained and verified from the businesses to assign Standard Industrial Classification (SIC) codes to each business. SIC codes are standardized 4-digit codes that were developed and updated in 1987 by the Office of Budget and Management and used by government agencies to monitor economic activity and business patterns in the United States.[20] SIC codes were supplemented with an additional 2-digit code developed by InfoUSA to further detail types of businesses. All establishments classified as retail food and liquor stores (SIC codes 54 and 5912) were obtained from these commercial lists. The

information obtained on each establishment included name, address, SIC code, number of annual employees, annual sales volume, approximate square footage, and type of business (branch, single location, franchised, headquarters, and so forth). All locations were geocoded to the 2000 US Census.

The 3 study areas included a total of 3337 food and liquor stores. These were classified into the following categories using the SIC codes: grocery stores and supermarkets (541101, 541104–541106); convenience stores (541102, 541103); meat and fish markets (5421, 549907, 549911); fruit and vegetable markets (543101–543103, 549933); bakeries (5461); natural food stores (549901, 549909, 549935); specialty food stores (549910, 549912, 549914, 549916–549921, 559923, 549926–549928, 549930, 549937); and liquor stores (5912). Manufacturing plants and corporate headquarters as identified by the InfoUSA database were excluded from analysis because of their inaccessibility to the public. Following prior work,[14,16] supermarkets were differentiated from grocery stores on the basis of chain name recognition or an annual payroll of greater than 50 employees. Information on census tract characteristics including population, land area, racial/ethnic composition, and tract median household income was obtained from the 2000 US Census. Census tracts with greater than 60% of the residents in any particular racial/ethnic group were defined as predominantly non-Hispanic White, predominantly non-Hispanic Black, or predominantly Hispanic areas. Tracts that did not fall into any of these categories were classified as racially mixed areas.

Census tract and food store characteristics were compared across study areas and across categories of racial/ethnic composition using $\chi^2$ tests (for proportions) or analysis of variance (for continuous variables). Because the dependent variable is a count (the number of stores present within each census tract), Poisson regression was used to examine associations of tract racial/ethnic composition and income with the number of stores.[21] The logarithm of the number of the various types of stores in each tract was modeled as a function of the census tract racial/ethnic composition, the area of the tract in square miles, and the population size as an offset. Exponentiated coefficients can be interpreted as ratios of stores per population, adjusted for tract area.

We did not attempt to isolate the effects of racial/ethnic composition from socioeconomic composition in this study because the socioeconomic composition of tracts was strongly associated with the ethnic composition of the tract (for example, 56% of non-Hispanic Black tracts and only 6% of White tracts were in the lowest tertile of census tract median income categories). However, we did repeat selected analyses for categories of census tract median household income. We used SAS GENMOD[22] to run models separately for each type of store. Tracts in each study site were also run separately because of the different ethnic composition of the areas and to capture differing patterns in the food store distributions across sites. Models combining all 3 study areas but adjusting for the site were also run excluding predominantly Hispanic areas in New York because of the absence of these tracts in the other study sites.

## RESULTS

Table 1 presents characteristics of the census tracts and the food environment in each site. North Carolina was the largest of the study sites in terms of area, covering almost 410 square miles, with an average of 747

