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Original Contribution

Fast-Food Consumption, Diet Quality, and Neighborhood Exposure to Fast Food

The Multi-Ethnic Study of Atherosclerosis

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The authors examined associations among fast-food consumption, diet, and neighborhood fast-food exposure by using 2000–2002 Multi-Ethnic Study of Atherosclerosis data. US participants ($n = 5{,}633$; aged 45–84 years) reported usual fast-food consumption (never, <1 time/week, or ≥1 times/week) and consumption near home (yes/no). Healthy diet was defined as scoring in the top quintile of the Alternate Healthy Eating Index or bottom quintile of a Western-type dietary pattern. Neighborhood fast-food exposure was measured by densities of fast-food outlets, participant report, and informant report. Separate logistic regression models were used to examine associations of fast-food consumption and diet; fast-food exposure and consumption near home; and fast-food exposure and diet adjusted for site, age, sex, race/ethnicity, education, and income. Those never eating fast food had a 2–3-times higher odds of having a healthy diet versus those eating fast food ≥1 times/week, depending on the dietary measure. For every standard deviation increase in fast-food exposure, the odds of consuming fast food near home increased 11%–61% and the odds of a healthy diet decreased 3%–17%, depending on the model. Results show that fast-food consumption and neighborhood fast-food exposure are associated with poorer diet. Interventions that reduce exposure to fast food and/or promote individual behavior change may be helpful.

diet; food; residence characteristics

Abbreviations: AHEI, Alternate Healthy Eating Index; aOR, adjusted odds ratio; CI, confidence interval; FPM, fats and processed meats dietary pattern; MESA, Multi-Ethnic Study of Atherosclerosis.

Money spent on food away from home (1) and energy consumed away from home (2) have increased steadily in the United States. In 2007, 37.4% of food eaten away from home was purchased from limited-service restaurants such as fast-food outlets (3). Fast-food consumption has been linked to weight gain, poorer dietary indicators, insulin resistance, and obesity in adults in cross-sectional (4–8) and longitudinal (5, 9–11) studies, with exceptions (12–14). The larger portion sizes, higher energy densities, high fat content, and low prices (2, 4, 11, 15–20) of fast foods are hypothesized to be causally related to rising obesity rates (21, 22). Given the high prevalence of obesity in the United States (23–25), this shift in eating patterns is a growing public health concern.

As evidence of the potential adverse effects of consuming fast food has increased, public health researchers have focused on identifying factors that may encourage consumption. Recent studies have indicated that fast-food places tend to be concentrated around lower-income areas and predominantly minority neighborhoods (26–34), although not consistently (33, 35–37). A lack of healthier options (38, 39), along with the palatability and convenience of fast food, may contribute to health disparities in obesity and related chronic conditions. Although exposure to fast-food places has been hypothesized to encourage consumption (26–30, 40) and contribute to poorer diet quality, empirical verification of these links remains rare (14, 36, 41, 42).

Using data from the Multi-Ethnic Study of Atherosclerosis (MESA), we examined links between fast-food consumption and diet, neighborhood exposure to fast foods and consumption of fast food near home, and neighborhood

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fast-food exposure and diet. Neighborhood exposure was assessed by 3 complementary methods: self-reported and informant-reported opportunities to purchase fast food within 1 mile (1.6 km) of home, and geographic information systems–derived densities of fast-food outlets within a mile of participants' homes. Diet quality was characterized by the Alternate Healthy Eating Index (AHEI) (43, 44) and an empirically derived Western-type dietary pattern (45).

