Neighborhood Disparities in the Restaurant Food Environment

Ana P. Martinez-Donate, PhD; Jennifer Valdivia Espino, MS; Amy Meinen, MPH, RDN; Anne L. Escaron, PhD, MPH; Anne Roubal, PhD; F. Javier Nieto, MD, PhD, MPH; Kristen Malecki, PhD, MPH

ABSTRACT

Importance: Restaurant meals account for a significant portion of the American diet. Investigating disparities in the restaurant food environment can inform targeted interventions to increase opportunities for healthy eating among those who need them most.

Objective: To examine neighborhood disparities in restaurant density and the nutrition environment within restaurants among a statewide sample of Wisconsin households.

Methods: Households (N = 259) were selected from the 2009-2010 Survey of the Health of Wisconsin (SHOW), a population-based survey of Wisconsin adults. Restaurants in the household neighborhood were enumerated and audited using the Nutrition Environment Measures Survey for Restaurants (NEMS-R). Neighborhoods were defined as a 2- and 5-mile street-distance buffer around households in urban and non-urban areas, respectively. Adjusted linear regression models identified independent associations between sociodemographic household characteristics and neighborhood restaurant density and nutrition environment scores.

Results: On average, each neighborhood contained approximately 26 restaurants. On average, restaurants obtained 36.1% of the total nutrition environment points. After adjusting for household characteristics, higher restaurant density was associated with both younger and older household average age ($P < .05$), all white households ($P = .01$), and urban location ($P < .001$). Compared to rural neighborhoods, urban and suburban neighborhoods had slightly higher (ie, healthier) nutrition environment scores ($P < .001$).

Conclusions and Relevance: The restaurant food environment in Wisconsin neighborhoods varies by age, race, and urbanicity, but offers ample room for improvement across socioeconomic groups and urbanicity levels. Future research must identify policy and environmental interventions to promote healthy eating in all restaurants, especially in young and/or rural neighborhoods in Wisconsin.

• • •

Author Affilations: Department of Community Health and Prevention, Dornsife School of Public Health, Drexel University, Philadelphia, Penn (Martinez-Donate); Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, Madison, Wis (Martinez-Donate, Valdivia Espino, Meinen, Nieto, Malecki); AltaMed Health Services Corporation, Los Angeles, CA (Escaron); Center for Population Science and Discovery, University of Arizona, Tucson, Arizona (Roubal).

Corresponding Author: Ana P. Martinez-Donate, PhD, Associate Professor, 3215 Market St, Nesbitt Hall 458, Philadelphia, PA 19104; phone 267.359.6124; fax 267.359.6009; e-mail martinez-donate@drexel.edu; website: www.martinez-donate.weebly.com.

INTRODUCTION

The food environment influences dietary choices[1,2] and represents a modifiable factor to reduce the obesity epidemic in the United States.[3] Approximately 30% of Americans' caloric intake comes from restaurant meals, which are generally more energy dense compared to meals prepared at home.[4] The restaurant food environment comprises the number and types of restaurants in an area (ie, density), as well as the availability and promotion of healthy food, and the facilitators and barriers to healthful eating within restaurants.[5] The density of restaurants in an area is associated with the diet and weight status of residents.[6,7] Low-income and minority-populated neighborhoods appear to have a higher density of fast-food restaurants.[6,7] However, less is known about neighborhood differences in the environment consumers find within restaurants (eg, availability, affordability of healthy food, signage, and barriers). A few studies have found that affluent neighborhoods have restaurants with more healthy options and better environments compared to those located in poorer neighborhoods.[8,9] Most research has focused on fast-food restaurants,[6] used secondary data,[10,11] and/or relied on aggregate data for large areas.[6,11] Few studies have linked primary restaurant food environment data to individual- or household-level characteristics. There is also limited knowledge about the restaurant food environment in rural areas, despite these having higher obesity rates than urban and suburban areas.[12,13]

This study—"Assessing the Nutrition Environment in Wisconsin Communities"—aimed to examine disparities in the food environment surrounding a statewide sample of Wisconsin households. We used population-based sampling methods covering urban, suburban, and rural areas. Food environment data (eg,

restaurant location, type) were collected using ground-truthing methods and a validated observational tool to audit the environment within all restaurants located in the study areas. The data were linked to individual and household data from a statewide health examination survey, thus allowing for the investigation of differences in the food environment by socioeconomic characteristics. By investigating differences in the restaurant food environment of Wisconsin communities, we hoped to illuminate barriers to, and opportunities for, healthy eating among different population groups and allow the targeting and tailoring of future interventions aimed at improving the restaurant food environment surrounding population groups most in need.