**TABLE 1—Characteristics of Census Tracts Included in the Analyses, by Site: Maryland, North Carolina, and New York**

| | Maryland | North Carolina | New York | $P^a$ |
|---|---|---|---|---|
| Number of tracts | 276 | 75 | 334 | ... |
| Total area, $mi^2$ | 241.5 | 409.6 | 26.0 | ... |
| Median tract population | 3341 | 3779 | 4629 | <.0001 |
| (Q1, Q3) | (2365, 4522) | (2684, 5247) | (2686, 7091) | ... |
| Median tract household income, $ | 37 758 | 41 579 | 25 063 | .005 |
| (Q1, Q3) | (26 530, 49 270) | (30 230, 51 149) | (18 207, 38 446) | ... |
| Tract racial/ethnic composition, % | | | | |
| Predominantly White tracts | 41.3 | 64.0 | 19.5 | ... |
| Predominantly Black tracts | 47.1 | 16.0 | 13.5 | ... |
| Hispanic tracts | ... | ... | 34.1 | ... |
| Mixed tracts | 11.6 | 20.0 | 32.9 | <.0001 |
| Food stores | | | | |
| Number | 821 | 286 | 1753 | ... |
| Number per 10 000 population | 8 | 9 | 10 | 0.2 |
| Number per $mi^2$ | 3 | 1 | 67 | <.0001 |
| Types of stores, % | | | | |
| Grocery stores | 37.0 | 22.4 | 52.3 | ... |
| Supermarkets | 10.4 | 13.3 | 5.0 | ... |
| Convenience stores | 15.6 | 40.6 | 8.2 | ... |
| Meat and fish markets | 11.7 | 4.9 | 11.1 | ... |
| Fruit and vegetable markets | 3.8 | 1.8 | 5.7 | ... |
| Bakeries | 15.7 | 9.8 | 11.8 | ... |
| Natural food stores | 4.0 | 3.9 | 3.8 | ... |
| Specialty stores | 2.1 | 3.5 | 2.3 | <.0001 |
| Liquor stores | | | | |
| Number | 259 | 18 | 200 | ... |
| Number per 10 000 population | 3 | 1 | 1 | <.0001 |
| Number per $mi^2$ | 1 | 0 | 8 | <.0001 |

*Note.* Q1 = 25th percentile; Q3 = 75th percentile.
[a] *P* value for differences across sites from analysis of variance (for means) or $\chi^2$ tests (for proportions).

**TABLE 2—Selected Census Tract Characteristics, by Site and Tract Racial/Ethnic Composition: Maryland, North Carolina, and New York**

| | Predominantly Black | Predominantly Hispanic | Racially Mixed | Predominantly White | P[a] |
|---|---|---|---|---|---|
| **Maryland tracts** | | | | | |
| Median household income, $ | 27 384 | ... | 42 732 | 48 496 | <.0001 |
| Households without vehicle, % | 39.4 | ... | 22.4 | 12.3 | <.0001 |
| Food stores | | | | | |
| Number | 377 | ... | 133 | 311 | ... |
| Number per 10 000 population | 8 | ... | 10 | 8 | .09 |
| Number per mi$^2$ | 7 | ... | 6 | 2 | .004 |
| >2500 sq ft, % | 18 | ... | 35 | 46 | <.0001 |
| Types of stores, % | | | | | |
| Grocery stores | 54.6 | ... | 21.8 | 21.5 | ... |
| Supermarkets | 6.9 | ... | 12.0 | 13.8 | ... |
| Convenience stores | 14.9 | ... | 18.1 | 15.4 | ... |
| Meat and fish markets | 9.8 | ... | 16.5 | 11.9 | ... |
| Fruit and vegetable markets | 2.7 | ... | 6.0 | 4.2 | ... |
| Bakeries | 8.5 | ... | 16.5 | 24.1 | ... |
| Natural food stores | 1.6 | ... | 8.3 | 5.1 | ... |
| Specialty stores | 1.1 | ... | 1.0 | 3.9 | <.0001 |
| Liquor stores | | | | | |
| Number | 133 | ... | 37 | 89 | ... |
| Number per 10 000 population | 3 | ... | 3 | 2 | .04 |
| Number per mi$^2$ | 2 | ... | 2 | 1 | <.0001 |
| **North Carolina tracts** | | | | | |
| Median household income, $ | 19 321 | ... | 30 230 | 48 815 | <.0001 |
| Households without vehicle, % | 32.7 | ... | 15.2 | 4.7 | <.0001 |
| Food stores | | | | | |
| Number | 39 | ... | 67 | 180 | ... |
| Number per 10 000 population | 11 | ... | 11 | 9 | .6 |
| Number per mi$^2$ | 3 | ... | 1 | 1 | <.0001 |
| >2500 sq ft, % | 28 | ... | 39 | 37 | .002 |
| Types of stores, % | | | | | |
| Grocery stores | 30.8 | ... | 32.8 | 16.7 | ... |
| Supermarkets | 5.1 | ... | 6.0 | 17.8 | ... |
| Convenience stores | 33.3 | ... | 35.8 | 43.9 | ... |
| Meat and fish markets | 18.0 | ... | 3.0 | 2.8 | ... |
| Fruit and vegetable markets | 2.6 | ... | 0.0 | 2.2 | ... |
| Bakeries | 7.7 | ... | 14.9 | 8.3 | ... |
| Natural food stores | 0.0 | ... | 3.0 | 5.0 | ... |
| Specialty stores | 2.6 | ... | 4.5 | 3.3 | .0005 |
| Liquor stores | | | | | |
| Number | 0 | ... | 7 | 11 | ... |
| Number per 10 000 population | 0 | ... | 1 | 1 | .03 |
| Number per mi$^2$ | 0 | ... | <1 | <1 | .02 |