MATERIALS AND METHODS

MESA was initiated in July 2000 to investigate subclinical cardiovascular disease in a population-based sample of 6,814 men and women aged 45–84 years (mean age, 63 years) (46). The cohort was selected from 6 study sites: Baltimore City and County, Maryland; Chicago, Illinois; Forsyth County, North Carolina; New York, New York; Los Angeles County, California; and St. Paul, Minnesota. Sampling and recruitment have been previously described (46). Among those screened and deemed eligible, the participation rate was 59.8%. Analyses were restricted to the 6,191 MESA subjects who agreed to participate in the MESA Neighborhood Study, an ancillary study that collected information on neighborhood characteristics, including reported opportunities to purchase fast food. A total of 558 persons were excluded because of missing data, leaving 5,633 participants for analyses. Analyses using geographic information systems measures were restricted to participants in Maryland, North Carolina, and New York, where locational data on fast-food outlets were collected (n = 2,447). The study was approved by institutional review boards at each site, and all participants gave written, informed consent. Analyses presented in this paper are based on self-administered survey data obtained from the baseline visit (July 2000–September 2002).

Dietary intake was assessed by a self-administered, modified-Block-style, 120-item food frequency questionnaire adapted from the Insulin Resistance Atherosclerosis Study instrument (45, 46). Dietary quality was characterized by 2 global dietary measures derived from the food frequency questionnaire, the AHEI (43, 44), and an empirically derived dietary pattern (45).

AHEI is a summary index of dietary indicators that have been associated with a lower chronic disease risk (43, 44). AHEI was derived following prior work (43), except where noted. Higher scores indicate higher intake of fruits and vegetables, nuts and soy protein, white versus red meat, cereal fiber, and polyunsaturated versus saturated fat. Higher scores also reflect moderate alcohol consumption, multivitamin use, and lower intake of *trans* fatty acids. Previous studies used fiber from all grain sources and long-term (5-year) multivitamin use (43), data that were not available in MESA. Cereal fiber and vitamin use at least once per month were substituted for these items in this study. Participants whose AHEI scores ranked in the top quintile of the distribution for the sample (range, 53–81) were classified as having a high-quality diet or a healthy diet. In other cohorts, scoring in the top quintile of the population distribution (i.e., AHEI scores of 47–86) versus in the bottom quintile was associated with a 28%–39% reduced risk of cardiovascular disease (43, 44).

A Western-type dietary pattern, the "fats and processed meats" dietary pattern (FPM), was also used to measure diet quality. Nettleton et al. (45) developed the FPM by using a principal components analysis of MESA food frequency data. Higher scores indicate higher intake of fats and oils, high-fat and processed meats, fried potatoes, salty snacks, and desserts. Participants scoring in the bottom FPM quintile were classified as having a healthy diet. Persons with lower values for the FPM pattern had lower mean levels of biochemical markers related to early atherosclerosis in this cohort (45).

Two MESA survey questions assessed fast-food consumption. To assess overall fast-food consumption, participants were asked to indicate "in an average week how often do you eat [eat in or take out] a meal from a fast-food place such as McDonald's, KFC, Taco Bell, or take out pizza places?" Five response options were provided: never, less than once per week, 1–2 times a week, 3–4 times a week, or 5 or more times a week. Because small numbers of participants consumed fast food more than 3 times a week, the top 3 response categories were collapsed into the single category, more than once a week.

To assess average fast-food consumption near home, participants who reported consuming fast food were also asked how frequently they "eat a meal from a fast-food place which was located within 1 mile (or 20-minute walk) from their home." Response options were identical to those above. Participants who reported never eating fast food (i.e., from the first survey question) or never consuming fast food within 1 mile from home (i.e., from the second survey question) were classified as "never eating fast food within 1 mile of home." All other responses were coded as "eating fast food within 1 mile of home."

The following 3 measures of neighborhood exposure to fast food were investigated: self-report, informant report, and geographic information systems–derived densities of fast-food outlets. To estimate self-reported neighborhood exposure to fast food, each MESA participant was asked to consider his or her neighborhood as the area within a 20-minute walk or 1 mile around the home and indicate the extent to which they agreed (1 = strongly agree to 5 = strongly disagree) with the statement, "There are many opportunities to purchase fast food in my neighborhood." Responses were reverse recoded so that a higher score indicated greater neighborhood exposure to fast food.