METHODS

Sampling—This was an ancillary study to the Survey of the Health of Wisconsin (SHOW), a statewide health examination survey of a representative sample of Wisconsin adults ages 21-74.[14] Briefly, SHOW households are selected using 2-stage cluster sampling, including random selection of households within census block groups.[14] To facilitate pilot testing of our methods, we selected all the households in the 2009 SHOW located in 4 counties. The next year, two-thirds of households in the entire 2010 SHOW sample were selected at random.

Data Collection—Number of adults and number of children living in the household and the gender of all household residents were determined during the SHOW eligibility screening. Additional sociodemographic data were collected from participating adults (age 21-74).[14] Study methods were approved by the University of Wisconsin-Madison Health Sciences Institutional Review Board. Written informed consent was obtained from participants.

Food environment data were collected during the summer months of 2010 and 2011. We defined a 2- or 5-mile street network buffer around each household, depending on census block group, urban or non-urban designation, respectively. Heretofore, we refer to these buffers as "neighborhoods." In defining neighborhoods, urban areas were those within 40 minutes travel time from a populated area (≥ 50,000 residents) with all other regions classified as non-urban.[15,16]

Lists of restaurants within neighborhoods were compiled using various data sources, including ArcGIS business analyst and phone book records. Trained raters visited each neighborhood and ground-truthed these data sources, adding and removing restaurants based on direct observation.

Measures—Restaurant density was defined as the number of restaurants located in a neighborhood. Restaurant types included sit-down, fast-casual, fast-food, or other. Sit-down restaurants offer a full menu with table service by wait staff. Fast-casual restaurants serve food that is considered higher quality compared to fast-food and do not offer table service. Fast-food restaurants cook food in bulk, provide it quickly, and do not offer table service.[5] Trained raters completed the Nutrition Environment Measures Survey for Restaurants (NEMS-R) in all restaurants.[5] The survey is a reliable and validated audit tool that assigns points to 7 food environment dimensions within restaurants (Table 2).[5] Dimension subscores were summed to obtain a total score representing the overall healthfulness of the nutrition environment. A Children's Menu score was computed separately. Similar to other research, scores were rescaled to positive numbers.[9] Higher values indicate a nutrition environment more conducive to healthy eating, although there is no point threshold that defines a "healthy restaurant."[5,9,12] We computed neighborhood-level scores (ie, average scores and subscores for all restaurants within each household's neighborhood).

Based on SHOW eligibility screening of all household residents and data from SHOW participants, households were categorized as all female, all male, or containing both male and female adult residents. An indicator variable was used to signify the presence of children (< 21 years) in the household. The average age of adult household residents was described in 3 levels: younger adults (21-30 years), middle age adults (31-60 years), and older adults (> 60 years). Households were classified as having all racial minority residents, both white and minority residents, or all non-Hispanic white residents. Based on the educational status of adults 25 or older, households were described as containing all residents with a college degree, some residents with a college degree, or no residents with a college degree. Households were classified as below 100% federal poverty level (FPL), between 100% and 400% FPL, and ≥ 400% FPL based on the combined income of all household residents relative to FPL guidelines.[17] Household location was defined as urban, suburban, and rural areas according to Rural-Urban Commuting Area Code values of 1, between 2 and 6, or > 6, respectively.[15]

Analyses—The neighborhood-level food environment data were linked to household-level data. Descriptive statistics were computed. Unadjusted analyses of variance (ANOVA) were conducted. The resulting F test statistics and their corresponding P values were used to test whether mean nutrition environment scores corresponding to different types of restaurants were significantly different. Post hoc multiple pairwise comparisons using the Bonferroni correction method also were run to identify specific types of restaurants whose mean food environment scores differed.