*Continued*

people per square mile (not shown), and the majority of neighborhoods were predominantly White. The Maryland study area covered more than 240 square miles, with approximately 4127 people per square mile and almost equal numbers of predominantly Black and predominantly White neighborhoods. New York was the most densely populated area, with 65 230 people per square mile in an area of 26 square miles and was also the most ethnically diverse. Tract median household income was highest in North Carolina and lowest in New York. The New York site consisted of only urban tracts. The Maryland and North Carolina sites included a small number of predominantly rural tracts (less than 50% of the population in the census tract living in an urban area as defined by the US Census, less than 1% in Maryland and 4% in North Carolina).

The number of food stores per population was fairly constant across the 3 sites (8 to 10 per 10 000 people). However, in New York there were significantly more food stores per square mile than in Maryland or North Carolina (67 stores per square mile vs 1 to 3 stores per square mile), which reflects the much higher population density in New York. Despite similarities in the total number of stores per population, the distribution of the types of stores varied across the 3 sites. Grocery stores were the most common type of store in New York and Maryland, and convenience stores were the most common type of store in North Carolina. North Carolina neighborhoods also had fewer meat and fish markets, fruit and vegetable markets, and bakeries than did the other 2 study sites. Natural food stores were equally common across the 3 study sites. Maryland neighborhoods had 3 times more liquor stores per population than the other 2 sites.

Table 2 shows selected census tract characteristics and types of stores by census tract racial/ethnic composition for each site. Predominantly Black and Hispanic neighborhoods had lower median incomes and proportionately more people without a vehicle than did predominantly White census tracts. The total number of stores per population was generally similar across categories, although predominantly White areas generally had slightly lower numbers of stores per population, possibly reflecting the larger sizes of stores in these areas (overall, 19% of stores in predominantly Black areas were 2500 sq ft or more compared with 42% of stores in predominantly White areas). The types of stores present differed significantly across categories of racial/ethnic composition ($P<.001$ in all sites). In all 3 sites, the percentage of

**TABLE 2—*Continued***

| | New York tracts | | | | |
|---|---|---|---|---|---|
| Median household income, $ | 21 480 | 21 209 | 25 114 | 71 283 | <.0001 |
| Households without vehicle, % | 77.4 | 78.3 | 71.2 | 64.5 | <.0001 |
| Food stores | | | | | |
| Number | 152 | 810 | 475 | 316 | ... |
| Number per 10 000 population | 9 | 13 | 10 | 8 | .2 |
| Number per $mi^2$ | 48 | 116 | 42 | 69 | <.0001 |
| >2500 sq ft, % | 18 | 13 | 20 | 40 | <.0001 |
| Types of stores, % | | | | | |
| Grocery stores | 55.9 | 59.8 | 55.2 | 26.9 | ... |
| Supermarkets | 6.6 | 2.5 | 5.3 | 10.1 | ... |
| Convenience stores | 10.5 | 9.4 | 8.8 | 2.9 | ... |
| Meat and fish markets | 11.2 | 11.7 | 11.0 | 9.5 | ... |
| Fruit and vegetable markets | 4.0 | 5.3 | 4.8 | 8.5 | ... |
| Bakeries | 8.6 | 9.1 | 9.1 | 24.4 | ... |
| Natural food stores | 3.3 | 1.9 | 3.8 | 9.2 | ... |
| Specialty stores | 0.0 | 0.4 | 2.1 | 8.5 | <.0001 |
| Liquor stores | | | | | |
| Number | 19 | 72 | 49 | 60 | ... |
| Number per 10 000 population | 1 | 1 | 1 | 2 | .3 |
| Number per $mi^2$ | 6 | 10 | 4 | 13 | .001 |