Informant-based measures of neighborhood exposure to fast food were created by aggregating survey responses of neighboring MESA participants. For each participant, we averaged the responses of all neighboring participants, referred to as informants, within 1 euclidean mile of their home. The median number of informants was 47 (25th and 75th percentiles, 16 and 147). By pooling the responses of multiple informants within a given geographic area, this approach may reduce noise resulting from individual subjectivities and improve the validity of the measure. Informant report measures may also avoid same-source bias that may arise if, for example, respondents who eat more fast food are more likely to report fast food near their home.

For each participant, we estimated the density of fast-food restaurants within a 1-mile window of the residence for the 3 study sites for which data on location of fast-food outlets were available (Maryland, North Carolina, and New York). The density of fast-food restaurants available per square mile was calculated by using the Spatial Analyst extension of ArcGIS v.9.2 software (ESRI, Inc., Redlands, California). Information on restaurants was purchased in November 2003 from InfoUSA Inc. (Omaha, Nebraska). Restaurants were identified on the basis of 33 nationally recognized chain names (47). Densities were calculated by using kernel estimation so that restaurants located closer to the residence are given more weight than those located further away, with the weight approaching 0 at the boundary of the window (48, 49). The weights follow a bivariate normal (Gaussian) distribution (48, 49).

Three sets of statistical analyses using logistic regression were conducted to examine associations among neighborhood exposure to fast food, fast-food consumption, and diet quality. All models were adjusted for study site, participant age (years), sex, race/ethnicity (Hispanic, non-Hispanic white, Chinese, non-Hispanic black), education (less than high school, high school graduate, some college, college graduate, graduate degree), and annual per capita household income (not reported, \$0–\$9,999, \$10,000–\$19,999, \$20,000–\$29,999, ≥\$30,000). Categories for annual per capita household income were calculated by dividing interval midpoints of 13 household income categories (in US dollars) by the reported number of persons within the household. Participants who did not report income (n = 190) were included in models as a separate category. Heterogeneity of associations by study site was also examined by using interaction terms and stratified analyses, where appropriate.

In the first set of analyses relating diet to fast-food consumption, the odds of having a healthy diet (top quintile of AHEI or bottom quintile of FPM, in separate models) was modeled by the number of times fast food was consumed in an average week (never, <1, ≥1). The second set of analyses explored whether being exposed to more fast foods in neighborhoods was associated with consuming fast food near home. In this analysis, the odds of consuming fast food near home (1 = ate fast food near home, 0 = never ate fast food near home) was modeled as a function of neighborhood exposure to fast food. The third set of analyses examined the relation between neighborhood exposure to fast food and the odds of having a healthy diet (top quintile of AHEI or bottom quintile of FPM (separate models for each)). Neighborhood exposure to fast food was modeled in standard deviation units and was assessed by self-reports, informant reports, and densities of fast-food outlets in separate models.

RESULTS

Thirty-seven percent of respondents reported that they never eat fast food in an average week (Table 1). Almost half of participants older than 65 years of age and 41% of women reported never consuming fast food compared with 30% of younger participants and 33% of men. Only 14% of Chinese participants reported eating fast food more than once per week versus 30%–35% for other racial/ethnic groups. No clear dose-response relation by income or education was observed.

Among those who reported eating fast food (n = 3,556), 62% indicated that, in an average week, they consumed fast food within 1 mile of their home. White, higher income, and more highly educated participants were less likely to consume fast food near their home than other groups were.

Respondents older than 65 years of age, women, and Chinese participants were more likely than younger participants, men, and other racial/ethnic groups to report a healthy diet. When diet was characterized by AHEI, white participants and those with higher incomes and education reported better diets than blacks, Hispanics, and persons with lower incomes and education. This pattern was reversed for the FPM dietary measure.

Neighborhood exposure to fast food was patterned by race/ethnicity, education, and income. According to all 3 measures ($P \leq 0.0001$), white participants were less exposed than other participants to fast food in their neighborhood. Participants in the lowest educational attainment and income categories were more exposed to fast food than participants in the highest categories.

