Neighborhood Characteristics and Availability of Healthy Foods in Baltimore

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Background: Differential access to healthy foods may contribute to racial and economic health disparities. The availability of healthy foods has rarely been directly measured in a systematic fashion. This study examines the associations among the availability of healthy foods and racial and income neighborhood composition.

Methods: A cross-sectional study was conducted in 2006 to determine differences in the availability of healthy foods across 159 contiguous neighborhoods (census tracts) in Baltimore City and Baltimore County and in the 226 food stores within them. A healthy food availability index (HFAI) was determined for each store, using a validated instrument ranging from 0 points to 27 points. Neighborhood healthy food availability was summarized by the mean HFAI for the stores within the neighborhood. Descriptive analyses and multilevel models were used to examine associations of store type and neighborhood characteristics with healthy food availability.

Results: Forty-three percent of predominantly black neighborhoods and 46% of lower-income neighborhoods were in the lowest tertile of healthy food availability versus 4% and 13%, respectively, in predominantly white and higher-income neighborhoods ($p<0.001$). Mean differences in HFAI comparing predominantly black neighborhoods to white ones, and lower-income neighborhoods to higher-income neighborhoods, were −7.6 and −8.1, respectively. Supermarkets in predominantly black and lower-income neighborhoods had lower HFAI scores than supermarkets in predominantly white and higher-income neighborhoods (mean differences −3.7 and −4.9, respectively). Regression analyses showed that both store type and neighborhood characteristics were independently associated with the HFAI score.

Conclusions: Predominantly black and lower-income neighborhoods have a lower availability of healthy foods than white and higher-income neighborhoods due to the differential placement of types of stores as well as differential offerings of healthy foods within similar stores. These differences may contribute to racial and economic health disparities.

(Am J Prev Med 2008;35(6):561–567) © 2008 American Journal of Preventive Medicine

Introduction

The contribution of unhealthy diets[1] to the obesity and diabetes epidemics in the U.S.[2] is well recognized. The 2005 Dietary Guidelines for Americans emphasized the large deficit in the intake of fresh fruits and vegetables, low-fat dairy products, and whole grain foods of the U.S. population,[3] and suggested that race and income are related to healthy food intake. However, the availability of these healthy foods and its relationship to race and economic status has received little research attention. Although racial and socioeconomic disparities in diet-related conditions such as diabetes and obesity have been consistently reported,[4,5] little research has investigated the role of the food environment in generating and perpetuating these disparities.

Given the strong residential segregation by race and income in the U.S., differences in local food environments associated with neighborhood composition could be important contributors to racial and income differences in diet. Prior research has documented the associations of neighborhood racial and socioeconomic characteristics with neighborhood food availability. For example, the type and number of food stores present have been shown to vary according to the racial and

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0749-3797/08/$–see front matter
doi:10.1016/j.amepre.2008.07.003

income composition of neighborhoods, with supermarkets generally more common in white and wealthier areas compared to minority and poorer neighborhoods.[6–8] A limitation of these studies is that they generally use the presence of different types of stores as crude proxies for healthy food availability. To date, very few studies have measured healthy food availability directly across different types of neighborhoods,[9–13] and most existing studies relied on very simple measures, often of a single food item, rather than a comprehensive assessment.[10–13]

To investigate associations of neighborhood racial and income composition with healthy food availability in selected areas of Baltimore City and Baltimore County, a recently validated comprehensive instrument, the nutrition environment measures survey in stores (NEMS-S), was used and adapted to the Baltimore environment.[9]

It was hypothesized that healthy foods would be less available in predominantly black and lower-income neighborhoods than in predominantly white and higher-income neighborhoods. A secondary hypothesis was that within a given type of store, stores located in predominantly black and lower-income neighborhoods would have poorer healthy food availability than similar stores located in predominantly white and higher-income neighborhoods.

Methods

As part of the multiethnic study of atherosclerosis (MESA) neighborhood study[14]—an ancillary study to the MESA study[15]—the local food environment of the neighborhoods of Baltimore MESA participants was characterized by measuring directly the availability of healthy foods. The area included in the study encompassed 159 contiguous census tracts, of which 112 were in Baltimore City and 47 were in Baltimore County. Following prior work, census tracts (administrative areas with a mean of 3500 residents of relatively homogeneous socioeconomic characteristics)[16] were used as proxies for neighborhoods.