[a] *P* value for differences across categories of tract racial/ethnic composition from analysis of variance (for means) or $\chi^2$ tests (for proportions).

stores that were grocery stores was higher in predominantly minority than in predominantly White census tracts. In contrast, the percentage of stores that were supermarkets was much higher in predominantly White areas. Natural food stores and specialty food stores were also more common in predominantly White neighborhoods than in predominantly minority ones. Differences in other types of stores were not always consistent across sites: convenience stores were more common in minority neighborhoods in New York, but not in Maryland or North Carolina; meat and fish markets were more common in minority neighborhoods in North Carolina but not at the other 2 study sites; fruit and vegetable markets and bakeries were less common in minority neighborhoods in New York and Maryland but not in North Carolina. Differences between low- and high-income neighborhoods were analogous to those observed between minority and predominantly White neighborhoods (not shown). On average, there were no clear differences in the number of liquor stores per population across categories of neighborhood ethnic composition.

Ratios of the number of stores by racial/ethnic composition are shown in Table 3. These correspond to the ratio of the number of stores per population in each category versus the reference category (predominantly White tracts), adjusted for census tract size and site where appropriate. Site-adjusted estimates are not shown for predominantly Hispanic tracts because these tracts were only present in the New York site. Interactions of racial/ethnic composition of tracts with site were not statistically significant at the $P=.05$ level. Overall, predominantly minority and racially mixed neighborhoods had significantly more grocery stores than

**TABLE 3—Ratios of Food Stores per 10 000 Population, by Tract Racial/Ethnic Composition and Site[a]**

| | Maryland | | North Carolina | | New York | | | Overall (Adjusted for Site) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Type of Store | Racially Mixed,Ratio (95% CI) | Predominantly Black, Ratio (95% CI) | Racially Mixed, Ratio (95% CI) | Predominantly Black, Ratio (95% CI) | Racially Mixed, Ratio (95% CI) | Predominantly Black, Ratio (95% CI) | Predominantly Hispanic, Ratio (95% CI) | Racially Mixed, Ratio (95% CI) | Predominantly Black, Ratio (95% CI) | *P* for Interactions[b] |
| Grocery stores | 1.2 (0.8, 1.8) | 1.7 (1.3, 2.2) | 2.8 (1.6, 5.2) | 3.0 (1.4, 6.5) | 2.5 (1.9, 3.2) | 2.5 (1.9, 3.4) | 3.7 (3.0, 4.7) | 2.2 (1.9, 2.7) | 2.7 (2.2, 3.2) | .2407 |
| Supermarkets | 1.2 (0.7, 2.1) | 0.5 (0.3, 0.9) | 0.3 (0.1, 0.9) | 0.2 (0.1, 1.0) | 0.6 (0.4, 1.1) | 0.8 (0.4, 1.6) | 0.4 (0.2, 0.7) | 0.7 (0.5, 1.0) | 0.5 (0.3, 0.7) | .4201 |
| Convenience stores | 1.6 (0.9, 2.5) | 1.0 (0.7, 1.5) | 0.9 (0.6, 1.5) | 0.9 (0.5, 1.6) | 3.7 (1.8, 7.7) | 4.4 (2.0, 10.1) | 5.5 (2.8, 11.0) | 1.5 (1.1, 1.9) | 1.2 (0.9, 1.6) | .0720 |
| Meat and fish markets | 1.8 (1.0, 3.0) | 0.7 (0.5, 1.2) | 0.9 (0.2, 4.7) | 3.2 (0.9, 11.5) | 1.4 (0.9, 2.2) | 1.4 (0.8, 2.6) | 2.0 (1.3, 3.1) | 1.4 (1.0, 2.0) | 1.0 (0.7, 1.4) | .2269 |
| Fruit and vegetable markets | 1.9 (0.8, 4.6) | 0.7 (0.3, 1.5) | 0.0 (0.0, 0.0) | 2.6 (0.2, 32.3) | 0.7 (0.4, 1.2) | 0.6 (0.2, 1.3) | 1.0 (0.6, 1.7) | 0.9 (0.5, 1.4) | 0.6 (0.3, 1.1) | .5149 |
| Bakeries | 0.9 (0.6, 1.6) | 0.4 (0.3, 0.6) | 1.6 (0.7, 3.7) | 0.6 (0.2, 2.2) | 0.5 (0.3, 0.7) | 0.4 (0.2, 0.8) | 0.6 (0.4, 0.8) | 0.6 (0.5, 0.8) | 0.4 (0.3, 0.5) | .1909 |
| Natural food stores | 2.3 (1.1, 5.0) | 0.4 (0.1, 1.0) | 0.5 (0.1, 2.4) | 0.0 (0.0, 0.0) | 0.5 (0.3, 0.9) | 0.4 (0.2, 1.1) | 0.3 (0.2, 0.6) | 0.8 (0.5, 1.2) | 0.3 (0.2, 0.6) | .2384 |
| Specialty food stores | 0.3 (0.0, 2.1) | 0.3 (0.1, 1.0) | 1.3 (0.3, 5.4) | 0.6 (0.1, 5.5) | 0.3 (0.2, 0.6) | 0.0 (0.0, 0.0) | 0.1 (0.0, 0.2) | 0.4 (0.2, 0.7) | 0.2 (0.1, 0.5) | .3991 |
| Liquor stores | 1.3 (0.9, 1.8) | 1.1 (0.9, 1.5) | 1.6 (0.6, 4.1) | 0.0 (0.0, 0.0) | 0.7 (0.5, 1.0) | 0.8 (0.5, 1.3) | 0.8 (0.5, 1.1) | 0.9 (0.7, 1.2) | 1.0 (0.3, 1.3) | .1061 |