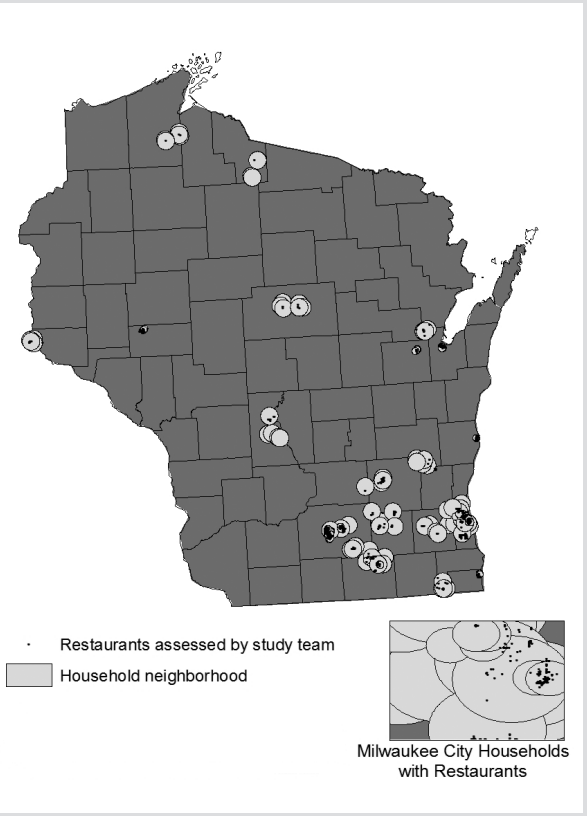
Using the household as the unit of analysis, we estimated multivariate linear regression models. We included gender, age, racial, and educational composition of household residents, as well as household income level and location in all multivariate models to investigate independent associations between each household characteristic and food environment indicators. The resulting unstandardized regression coefficients B and P values indicate the direction, magnitude, and statistical significance

Table 1. Household-Level Sociodemographic Characteristics in the Assessing the Nutrition Environment in Wisconsin Communities Study Sample (N = 259 households)

Characteristics	%	Mean (SD)
Gender of adult household residents[a]		
All females	40.2	
All males	15.8	
Both females and males	44.0	
Number of adult residents per household		2.6 (1.4)
Number of children per household		0.8 (1.1)
Average age of adult household residents[b]		
Younger age (21-30)	16.6	
Middle age (31-60)	62.2	
Older age (> 60)	21.2	
Households with children (< 21 yrs.)[a,c]	40.2	
Race of adult residents[b]		
All non-Hispanic white	86.9	
All minority	13.1	
Education of adult residents[b]		
All college degree	48.3	
No college degree	40.9	
Some college degree	10.8	
Combined household income[a]		
< 100% FPL	16.2	
100% - 400% FPL	48.5	
≥ 400% FPL	35.3	
Urbanicity (based on household location)		
Rural	18.5	
Urban	61.0	
Suburban	20.5	

Abbreviations: SD, standard deviation; FPL, federal poverty level.
[a] Descriptive of all enumerated individuals in the household.
[b] Restricted to adult residents that participated in the Survey of the Health of Wisconsin (SHOW).
[c] Children were defined as minors under the age of 18 as well as those 18-20 years in the household, yet ineligible for participation in SHOW.

Figure 1. Statewide Sample of Household Neighborhoods and Restaurants in the Assessing the Nutrition Environment in Wisconsin Communities Study



Note: Household neighborhood is defined as a 2- or 5-mile street-network buffer surrounding urban and non-urban households, respectively. Urbanicity was based on the census tract, where the household was located. The neighborhoods displayed have been moved 1 to 3 miles north, south, east, or west to mask the exact location of participating households.

of change in outcome associated with a household characteristic compared to the respective reference category. Analyses were conducted in IBM SPSS Statistics version 22 (IBM Corporation, Armonk, New York).

RESULTS

Household-Level and Neighborhood-Level Characteristics—The sample included 259 households, with 672 adults and 186 children, located in 17 counties (Table 1 and Figure 1). On average, the neighborhood around each household contained 25.7 restaurants: 10.3 sit-down, 3.0 fast-casual, 8.2 fast-food, and 3.98 other restaurants. Thirty urban households and 12 rural households had no restaurants in their neighborhoods.

Restaurant Characteristics—Trained staff identified 1,083 restaurants located within the study neighborhoods (Figure 1). Most were sit-down (40.2%) or fast-food restaurants (32.0%); 11.4% were fast-casual and 15.4% were other types of restaurants. A small percentage (1.4%) of the restaurants could not be classified due to missing data. Mean nutrition environment scores varied significantly by type of restaurant (Table 2). On average, both fast-casual and fast-food restaurants scored up to 8 points higher on the nutrition environment total score compared to sit-down and other restaurants, with higher scores equating to "healthier" environments. Statistically significant differences in specific food environment dimensions also were observed. These differences showed slightly higher (ie, healthier) scores in fast-food (eg, nutrition information, price incentives) and fast-casual restaurants (eg, healthier snacks/drinks, barriers to healthy eating) compared to sit-down and other restaurants.