More frequent consumption of fast food was associated with poorer diet after we adjusted for participant age, education, per capita household income, race/ethnicity, sex, and study site (Table 2). Compared with participants who reported that they consumed fast food more than once per week, those who never ate fast food had an approximately 2- to 3-fold greater odds of a healthy diet, depending on the dietary measure used (adjusted odds ratio (aOR) = 1.63, 95% confidence interval (CI): 1.36, 1.95 for AHEI and aOR = 3.49, 95% CI: 2.82, 4.31 for FPM). Participants who consumed fast food less than once per week also had higher odds of having a healthy diet than those who consumed fast food once or more per week (aOR = 1.18 for AHEI and aOR = 1.56 for FPM). Associations did not vary significantly across sites (P for heterogeneity by site = 0.1647 for AHEI and P for heterogeneity by site = 0.1091 for FPM).

Table 3 shows the adjusted odds of consuming fast food within a mile of the home for every standard deviation increase in neighborhood exposure to fast food. Participants who lived in areas with higher self-reported and informant-reported exposure to fast food near their homes had 27% and 61% higher odds, respectively, of consuming fast food near their home than those who lived in areas with lower reported exposure (aOR = 1.61, 95% CI: 1.51, 1.72 for self-reports and aOR = 1.27, 95% CI: 1.17, 1.39 for informant reports). Associations varied by study site but were consistent in direction (aOR range, 1.22 for New York to 1.86 for North Carolina; P for heterogeneity by site = 0.0177; data not shown). In North Carolina, but not other sites, a standard deviation increase in the density of fast-food outlets was associated with a 56% higher odds of consuming fast food (aOR = 1.56, 95% CI: 1.17, 2.07; data not shown; P for heterogeneity by site = 0.0143).

Depending on the neighborhood measure investigated, the odds of having a healthy diet decreased by 12%–17% for every standard deviation increase in neighborhood exposure to fast food when diet was measured by FPM (aOR =

Table 1. Participants Consuming Fast Food, Participants With a Healthy Diet, and Neighborhood Exposure to Fast Food, by Selected Personal Characteristics, Multi-Ethnic Study of Atherosclerosis, 2000–2002