*Note.* CI = confidence interval.
[a]Models adjusted for census tract population and tract area size. Reference = predominantly White census tracts.
[b]Interaction between race/ethnicity and site.

**TABLE 4—Ratios of Food Stores per 10 000 Population, by Tertile of Tract Median Income and Site[a]**

| Type of Store | Lowest-Income Tracts (≤$25 000), Ratio (95% CI) | Middle-Income Tracts ($25 001–$45 000), Ratio (95% CI) |
|---|---|---|
| Grocery stores | 4.3 (3.6, 5.2) | 2.8 (2.3, 3.3) |
| Supermarkets | 0.5 (0.3, 0.8) | 0.8 (0.6, 1.0) |
| Convenience stores | 2.4 (1.8, 3.2) | 1.6 (1.2, 2.1) |
| Meat and fish markets | 2.1 (1.5, 2.8) | 1.5 (1.1, 2.1) |
| Fruit and vegetable markets | 0.9 (0.6, 1.4) | 0.8 (0.5, 1.2) |
| Bakeries | 0.6 (0.5, 0.8) | 0.9 (0.7, 1.1) |
| Natural food stores | 0.3 (0.2, 0.5) | 0.5 (0.3, 0.8) |
| Specialty food stores | 0.2 (0.1, 0.4) | 0.5 (0.3, 0.8) |
| Liquor stores | 1.3 (1.0, 1.6) | 0.9 (0.7, 1.2) |

[a]Models adjusted for census tract population and tract area size. Referent = highest-income census tracts (median income = $45 001 to $175 000).

predominantly White neighborhoods (site-adjusted store per population ratios [SRs] and 95% confidence intervals [CIs]: SR=2.7; 95% CI=2.2, 3.2 for predominantly Black tracts, and SR=2.2; 95% CI=1.9, 2.7 for mixed tracts). In contrast, supermarkets were less common in predominantly minority and racially mixed neighborhoods (SR=0.5; 95% CI=0.3, 0.7 for predominantly Black tracts and SR=0.7; 95% CI=0.5, 1.0 for mixed tracts). In general, predominantly Black neighborhoods also had fewer fruit and vegetable markets (except in North Carolina), bakeries, specialty stores, and natural food stores than did predominantly White neighborhoods. In New York, convenience stores were significantly more common in predominantly minority and racially mixed neighborhoods, but no differences were observed for the other sites. Meat and fish markets were significantly more common in mixed neighborhoods in Maryland and Hispanic neighborhoods in New York. They were also more common in predominantly Black than in predominantly White neighborhoods in North Carolina, but confidence intervals on this estimate varied. Predominantly minority and racially mixed neighborhoods did not differ significantly from White neighborhoods in terms of liquor stores.