Differences in Restaurant Density by Household-Level Factors—Age, race, and urbanicity were independently associated with restaurant density (Table 3). Additionally, households with older average age or younger average age had approximately 10 to 15 more restaurants in their neighborhoods than households with middle

Table 2. Nutrition Environment Measures Survey for Restaurants (NEMS-R) Scores and Subscores by Type of Restaurant (N=1083)[a]

	Mean (SD)							
	All Restaurants (N = 1083)[b]	Sit-Down Restaurants (N = 435)	Fast-Casual Restaurants (N = 119)	Fast-Food Restaurants (N = 347)	Other Restaurants (N = 167)	F (*p*)[c]	Multiple Comparisons (*p*)[d]	
Total (0-90)[e]	32.5 (10.2)	31.1 (7.8)	33.9 (8.7)	35.7 (13.5)	28.4 (6.0)	25.8 (<.001)	Sit-down<Fast-casual	(.030)
							Sit-down<FF	(<.001)
							Fast-casual<Fast-food	(.020)
							Other<Fast-casual	(<.001)
							Other<Fast-food	(<.001)
Nutrition information (0-12)	1.5 (2.8)	0.6 (1.7)	1.1 (2.0)	3.4 (3.5)	0.1 (0.8)	114.4 (<.001)	Sit-down<Fast-food	(<.001)
							Fast-casual<Fast-food	(<.001)
							Other<Fast-casual	(.003)
							Other<Fast-food	(<.001)
Signage identifying healthy options (0-18)	8.5 (2.2)	8.3 (1.7)	8.8 (2.3)	8.6 (2.8)	8.5 (1.6)	2.3 (0.08)	Not applicable	
Healthier snacks/drinks (0-12)	3.4 (3.3)	3.5 (2.8)	4.2 (3.9)	3.1 (3.9)	3.2 (2.5)	4.2 (0.006)	Fast-food <Fast-casual	(.006)
							Other<Fast-casual	(.042)
Healthy menu options (0-18)	6.2 (3.5)	6.4 (3.1)	6.2 (3.2)	6.8 (4.1)	4.5 (2.6)	17.2 (<.001)	Other<Sit-down	(<.001)
							Other<Fast-casual	(<.001)
							Fast-food<Other	(<.001)
Facilitators of healthy eating (0-9)	1.0 (1.7)	1.0 (2.0)	1.1 (1.6)	1.3 (1.8)	0.3 (0.9)	12.4 (<.001)	Other<Sit-down	(<.001)
							Other<Fast-casual	(.001)
							Fast-food<Other	(<.001)
Barriers to healthy eating (reversed, 0-9)	8.1 (1.6)	7.9 (1.8)	8.5 (1.20)	8.1 (1.6)	8.4 (1.3)	8.3 (<.001)	Sit-down<Fast-casual	(.001)
							Sit-down<Other	(<.001)
Price incentives for unhealthy eating (reversed, 0-12)	4.0 (1.8)	3.5 (1.7)	4.2 (1.7)	4.7 (1.9)	3.4 (1.2)	37.4 (<.001)	Sit-down<Fast-casual	(.001)
							Sit-down<Fast-food	(<.001)
							Fast-casual<Fast-food	(.038)
							Other<Fast-casual	(<.001)
							Other<Fast-food)	(<.001)
Children's Menu (0-30)[f]	10.8 (5.8)	10.3 (4.8)	12.3 (5.7)	11.4 (6.9)	8.8 (4.7)	3.8 (.010)	Other<Fast-casual	(.030)

Abbreviations: NEMS-R, Nutrition Environment Measures Survey for Restaurants.

[a] Range of scores possible is described within parentheses. Higher scores represent environment more conducive to healthy eating.

[b] "All restaurants" also includes restaurants that could not be classified into a specific type due to missing data. These are not shown in the table.

[c] Based on unadjusted analyses of variance (ANOVA) using type of restaurant as the independent variable and NEMS-R scores as the dependent variables.

[d] Based on post hoc multiple pairwise comparisons using the Bonferroni correction method. The symbol < indicates the direction of significant differences in NEMS-R scores found between specific types of restaurants.

[e] NEMS-R Total Score is the sum of other NEMS-R dimensions except the Children's Menu score.

[f] Only calculated for restaurants with a separate Children's Menu.

age residents. On average, the neighborhoods of households with all white residents included 14 more restaurants compared to those with minority residents. Households in urban areas had approximately 30 additional restaurants in their neighborhoods than rural households.