	No. of Participants	% Consuming Fast Food			% Consuming Fast Food Near Home (n = 2,201)[a]	% With a Healthy Diet[b]		Mean (SD) Neighborhood Exposure to Fast Food		
		Never (n = 2,077)	<1 Time/Week (n = 1,885)	≥1 Times/Week (n = 1,671)		AHEI (n = 1,156)	FPM (n = 1,114)	Self-reports (n = 5,633)	Informant Reports (n = 5,502)[c]	No. of Fast-food Outlets/Square Mile (1.6 km^2) (n = 2,447)[d]
Overall	5,633	36.9	33.5	29.7	61.9	20.5	19.8	3.5 (1.1)	3.5 (0.6)	2.0 (2.2)
Age, years										
<65	3,210	30.4	33.3	36.3	60.9	19.3	16.8	3.5 (1.2)	3.5 (0.6)	2.0 (2.3)
≥65	2,423	45.5	33.7	20.8	63.7	22.1	23.8	3.5 (1.1)	3.5 (0.6)	1.9 (2.2)
P value[e]				<0.0001	0.0950	0.0119	<0.0001	0.8654	0.0097	0.2308
Gender										
Female	2,963	40.6	34.8	24.6	62.6	22.3	24.3	3.5 (1.1)	3.5 (0.6)	2.0 (2.3)
Male	2,670	32.8	32.0	35.2	61.2	18.5	14.8	3.4 (1.1)	3.5 (0.6)	1.9 (2.2)
P value				<0.0001	0.3685	0.0005	<0.0001	0.0004	0.0820	0.1002
Race/ethnicity										
Non-Hispanic black	1,443	30.7	34.4	34.9	67.5	19.8	10.9	3.6 (1.1)	3.5 (0.6)	1.8 (2.2)
Chinese	710	39.9	46.1	14.1	71.7	24.8	47.6	3.4 (1.0)	3.5 (0.4)	—[f]
Hispanic	1,203	43.2	23.9	32.8	67.9	14.9	30.3	3.8 (0.9)	3.7 (0.5)	4.3 (2.0)
Non-Hispanic white	2,277	36.5	34.0	29.5	52.3	22.6	11.2	3.2 (1.3)	3.3 (0.7)	1.4 (1.9)
P value				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Education										
Less than high school	942	48.8	26.4	24.7	69.7	15.4	36.5	3.6 (0.9)	3.6 (0.5)	2.8 (2.3)
High school graduate	1,009	33.9	34.8	31.3	62.7	13.5	16.7	3.5 (1.1)	3.4 (0.6)	1.8 (2.2)
Some college	1,572	31.0	35.5	33.5	60.6	19.1	14.8	3.4 (1.2)	3.5 (0.6)	1.9 (2.2)
College graduate	1,035	34.2	36.9	28.9	58.9	25.5	18.1	3.4 (1.3)	3.4 (0.6)	1.6 (2.2)
Graduate degree	1,075	40.4	32.1	27.5	60.5	28.8	16.9	3.5 (1.2)	3.5 (0.6)	1.9 (2.3)
P value				<0.0001	0.0024	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Per capita income[g]										
$0–$9,999	1,256	46.1	30.2	23.7	69.4	17.2	32.8	3.6 (0.9)	3.6 (0.5)	3.1 (2.4)
$10,000–$19,999	1,229	28.8	37.3	33.8	65.8	17.1	19.4	3.5 (1.1)	3.5 (0.6)	2.0 (2.1)
$20,000–$29,999	934	30.6	36.2	33.2	60.2	20.1	14.8	3.4 (1.2)	3.4 (0.6)	1.8 (2.3)
≥$30,000	2,024	38.5	32.3	29.2	56.7	25.4	14.3	3.4 (1.3)	3.5 (0.7)	1.7 (2.1)
P value				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Abbreviations: AHEI, Alternate Healthy Eating Index; FPM, fats and processed meats dietary pattern; SD, standard deviation.

[a] Among those consuming fast food (consume fast food >never, $n = 3,556$), % consuming fast food within 1 mile (1.6 km) from home.

[b] Healthy diet was defined as the top quintile of the AHEI or the bottom quintile of the FPM.

[c] 131 participants did not have any informants within 1 mile of their residence.

[d] Analyses involving densities were restricted to 3 of the 6 study sites (Maryland, North Carolina, New York) for which location data were available.

[e] *P* value for differences between distributions of demographic subgroups using chi-square tests for proportions and analysis of variance for means.

[f] Densities of outlets are not shown because of insufficient sample size of the subpopulation in 3 of the 6 study sites to which these analyses were restricted.

[g] 190 participants did not report household income but were included in analyses.

Table 2. Odds of Having a Healthy Diet,[a] by Average Fast-food Consumption Adjusted for Selected Personal Characteristics and Site,[b] Multi-Ethnic Study of Atherosclerosis, 2000–2002

Average Fast-food Consumption	Alternate Healthy Eating Index			Fats and Processed Meats Dietary Pattern		
	No.	aOR	95% CI	No.	aOR	95% CI
Never	2,077	1.63	1.36, 1.95	2,077	3.49	2.82, 4.31
<1 time/week	1,885	1.18	0.98, 1.42	1,885	1.56	1.25, 1.96
≥1 times/week	1,671	Referent		1,671	Referent	
P value for site heterogeneity		0.1647			0.1091	

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval.

[a] Healthy diet was defined as scoring in the top quintile of the Alternate Healthy Eating Index or bottom quintile of the fats and processed meats dietary pattern.

[b] Models were pooled across study sites and were adjusted for participant age, per capita household income, race/ethnicity, sex, and site.