Low-income neighborhoods had 4 times as many grocery stores per population as the wealthiest neighborhoods (SR=4.3; 95% CI=3.6, 5.2) and half as many supermarkets (SR=0.5; 95% CI=0.3, 0.8) (Table 4). Fruit and vegetable markets, bakeries, natural food stores, and specialty stores were also less common in low-income neighborhoods, although confidence intervals for some estimates overlapped. In contrast, meat and fish markets were more common in low-income neighborhoods. Liquor stores were also more common in the poorest than in the wealthiest neighborhoods (SR=1.3; 95% CI=1.0, 1.6).

## DISCUSSION

Our results show that neighborhoods differ in the types of food stores that are available, and that the location of food stores is associated with neighborhood racial/ethnic and socioeconomic composition. Predominantly White and wealthier areas were found to have more supermarkets than were predominantly minority and poorer areas after we accounted for population and geographic size. In contrast, small grocery stores were more common in predominantly minority areas and in poorer areas. In general, poorer areas and non-White areas also tended to have fewer fruit and vegetable markets, bakeries, specialty stores, and natural food stores. Liquor stores were more common in poorer than in wealthier areas.

In a study of 4 areas (of which 1 was Forsyth County, NC, also included in these analyses), Morland et al.[4] also found that significantly more supermarkets were located in White than in Black neighborhoods and that smaller grocery stores were more common in Black neighborhoods. Sloane et al.[7] also reported that a higher proportion of convenience stores and small grocery stores were in predominantly minority communities than were in predominantly White neighborhoods. To the extent that supermarkets offer a broader choice of affordable healthy foods, these patterns could have consequences for the diets of residents.

By examining a range of different types of stores, we showed that the pattern is significantly more complex than simply fewer supermarkets and more small grocery stores in predominantly minority neighborhoods. Minority and poor neighborhoods also had proportionately fewer bakeries, natural food stores, and specialty stores. Predominantly Black neighborhoods had fewer fruit and vegetable markets in 2 of the 3 sites. In contrast, meat and fish markets were more common in minority neighborhoods in New York and North Carolina and in poor neighborhoods generally. Convenience stores were more common in minority neighborhoods in New York. In general, the food environment appears to be less diverse in poor and minority neighborhoods than in wealthier and predominantly White neighborhoods. Clearly, the food store environment differs across the 3 sites studied and also differs in complex ways across neighborhoods within sites. The types of stores present are clearly a limited measure of the availability of healthy foods, because even the same "type" of store may offer very different food choices in different types of neighborhoods. A recent study by Horowitz et al.[23] found that only 18% of bodegas, or small grocery stores, in a minority neighborhood carried a selection of healthy foods compared with 58% of those in a predominantly White area. Thus, more detailed assessment of actual food offered may show even greater differences in the local food environment than those suggested by differences in the simple counts of different types of stores.

The dietary consequences of neighborhood differences in food stores depends on many factors including the types of foods available at the stores and the extent to which residents rely on local stores for shopping. If small grocery stores do indeed offer fewer healthy foods than supermarkets

and other types of stores are not present (as suggested by our data), residents of poor and minority neighborhoods who depend on local stores as their main source of food may be nutritionally disadvantaged. However, it is important to emphasize that the relation between the type of store and the products offered is by no means fixed. It is perfectly possible that a multiplicity of varied small stores could offer the range of food products necessary for a healthy diet. There are also important trade-offs between large supermarkets (which often require large parking lots) and small stores in terms of automobile traffic and consequences for neighborhood walkability and street life (including social interactions between neighborhoods), all of which may have health consequences. In the US context, the presence of a supermarket may be an adequate marker for the availability of affordable healthy foods. However, it does not necessarily follow that improving the food environment of disadvantaged communities requires only increasing the number of large supermarkets.