This pattern of findings held for the density of sit-down, fast-casual, and fast-food restaurants. On average, households with younger adult residents had 5.8 additional fast-food restaurants and households with older adults had 2.7 additional fast-food restaurants in their neighborhoods compared to households with middle age residents. Neighborhoods around households with all white residents had greater sit-down restaurant density compared to households with minority residents. Urban households had, on average, 13.2 more sit-down and 9.6 additional fast-food restaurants within their neighborhoods than households in rural areas (Table 3).

Differences in Nutrition Environment Scores by Household-Level Factors—Mean nutrition environment scores were 2.5 points higher (ie, healthier) in neighborhoods surrounding urban households and 3.8 points higher for suburban neighborhoods compared to rural neighborhoods (Table 4). Children's Menu scores were, on average, 1.8 points higher (ie, healthier) in restaurants in urban neighborhoods compared to rural. Nutrition Information and Facilitators subscores were also slightly higher for urban and suburban areas than rural areas. Signage and Price Incentives subscores were slightly higher for suburban households than rural households. Finally, households with all college graduates had higher subscores for Barriers—a reversed measure—meaning the restaurant food environment for college graduates is more supportive of healthy eating compared to the environment surrounding households with no college graduates. Nutrition environment scores did not vary significantly by race or income level.

Table 3. Differences in Restaurant Density by Household-Level Factors: Adjusted Multivariate Linear Regression Analyses[a]

Household-Level Characteristics	B (*p*) All Restaurants	Sit-Down Restaurants	Fast-Casual Restaurants	Fast-Food Restaurants	Other Restaurants
Mean Age of Adult Residents[b]					
Middle age (31-60)	REF	REF	REF	REF	REF
Younger adults (21-30)	15.0 (.001)	4.6 (.037)	1.4 (.048)	5.8 (<.001)	2.9 (<.001)
Older adults (>60)	10.5 (.015)	5.0 (.021)	1.4 (.039)	2.7 (.043)	1.0 (.181)
Gender Composition[c]					
All males	REF	REF	REF	REF	REF
All females	-6.4 (.181)	-3.1 (.198)	-0.6 (.394)	-2.1 (.161)	-0.5 (.570)
Both	-2.5 (.609)	-0.3 (.915)	-0.3 (.710)	-1.2 (.432)	-0.6 (.498)
Children (<21 years)[c,d]					
No	REF	REF	REF	REF	REF
Yes	5.3 (.143)	1.7 (.335)	0.4 (.538)	1.0 (.383)	1.6 (.011)
Racial Composition[b]					
All minority	REF	REF	REF	REF	REF
All non-Hispanic white	14.4 (.010)	6.0 (.034)	1.6 (.074)	1.6 (.352)	4.8 (<.001)
Education Composition[b]					
None college degree	REF	REF	REF	REF	REF
All college degree	0.4 (.908)	1.1 (.551)	0.1 (.845)	0.9 (.425)	-1.5 (.025)
Some college degree	-1.0 (0.873)	0.2 (.949)	0.4 (.684)	-0.6 (.750)	-0.7 (.489)
Combined Income[b]					
Below FPL	REF	REF	REF	REF	REF
100% - 400% FPL	-9.4 (.065)	-4.7 (.070)	-1.2 (.129)	-0.6 (.714)	-2.3 (.013)
≥ 400% FPL	-8.4 (.135)	-4.3 (.132)	-0.8 (.344)	-0.8 (.637)	-1.9 (.055)
Urbanicity					
Rural	REF	REF	REF	REF	REF
Urban	30.7 (<.001)	13.2 (<.001)	3.9 (<.001)	9.6 (<.001)	3.6 (<.001)
Suburban	7.0 (.163)	1.8 (.462)	0.9 (.254)	2.2 (.170)	2.0 (.021)

Abbreviations: REF, Reference category; FPL, federal poverty level.

[a] Restaurant density total number of restaurants located in a neighborhood (defined as the area comprised within a 2- or 5- mile street network buffer surrounding urban and non-urban households, respectively). B coefficients and *P* values based on linear regression models with number restaurants surrounding households in the sample as dependent variable and household gender, age, race/ethnicity, education, income, and urbanicity as predictors. Separate models were fitted for overall density (total number of restaurants) and number of each type of restaurant (eg, sit-down, fast-casual, etc).

[b] Restricted to adult residents that participated in the Survey of the Health of Wisconsin (SHOW).

[c] Descriptive of all enumerated individuals in the household.