Neighborhood racial and income composition was calculated, using data from the Year 2000 U.S. Census. Following prior work, census tracts in which >60% of the residents were either white or black were defined as predominantly white or predominantly black, respectively.[8] Tracts that did not fall into either of these categories were classified as racially mixed areas. Neighborhood income composition was categorized using tertiles of the census tract median household income distribution in the sample ($26,200 for the 33rd percentile and $38,500 for the 66th percentile).[17] Neighborhoods included in the study sample were heterogeneous in terms of racial and income composition.

Information on all food stores located in the study area census tracts was obtained from InfoUSA in 2004. Food stores were categorized following the Standard Industrial Classification (SIC) codes used in previous studies[7,8]: supermarkets (SIC codes 541101, 541104-541106), differentiated from grocery stores on the basis of chain-name recognition or an annual payroll of >50 employees; grocery stores (all remaining stores in SIC codes 541101, 541104-541106); and convenience stores (SIC codes 541102, 541103). Many of the grocery stores in Baltimore City were corner stores with very limited food offerings.[18,19] Convenience stores are generally 7-Eleven–type stores or food marts attached to gas stations. Three public markets located in the area were included in the study sample. Specialty stores such as bakeries and chocolate or candy stores were excluded. A total of 365 stores in the InfoUSA list fulfilled the inclusion criteria in the neighborhoods of interest.

Improvements were made to the original list by (1) comparing the list to Baltimore-area 2006 phone books, (2) comparing the list to Baltimore City Health Department 2006 food license records, and (3) having data collectors drive through the main thoroughfares of all the study neighborhoods to identify any omitted stores. A total of ten new stores were added to the list: eight were recently opened supermarkets (all of them situated in Baltimore County); two were new grocery stores in the city (corner stores). Of the 375 stores in the improved list, 86 (23%) had closed for business permanently at the time of data collection, and 42 (11%) were commercial businesses other than food stores (food places, food warehouses, and liquor stores). In addition, 21 food store managers (9%) refused to be part of the study, leaving 226 stores for assessment. All the refusals were corner stores located in predominantly black and lower-income city neighborhoods. There were 21 food stores (9% of the total number of stores) in which food items were displayed behind bulletproof glass and sold through a revolving window. These stores were all originally coded as grocery stores, and none was a gas station. Because the bulletproof glass limits the ability of consumers to examine food items and read expiration dates and nutrition labels, a special category, behind-glass stores, was created for these stores.

Developed as part of the nutrition environment measures survey, the NEMS-S was used to measure food availability in each store.[20] The instrument's reliability was previously tested in 85 stores located in Atlanta. Both inter-rater reliability and test–retest reliability (over a mean of 9 days) for food items were high (κ statistics $\geq$0.83 and $\geq$0.73, respectively, for all food items examined).[9] In the spring of 2006, trained research assistants visited the 226 Baltimore stores to assess the availability of eight food groups: nonfat/low-fat milk, fruits, vegetables, low-fat meat, frozen foods, low-sodium foods, 100% whole wheat bread, and low-sugar cereals. Items in the instrument were standardized by brand, type, and size.

A healthy food availability score (i.e., the healthy food availability index, or HFAI) was calculated for each store, following procedures developed as part of the NEMS-S.[9] Minor modifications were made to the NEMS-S to adapt it to local conditions. Local brands were used. Hot dogs, snacks, and baked goods were excluded, because pilot testing revealed local challenges in assessing these products in Baltimore. Low-sodium items were added because of their potential health relevance. Like the original NEMS-S availability score,[9] the HFAI ranges from 0 to 27 points, with a higher score indicating a greater availability of healthy foods. Points were assigned as in Table 1.