The primary source of data for this study is a commercial database established for marketing purposes rather than data collected for research purposes. However, we are aware of no better source of data for our analyses, and primary data collection across the very broad areas that we studied was not feasible. Although there was some under-representation of stores (approximately 12% of stores were not listed) and it is plausible that participation rate differed across store characteristics (e.g., type of store and store size), it is unlikely that these patterns differed systematically across neighborhoods in ways that explain the patterns that we observed. In addition, our findings are consistent with those of researchers using other sources of data.[4,7] Moreover, the use of this commercial database allowed us to examine 3 large diverse areas and multiple types of food stores, key strengths of our analyses, and a clear addition to prior work.

We relied on SIC codes, a standard classification system, to classify businesses into store types. Although any store classification scheme has its limitations, the use of a standard system allows replication across studies. There is no doubt that some misclassification occurred; however, we have no reason to believe that misclassification differed systematically across neighborhoods in ways that could have generated the patterns that we observed. Unfortunately, neither SIC codes nor the more recent standard classification system, the North American Industry Classification System codes, distinguish supermarkets from other grocery stores. We based our classification criteria on prior work.[14,16] In sensitivity analyses, we compared our supermarket classification scheme to that used by Kaufman[24] and found that only 8% of businesses were classified differently. Thus, we believe our results are likely to be robust to different approaches to classifying supermarkets.

An obvious limitation of using lists of businesses in the analyses is that they do not capture informal food sources such as street vendors and roadside stands. These sources may be important in certain types of neighborhoods. We were also unable to capture qualitative differences in the foods offered by the same type of store in different contexts. For example, a convenience store in New York could offer a plethora of healthful options compared with a small grocery store in North Carolina. The use of standardized data sources on businesses across large areas necessarily implies a lack of detailed, qualitative information. For these reasons, large studies like ours need to be complemented with more detailed in-depth assessments of the local food environment in small areas.

The analyses we present here show important differences across neighborhoods in the types of food stores available but do not answer the question of what implications this has for diet. Providing answers to this question requires characterizing the foods available at different types of stores and relating food availability and food store type to the dietary patterns of individuals. Although 2 recent studies have shown that the presence or proximity of supermarkets in neighborhoods is associated with the probability of meeting dietary recommendations in certain populations,[5,10] there is still very limited data on this question. Studies that examine how changes in the local food environments are related to changes in diet using experimental or quasi-experimental designs are an important need if causal inferences are to be drawn.

Our results provide empirical support for the often-cited claim that food options differ across neighborhoods and that healthy food options may be reduced in poor and minority areas. The location of food stores depends on a complex set of factors including the marketing decisions of large corporations, the perception of the market by small businesses, consumer demand and purchasing power, competition, local regulations, and also local culture. Thus, changing the local food environment will require intersectorial approaches. Our data also show that the patterns are complex. For example, poor and minority neighborhoods tend to have larger numbers of small stores, which may have substantial secondary benefits over small numbers of very large stores in terms of street life, social interactions, and traffic. Moreover, not all poor or minority neighborhoods have unhealthy food environments; in fact some poor, ethnic neighborhoods may offer more healthy choices than wealthier areas. Identifying the processes that allow poor and minority neighborhoods to attract and retain healthy food choices may suggest important avenues for intervention.

The infrastructure of the local food environment is yet-another feature of the built environment that varies substantially across neighborhoods and may contribute to disparities and social inequalities in health. Accurate description of area differences in the local food environment is an important step. However, future research will need to move beyond descriptive studies to investigations of how best to effect change in the local food environment and studies of whether changes in the local food environment are associated with changes in residents' diets. Collaboration between community organizations, economic development planners, and public health researchers will be key in moving this agenda forward. ■

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## Contributors

Both authors contributed to the conceptualization of the study. L. V. Moore led the data analysis and writing of the article. A. V. Diez Roux reviewed and revised all drafts of the article.

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## Human Participant Protection

No protocol approval was needed for this study.

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