[d] Children were defined as minors under the age of 18, as well as those 18-20 years in the household, yet ineligible for participation in SHOW.

DISCUSSION

This is the first study to examine disparities in restaurant density and nutrition environment in neighborhoods surrounding urban, suburban, and rural households across an entire state. On average, households in our sample had 26 restaurants within a 2- or 5-mile street distance neighborhood, 8 of which were fast-food restaurants. While we found that fast-food restaurants had slightly healthier nutrition environment scores relative to other types of restaurants, we found that all types of restaurants scored fewer than 50% of the possible points. Our findings are consistent with previous research[9] and underscore that there are many opportunities to improve the environment and promote healthy eating in all restaurants, regardless of type and location.

Our analyses revealed statistically significant differences in restaurant density and nutrition environment around households with different urbanicity levels and sociodemographic characteristics. Despite their smaller neighborhood size, urban households—compared to rural households—had approximately 30 additional restaurants within their neighborhoods, 13 and 9 of which were sit-down and fast-food establishments, respectively. Interestingly, urban and suburban households were surrounded by restaurants with better nutrition environments according to the NEMS-R audit tool. Stated differently, individuals in rural areas had fewer fast-food and sit-down restaurants in their neighborhoods, yet were systematically exposed to poorer nutrition environments within restaurants compared to individuals in urban areas.

The fast-food restaurants audited often had better availability of nutrition information and more healthy menu options compared to all other restaurants. Other studies have found that fast-food restaurants are more likely to provide nutrition information and have greater availability of healthy menu options

Table 4. Differences in Nutrition Environment Measures Survey for Restaurants (NEMS-R) Scores[a] by Household-Level Factors: Adjusted Multivariate Linear Regression Analyses[b]

	B (*p*)								
Household-Level Characteristics	**Total Score (0-90)[c]**	**Nutrition Information (0-12)**	**Signage Identifying Healthy Options (0-18)**	**Healthier Snacks/ Drinks (0-12)**	**Healthy Menu Options (0-18)**	**Facilitators of Healthy Eating (0-9)**	**Barriers to Healthy Eating (Reversed, 0-9)**	**Price Incentives for Unhealthy Eating (Reversed, 0-12)**	**Childrens Menu (0-30)[d]**
Mean Age[e]									
Middle age	REF	REF	REF	REF	REF	REF	REF	REF	REF
Younger adults	0.4 (0.486)	0.2 (0.229)	0.0 (0.919)	0.2 (0.251)	-0.3 (0.108)	0.1 (0.171)	0.1 (0.586)	0.1 (0.539)	0.6 (0.215)
Older adults	0.3 (0.613)	0.1 (0.494)	0.3 (0.028)	-0.1 (0.752)	-0.1 (0.824)	0.0 (0.871)	-0.1 (0.305)	0.0 (0.992)	0.1 (0.915)
Gender Composition[f]									
All males	REF	REF	REF	REF	REF	REF	REF	REF	REF
All females	0.7 (0.329)	0.2 (0.33)	-0.0 (0.896)	0.2 (0.406)	0.2 (0.177)	-0.0 (0.836)	-0.2 (0.167)	0.1 (0.481)	0.2 (0.748)
Both	0.7 (0.325)	0.2 (0.450)	0.1 (0.621)	0.2 (0.261)	0.2 (0.102)	0.0 (0.978)	-0.2 (0.130)	-0.0 (0.831)	0.6 (0.262)
Children (<21 years)[f,g]									
No	REF	REF	REF	REF	REF	REF	REF	REF	REF
Yes	-0.1 (0.880)	0.0 (0.849)	0.2 (0.076)	-0.1 (0.511)	-0.1 (0.255)	-0.1 (0.462)	-0.1 (0.445)	0.0 (0.929)	-0.2 (0.626)
Race Composition[e]									
All minority	REF	REF	REF	REF	REF	REF	REF	REF	REF
All non-Hispanic white	-1.6 (0.065)	-0.6 (0.053)	-0.3 (0.151)	0.1 (0.633)	0.1 (0.272)	-0.2 (0.248)	-0.1 (0.649)	-0.3 (0.113)	0.4 (0.585)
Education[e]									
None college	REF	REF	REF	REF	REF	REF	REF	REF	REF
All college	0.2 (0.728)	-0.0 (0.819)	0.0 (0.783)	0.1 (0.699)	0.1 (0.423)	-0.0 (0.907)	0.2 (0.017)	0.0 (0.722)	0.1 (0.902)
Some college	-1.1 (0.201)	-0.5 (0.055)	-0.3 (0.114)	0.2 (0.558)	0.2 (0.505)	-0.1 (0.515)	0.2 (0.163)	-0.3 (0.120)	0.6 (0.364)
Combined Income[e]									
Below FPL	REF	REF	REF	REF	REF	REF	REF	REF	REF
100% - 400% FPL	1.0 (0.178)	0.4 (0.093)	0.1 (0.637)	-0.2 (0.34)	-0.2 (0.283)	0.2 (0.519)	-0.0 (0.922)	0.3 (0.102)	0.7 (0.208)
≥400% FPL	0.9 (0.269)	0.3 (0.238)	0.1 (0.770)	-0.2 (0.397)	-0.2 (0.146)	0.1 (0.692)	0.0 (0.821)	0.1 (0.542)	0.2 (0.798)
Urbanicity									
Rural	REF	REF	REF	REF	REF	REF	REF	REF	REF
Urban	2.5 (<.001)	0.5 (0.030)	0.1 (0.490)	-0.2 (0.277)	-0.2 (<.001)	0.5 (<.001)	0.0 (0.86)	0.3 (0.066)	1.8 (0.001)
Suburban	3.8 (<.001)	0.9 (<.001)	0.4 (0.008)	0.1 (0.658)	0.1 (<.001)	0.6 (<.001)	-0.2 (0.186)	0.5 (0.001)	0.4 (0.479)