Of the 159 census tracts in the study area, 53 had no food stores. These included 17 suburban census tracts in Baltimore County, 17 small city tracts, nine tracts dedicated to parks, and ten tracts that were industrial areas. For neighborhoods

Table 1. Scoring system for healthy food availability, adapted to Baltimore from the Nutrition Environment Measures Survey in Stores[9]

Food groups	Availability scores
Nonfat/low-fat milk	1 pt. if available; 1 pt. if >33% shelf space; 2 pts. if >50% shelf space
Fresh fruits and vegetables	0 pts. if not available; 1–4 pts. based on increasing number of varieties available (frozen or canned fruits and vegetables are not included)
Ground beef	90% lean: 1 pt. if available; 1 pt. if two or more varieties
Chicken	boneless, skinless breast: 1 pt. if available; 1 pt. if two or more varieties
Frozen foods	1 pt. if low-fat TV dinners; 1 pt. if >33% shelf space; 1 pt. if ratio of vegetables/ice cream shelf space >15%
Low-sodium	1 pt. if low-sodium tuna; 1 pt. if low-sodium canned soups
100% whole wheat bread	2 pts. if available; 2 pts. if two or more varieties
Low-sugar cereals	<7 g/serving: 1 pt. if available; 1 pt. if two or more varieties

g, grams; pt., point; pts., points

with at least one food store (n=106), the neighborhood HFAI was calculated as the mean of the HFAI scores of all stores within the neighborhood. Neighborhood healthy food availability was categorized into tertiles based on the observed distribution in the sample. The analyses reported here are based on 226 food stores located in 106 census tracts.

Statistical Analysis

The primary goal of the analysis was to assess the associations among neighborhood racial and income compositions and healthy food availability. The distribution of neighborhood healthy food availability (as assessed by the mean HFAI for all stores within the neighborhood) and of types of stores (in broad categories) was compared across categories of neighborhood racial and income distribution using chi-square tests. Mean HFAI scores for different types of food stores and for food stores of a similar type located in different neighborhoods were compared, using t-tests or ANOVA. In a second set of analyses, multilevel models with stores as the Level-1 units, neighborhoods as the Level-2 units, and a random intercept for each neighborhood were used to assess associations of store type and neighborhood characteristics with store HFAI before and after adjustment for each other. Intraclass correlation coefficients (ICC), which quantify the correlation among HFAI within neighborhoods, were calculated, using variance estimates from the multilevel models. Analyses were conducted in 2007.

Results

Table 2 shows the distribution of healthy food availability tertiles by neighborhood racial and income composition. A low availability of healthy foods (defined as being in the lowest tertile of food availability scores) was present in 43% of predominantly black neighborhoods and in only 4% of predominantly white neighborhoods (p<0.001). A high availability of healthy foods (defined as being in the highest tertile of healthy food availability) was present in 19% of predominantly black neighborhoods versus 68% of predominantly white neighborhoods (p<0.001). Differences by income composition in neighborhood healthy food availability were also substantial, with higher-income neighborhoods showing greater availability than lower-income neighborhoods. Large differences were also observed between city and county

Table 2. Healthy food availability and type of stores by neighborhood racial and income composition in Baltimore neighborhoods

		Neighborhood healthy food availability tertile			Types of food stores				
	# neighborhoods with stores	% low	% medium	% high	# food stores	% supermarkets	% convenience stores	% grocery stores	% behind-glass stores
Total	106	32	33	34	226	18	24	49	9
Neighborhood race composition									
Black[a]	67	43**	38*	19**	139	11	16	58	15
Mixed	14	14	36	50	31	26	32	42	0
White	25	4	28	68	56	33	37	30	0
Neighborhood income									
Lower[b]	39	46**	31*	23**	85	11	16	55	18
Medium	36	25	47	28	86	10	19	64	7
Higher	31	13	26	61	55	42	44	14	0
Administrative boundaries									
City	78	39**	39*	22**	177	9	19	60	12
County	28	7	21	72	49	51	43	6	0

[a]Neighborhoods classified as predominantly white or black when >60% of residents were of that group
[b]Income tertiles based on census tract household median income
*p>0.05, compared to predominantly white and higher-income neighborhoods; **p<0.001, compared to predominantly white and high-income neighborhoods

neighborhoods, with county neighborhoods showing better healthy food availability than city neighborhoods.