0.88, 95% CI: 0.81, 0.96 for self-reports; aOR = 0.83, 95% CI: 0.74, 0.93 for informant reports; and aOR = 0.83, 95% CI: 0.71, 0.99 for densities, Table 3). For every standard deviation increase in informant-reported exposure to fast food, the odds of having a healthy diet, as measured by AHEI, decreased 14%. Greater neighborhood exposure to fast food, as assessed by self-reported exposure and densities, was not significantly associated with diet measured by AHEI. Associations did not vary by site.

DISCUSSION

In this study sample, consuming fast food was associated with an approximately 2- to 3-fold higher odds of having a poorer quality diet. Being exposed to more fast-food outlets in the neighborhood was associated with 11%–61% increased odds of consuming fast food near home and 12%–17% decreased odds of having a healthy diet, depending on the methods used to characterize neighborhood exposure to fast food and dietary quality. Associations were weaker when the AHEI (rather than the FPM measure) was used to assess diet and when densities of outlets (rather than self-reports or informant reports) were used to assess neighborhood exposure to fast food. In general, however, the robustness of associations with different measures of exposure to fast food and different measures of dietary quality strengthens our confidence that these associations are real.

Analyses using densities were restricted to 3 of the 6 study sites, which may have contributed to observed weaker associations. Associations with densities may have also been weaker because smaller fast-food restaurants were not accounted for. The 1-mile radius we investigated is likely an imperfect proxy for the spatial scale relevant to fast-food consumption and may certainly differ by

Table 3. Odds of Consuming Fast Food Near Home (1 Mile (1.6 km)) and of Having a Healthy Diet[a] per Standard Deviation Increase in Neighborhood Exposure to Fast Food Adjusted for Selected Personal Characteristics and Study Site,[b] Multi-Ethnic Study of Atherosclerosis, 2000–2002

Neighborhood Exposure to Fast Food	No.	Consuming Fast Food Near Home[c]			Having a Healthy Diet: Alternate Healthy Eating Index			Having a Healthy Diet: Fats and Processed Meats Dietary Pattern		
		aOR	95% CI	*P* Value for Site Heterogeneity	aOR	95% CI	*P* Value for Site Heterogeneity	aOR	95% CI	*P* Value for Site Heterogeneity
Self-reports	5,633	1.61	1.51, 1.72	0.0177	0.97	0.90, 1.04	0.8996	0.88	0.81, 0.96	0.1511
Informant reports[d]	5,502	1.27	1.17, 1.39	0.2926	0.86	0.78, 0.95	0.1747	0.83	0.74, 0.93	0.2625
No. of fast-food outlets/square mile[e]	2,447	1.11	0.98, 1.26	0.0143	0.97	0.84, 1.12	0.0364	0.83	0.71, 0.99	0.4779

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval.

[a] Healthy diet was defined as scoring in the top quintile of the Alternate Healthy Eating Index or bottom quintile of the fats and processed meats dietary pattern.

[b] Models were pooled across study site and were adjusted for participant age, educational level, per capita household income, race/ethnicity, sex, and site.

[c] Odds of consuming fast food ≥1 times/week within 1 mile of home versus never consuming fast food or never consuming fast food within 1 mile of home.

[d] 131 participants did not have any informants within 1 mile of their residence.

[e] Analyses involving densities were restricted to 3 of the 6 study sites (Maryland, North Carolina, New York) for which location data were available.

participant sociodemographic factors (e.g., access to transportation). There is little evidence on which to base the geographic definition of the relevant area. Analyses with informant reports may actually include restaurants as far as 2 miles from the participant's home (participants used as informants may live 1 mile from the participant in question and report on fast-food outlets up to an additional mile away). We also did not explore fast-food exposure around other potentially relevant places, such as participants' workplaces. However, 62% indicated that they ate fast food near home. These sources of measurement error could have led to underestimations of the true effects of fast-food access on fast-food consumption and diet.