Abbreviations: REF, Reference category.

[a] Range for each nutrition environment score and subscore are described in parentheses. Higher scores represent environment more conducive to healthy eating.

[b] B coefficients and *P* values based on linear regression models with nutrition environment scores as dependent variables and household gender, age, race/ethnicity, education, income, and urbanicity as predictors. A separate model was fitted for each nutrition environment dimension.

[c] NEMS-R Total Score is the sum of other NEMS-R dimensions except the Children's Menu score.

[d] Only calculated for restaurants with a separate Children's Menu.

[e] Restricted to adult residents that participated in the Survey of the Health of Wisconsin (SHOW).

[f] Descriptive of all enumerated individuals in the household.

[g] Children were defined as minors under the age of 18, as well as those 18-20 years in the household, yet ineligible for participation in SHOW.

compared to other food outlets.[5,9] However, these findings must be interpreted with caution. Despite offering information and providing healthy options, research has shown that fast-food restaurants encourage large portions and unhealthy eating through price discounts.[5] Furthermore, fast-food consumption is associated with poor diet and body weight.[6,18,19] Overall, the evidence justifies the need for interventions to limit the density of fast-food restaurants and improve other dimensions of their nutrition environment.

Our study revealed that older adults (> 60 years) and younger adults (21-30 years) in Wisconsin live in more restaurant-dense areas and are surrounded by more fast-food restaurants. Few studies have examined differences in the food environment by age.[6] Future research can shed light on whether or not these findings reflect younger and older adults' residential preferences or if this finding is a result of restaurant owners situating restaurants near these consumers. Our results suggest that older and young adults may be exposed to environments that impede a healthy diet and lead to excessive body weight gain at critical age periods.[6,7,19]

Unlike previous research,[6-9,20,21] we found only limited evidence of differences in restaurant density or nutrition environment by household-level income, education, and minority composition. Other studies have found that low-income individuals and racial

minorities are exposed to more obesogenic environments such as higher numbers of fast-food restaurants. We did not find such associations, perhaps in part because of the little racial diversity in our sample (13%), which reflects similarly low levels of diversity among the Wisconsin population (17%). The limited racial/ethnic diversity and high correlation with urbanicity in Wisconsin restrict our ability to disentangle the independent association of these variables with the food environment and limit our ability to generalize our findings to other regions.

Other limitations of this study include a moderate 51% SHOW response rate, possible seasonal changes in the food environment during summer months, and the inability to capture the environments around household residents' workplaces or schools. We chose to average the nutrition environment scores of all restaurants within a neighborhood, while other methods of handling aggregate data exist (eg, proportion of restaurants that use specific health promotion strategies, highest nutrition environment scores).[8,12] Future studies may consider using different methods and examine neighborhood- or county-level contextual factors that may interact with household-level characteristics.