Table 2 also shows differences in the types of food stores present by neighborhood racial and income composition. In predominantly black neighborhoods, the large majority of food stores (58%) were grocery stores, and there were more behind-glass stores (15%) than supermarkets (11%). In white neighborhoods, no behind-glass stores were present, and supermarkets, grocery stores, and convenience stores were approximately equally distributed (for differences in the types of stores by racial composition, $p<0.001$). Differences in the types of stores by neighborhood income composition were similar to those observed by racial composition: 42% of the stores in higher-income neighborhoods were supermarkets, compared to only 11% in lower-income neighborhoods ($p<0.001$).

Table 3 shows mean HFAIs by neighborhood characteristics and store type. The mean HFAI in predominantly black neighborhoods was 5.48, compared to 13.04 in predominantly white neighborhoods, a mean difference of 7.6 HFAI points (for differences in means across neighborhood race composition, $p<0.001$). Mean neighborhood HFAI increased in a graded manner, with increasing neighborhood income (p-trend<0.0001), with a mean difference between neighborhoods of lower and higher income of 8.1 HFAI points. The distribution of stores and their HFAIs by neighborhood racial composition is shown in Figure 1.

Overall, mean HFAI was highest in supermarkets and lowest in behind-glass stores, with grocery stores and convenience stores having similar low values (Table 3). Supermarkets in predominantly black and lower-income neighborhoods had lower HFAI scores than those located in predominantly white and higher-income neighborhoods (mean differences 3.7 for white versus black neighborhoods, and 4.9 for lower- versus higher-income neighborhoods, $p<0.05$). Grocery stores in predominantly white neighborhoods also had higher mean HFAIs than those located in predominantly black neighborhoods.

Table 4 shows mean differences in store HFAIs by store type and neighborhood characteristics of the store location, before and after adjusting for each other. Stores located in predominantly black neighborhoods and stores located in lower-income neighborhoods had significantly lower HFAIs than those located in predominantly white or higher-income neighborhoods, respectively (Table 4, Models 1 and 2). Convenience stores, grocery stores, and behind-glass stores have substantially lower mean HFAI scores than supermarkets (Table 4, Model 3). Associations of neighborhood characteristics with store HFAIs were reduced but persisted after adjustment for store type (Table 4, Models 4 and 5). Associations of neighborhood income with HFAIs were reduced and became nonsignificant when racial composition was also in the model, but both variables were strongly associated, making it difficult to estimate their independent effects (Table 4, Model 6). Interactions between neighborhood racial composition and income were not significant. HFAI scores for stores located within the same tract were correlated (ICC for model without covariates=0.41). This correlation was somewhat reduced after adjusting for neighborhood characteristics (ICCs=0.35 and 0.31, respectively, for models adjusted for neighborhood racial and income composition), and was sharply reduced after adjusting for store type (ICC=0.11). However, some correlation persisted even after accounting for store type and neighborhood characteristics (ICC for Model 6=0.10).

Discussion

In this sample of Baltimore City and County neighborhoods, there were important differences in healthy food availability by neighborhood racial and income composition. Predominantly black and lower-income neighborhoods had significantly lower availability of healthy foods, often lacking recommended foods such as fresh fruits and vegetables, skim milk, and whole wheat bread, than pre-

Table 3. Mean healthy food availability index (HFAI) by neighborhood characteristics and store type

	Neighborhood HFAI[a] M (SD)	Store HFAI (SD) (*n*)			
		Super-markets (41)	Grocery stores (110)	Behind-glass stores (21)	Convenience stores (54)
Neighborhood racial composition					
Black	5.48 (5.56)	20.34 (3.09) (15)	3.85 (2.89) (81)	1.76 (0.62) (21)	3.78 (1.81) (22)
Mixed	10.98 (8.08)	21.25 (5.34) (8)	5.54 (6.06) (13)	—	5.10 (2.47) (10)
White	13.04 (8.10)	24.00 (3.07) (18)	6.17 (4.93) (16)	—	5.05 (3.31) (22)
p-value across all categories	<0.001	0.02	0.04	—	0.21
Neighborhood income					
Lower	5.20 (4.37)	18.67 (3.87) (9)	4.36 (3.80) (47)	1.76 (0.62) (21)	3.50 (2.10) (14)
Medium	6.44 (6.20)	22.0 (3.00) (9)	4.49 (3.83) (55)	—	4.31 (2.75) (16)
Higher	13.30 (8.78)	23.52 (3.48) (23)	4.13 (4.26) (8)	—	5.25 (2.70) (24)
p-trend	<0.0001	<0.001	0.998	—	0.04