A major strength of our study is the use of 3 alternate measures of neighborhood availability of fast food. Results were generally consistent across measures, although associations were stronger for self- and informant reports. Another innovation of our study is the investigation of 2 different measures of overall diet quality. Associations were stronger for the empirically derived FPM measure than for the a priori–defined AHEI. FPM might have been more strongly associated with fast-food consumption and neighborhood exposure to fast food because foods that may be typically consumed in the fast-food restaurants listed in the questionnaire (McDonald's, KFC, Taco Bell, take-out pizza, etc.) may be building blocks of the FPM dietary pattern (foods high in fats and oils, high-fat and processed meats, fried potatoes, etc.). Differences in associations may also reflect differences in the substantive meaning of the diet scores. A high AHEI value indicates the relative presence of healthy foods in the diet, whereas a low FPM value indicates the relative absence of unhealthy foods. Each measure provides a unique perspective on eating behaviors, and each was differentially associated with other personal characteristics, such as race/ethnicity and income in the data. The generally consistent patterns observed for both measures highlight the robustness of our results to varying levels of confounding.

Contrary to the findings in this study, several studies in the United States and abroad have not found an association among neighborhood exposure to fast food, consumption of fast food, and diet (14, 36, 41, 42). For example, in a sample of 10,623 US whites and blacks, Morland et al. (14) found no association between increased exposure to fast food in the US Census tract of residence and intakes of fruits and vegetables, total fat, saturated fat, or cholesterol. A study of 1,033 Minnesota residents found that eating at fast-food restaurants (defined by proprietary information sources) was positively associated with a high-fat diet but that the proximity of fast-food restaurants to home or work (defined as 0.5-, 1-, and 2.0-mile radii) was not associated with eating at these establishments (41). Associations may vary by study because different methods were used to operationalize the concepts of fast food, neighborhood, and diet, limiting study comparability.

Limitations of our findings include the observational nature of our study, which did not enable us to rule out confounding by poorly measured or omitted individual-level variables or rule out a reverse-causal explanation for our results (food preferences influence fast-food availability in neighborhoods rather than exposure to neighborhood fast food influences consumption). The nutritional quality of foods eaten at the fast-food outlets could not be determined. The age of our study population may have also affected the strength of associations. Older adults tend to have healthier diets than younger adults in the United States (50, 51) and to eat food away from home less frequently (52). Associations may be stronger in other populations (53, 54). Another limitation is that dietary outcomes were derived from a food frequency questionnaire, which may not capture overall diet variability (55).

Although causation cannot be inferred from these results alone, this study indicates that greater neighborhood exposure to fast food is associated with a poorer diet and greater fast-food consumption. Strategies that would be most effective in promoting healthier diets remain to be determined. Manipulating fast food to make it healthier or educating consumers on healthier alternatives may have limited success in part because nutritional factors inherent to fast food, such as high palatability, energy density, fat content, glycemic load, and the content of sugar in liquid form, may promote passive excess energy intake (56). Legislation requiring nutrition labeling in fast-food venues, as well as other policy and environmental approaches including taxation, zoning ordinances, and pricing incentives/disincentives, have also been suggested as promising strategies to encourage the purchase of healthier options (57–60). Additional data are needed to rigorously evaluate the effects of these types of initiatives on diet. A lack of readily available nutritional information in restaurants and variable nutritional contents, even among the same chain restaurants, may hinder the utility of strategies based on increasing consumer information on food content (61, 62). It is also plausible that making healthy foods more affordable and accessible may be more effective and feasible than reducing exposure to unhealthy foods (63, 64).

If food purchases away from home increase as forecasted (65), research that evaluates the effectiveness, feasibility, and economic costs of interventions that use environmental and policy approaches to reduce exposure to fast food, as well as strategies focusing on individual behavior change, will be sorely needed. The impact of environmental changes and individual-level strategies on diet and related health outcomes, such as obesity, warrants further investigation in longitudinal, quasi-experimental, and experimental designs.

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