[a]Corresponds to the mean of all the stores within the neighborhood (census tract)

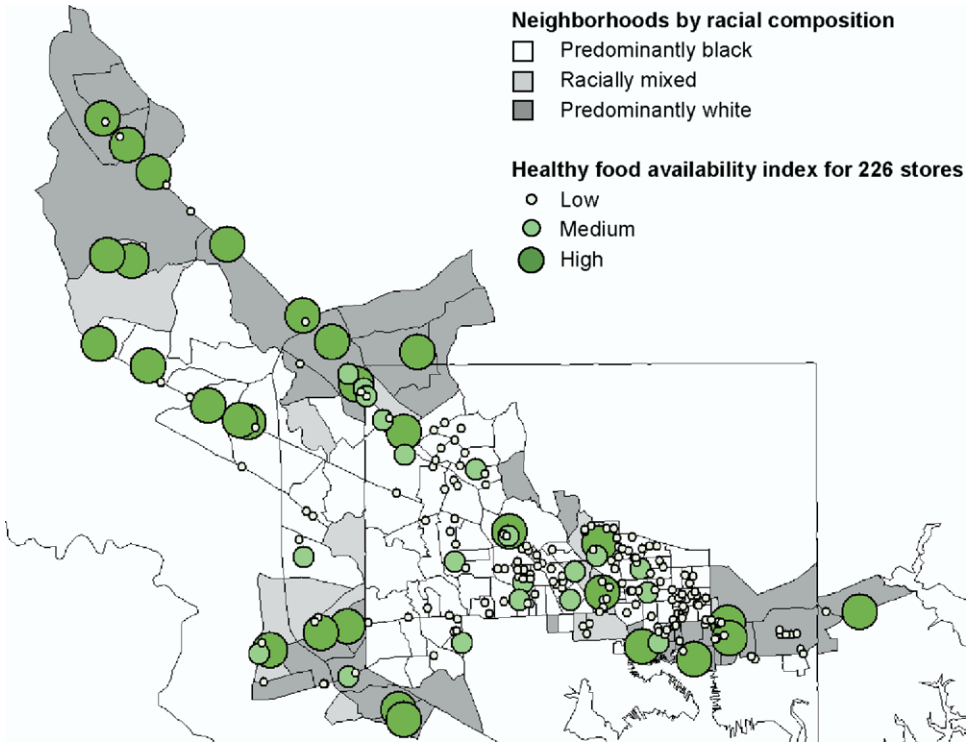

Figure 1. Racial composition of study neighborhoods and healthy food availability index of the 226 food stores in the study

dominantly white and higher-income neighborhoods. These differences were attributable, in large part, to fewer supermarkets in the predominantly black and lower-income neighborhoods, but there were also differences in food availability within similar types of stores located in different neighborhoods. Moreover, regression analyses also showed that both store type and location were independently associated with healthy food availability after adjustment for each other.

Few studies have examined the differences in measured food availability by neighborhood characteristics. The results of these analyses are consistent with those reported in a comparison of two distinct neighborhoods in New York City[11] and four neighborhoods in Atlanta.[9] As in this prior work, this study found that supermarkets were significantly more common in white and higher-income areas than in predominantly black and lower-income neighborhoods.[6–8] By systematically measuring the actual food availability in stores using a previously validated comprehensive instrument, this study also demonstrated that this differential placement of supermarkets has direct consequences for the availability of healthy foods. Results also show that there was variation in the availability of healthy foods within similar types of stores, depending on their location. For example, supermarkets in different types of neighborhoods did not have the same healthy food availability. In fact, several stores coded as grocery stores in predominantly white neighborhoods had a higher availability of healthy foods than did supermarkets in predominantly black neighborhoods. This study also found that many

Table 4. Adjusted mean differences in food store healthy food availability by store and neighborhood characteristics

	Model 1: NH race	Model 2: NH income	Model 3: store type	Model 4: store type + NH inc.	Model 5: store type + NH race	Model 6: store type + NH race + NH inc.
Type of store						
Supermarket	ref	ref	ref	ref	ref	ref
Convenience store			−17.48 (0.70)*	−17.31 (0.69)*	−17.32 (0.68)*	−17.23 (0.68)*
Grocery store			−17.50 (0.63)*	−16.78 (0.68)*	−16.76 (0.64)*	−16.40 (0.68)*
Behind-glass store			−20.15 (0.93)*	−19.18 (0.98)*	−18.93 (0.95)*	−18.50 (0.98)*
NH income tertiles						
Higher	ref	ref	ref	ref	ref	ref
Medium		−6.60 (1.50)		−1.29 (0.70)		−0.85 (0.69)
Lower		−7.66 (1.49)		−2.00 (0.71)**		−1.20 (0.72)
NH race categories						
Pred. white	ref	ref	ref	ref	ref	ref
Mixed	−1.85 (2.05)				−1.15 (0.80)	−1.01 (0.81)
Pred. black	−6.89 (1.44)				−2.52 (0.61)*	−2.20 (0.64)*
ICC	**0.35**	**0.31**	**0.11**	**0.12**	**0.10**	**0.10**

*$p<0.0001$; **$p=0.005$

ICC, intraclass correlation coefficient for store healthy food availability index within tracts; inc., income; NH, neighborhood; pred., predominantly

grocery stores in predominantly black and lower-income neighborhoods were behind-glass stores that provide limited opportunities for consumers to assess food offerings. In predominantly black neighborhoods, such stores accounted for 15% of the food stores, whereas supermarkets accounted for only 11%.

An important strength of this study is the systematic and detailed assessment of food availability and the diversity and number of food stores and neighborhoods that were studied. However, the study has also several limitations. First, the census tract was used as a proxy for the geographic area (or neighborhood) potentially relevant for food shopping. Unfortunately there is little empirical information on which to base the definition of the spatial units relevant to food shopping.[21–23] However, given the objective of the analyses—simply to describe patterns of food availability associated with area characteristics—the use of census tracts is informative, even if it mis-specifies the geographic area relevant for food shopping. A second limitation is the reliance on commercial lists to identify food stores. Every effort was made to validate and amend the commercial list. However, errors in the InfoUSA database could have led to the omission of stores or the misclassification of store types. Despite these inevitable inaccuracies, patterns were found to be consistent with prior work, and it is unlikely that store-assessment errors led to substantial bias in the general patterns reported. In addition, the refusal rate was only 9%, lower than in a similar study conducted in the United Kingdom.[24] However, given the important limitations of commercial databases, future work in this area needs to develop better approaches to characterizing food resources in areas.

The relationship between neighborhood food availability and the dietary preferences of its residents is likely to be bidirectional. Nevertheless, it is likely that changing dietary practices will be much more difficult in the absence of supportive environments. Primary and secondary prevention of conditions such as obesity and diabetes may be impaired by the lack of recommended foods in minority and lower-income neighborhoods. Food environment is affected by many different factors, including the price of food, food distribution channels, the perceptions and knowledge of store managers, and policies affecting the location of various types of stores. Changing the food environment will require input from governmental, academic, and community groups. Because minority and lower-income neighborhoods actually do have a large number of grocery stores—most of them lacking healthy foods—increasing the availability of healthy foods at these stores could be a useful strategy. Other relevant policies may involve both encouraging supermarkets in minority and lower-income areas to expand their offerings of healthy foods and attracting stores that offer healthy foods to neighborhoods without stores. Future work is necessary to evaluate the dietary consequences of these policies and interventions.

The differences in healthy food availability shown in this study may be contributing to racial and economic disease disparities. The joint efforts of public health researchers in collaboration with community groups and policymakers will be required to effectively change the current picture of the less-than-optimal availability of recommended healthy foods.

The authors would like to thank the NEMS study group at Emory University; Baltimore data collectors: Amanda Rosecrans, Brooke Mickle, Gila Neta, and Krissett Loya; participant, food store managers in Baltimore; Bonnie Wittstadt and Richard Zhu; and the Center for a Livable Future at The Johns Hopkins Bloomberg School of Public Health for the funding. This work was supported in part by R01 HL071759 (Diez Roux, Principal Investigator).

No financial disclosures were reported by the authors of this paper.

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