Our use of ground-truthing methods, direct observation of the environment within restaurants, and analysis using statewide household-level data represent unique and valuable contributions to understanding exposure to healthy food environments. Ground-truthing reduced error in estimating restaurant density. The rich nutrition environment data revealed some ways in which fast-casual and fast-food establishments encourage healthy eating, adding to our interpretation of a relatively blunt measure like restaurant density or type. Our choice of the NEMS-R as a food environment audit tool allowed us to report findings regarding Children's Menus, which are an active area in obesity prevention research.[22]

CONCLUSION

The healthiness of the restaurant food environment surrounding Wisconsin households varies according to age, race/ethnicity, and urbanicity, but is generally unhealthy across sociodemographic groups and urbanicity levels. Overall, the nutrition environment in restaurants in Wisconsin can be greatly enhanced in order to promote healthy eating. Using the data reported in this study as a baseline, we may be able to evaluate the effects of future interventions such as the enforcement of federal menu labeling regulations for chain restaurants.[23] Future comparative research could be conducted to examine the restaurant food environment of communities across states in the United States and to identify factors, particularly policies, associated with healthier nutrition environments. The results of such research could lead to the development of effective interventions to promote healthier nutrition environments in restaurants across Wisconsin and beyond.

Acknowledgements: We thank Norma-Jean Simon for her assistance with scoring of the NEMS data and the team of research assistants who collected the restaurant environment data.

Funding/Support: Funding for this study was provided by the University of Wisconsin School of Medicine and Public Health through the Wisconsin Partnership Program (Principal Investigators: Ana P. Martinez-Donate, F. Javier Nieto). We also recognize support from the National Institutes of Health's Clinical and Translational Science Award (5UL 1RR025011) and National Heart Lung and Blood Institute (1 RC2 HL 101468).

Financial Disclosures: None declared.

REFERENCES

1. Glanz K. Measuring food environments: a historical perspective. *Am J Prev Med.* 2009;36(4, Supplement):S93-S98. doi:10.1016/j.amepre.2009.01.010.

2. Bowen DJ, Barrington WE, Beresford SAA. Identifying the effects of environmental and policy change interventions on healthy eating. *Annu Rev Public Health.* 2015;36:289-306. doi:10.1146/annurev-publhealth-032013-182516.

3. Ogden CL, Carroll MD, Lawman HG, et al. Trends in obesity prevalence among children and adolescents in the United States, 1988-1994 through 2013-2014. *JAMA.* 2016;315(21):2292-2299. doi:10.1001/jama.2016.6361.

4. Lin B, Guthrie JF. *Nutritional quality of food prepared at home and away from home, 1977–2008.* Washington (DC): United States Department of Agriculture, Economic Research Service; 2012. Economic Information Bulletin No.: 142361. http://www.ers.usda.gov/publications/eib-economic-information-bulletin/eib105.aspx. Accessed Sept. 29, 2016.

5. Saelens BE, Glanz K, Sallis JF, Frank LD. Nutrition Environment Measures Study in restaurants (NEMS-R): development and evaluation. *Am J Prev Med.* 2007;32(4):273-281. doi:10.1016/j.amepre.2006.12.022.

6. Fleischhacker SE, Evenson KR, Rodriguez DA, Ammerman AS. A systematic review of fast food access studies. *Obes Rev.* 2011;12(5):e460-e471. doi:10.1111/j.1467-789X.2010.00715.x.

7. Larson NI, Story MT, Nelson MC. Neighborhood environments: disparities in access to healthy foods in the U.S. *Am J Prev Med.* 2009;36(1):74-81. doi:10.1016/j.amepre.2008.09.025.

8. Lewis LB, Sloane DC, Nascimento LM, et al; REACH Coalition of the African Americans Building a Legacy of Health Project. African Americans' access to healthy food options in South Los Angeles restaurants. *Am J Public Health.* 2005;95(4):668-673. doi:102105/AJPH.2004.050260.

9. Neckerman KM, Lovasi L, Yousefzadeh P, et al. Comparing nutrition environments in bodegas and fast-food restaurants. *J Acad Nutr Diet.* 2014;114(4):595-602. doi:10.1016/j.jand.2013.07.007.

10. Sharkey JR. Measuring potential access to food stores and food-service places in rural areas in the U.S. *Am J Prev Med.* 2009;36(4 Suppl):S151-S155. doi:10.1016/j.amepre.2009.01.004.

11. Holsten JE. Obesity and the community food environment: a systematic review. *Public Health Nutr.* 2009;12(03):397-405. doi:10.1017/S1368980008002267.

12. Pereira RF, Sidebottom AC, Boucher JL, Lindberg R, Werner R. Assessing the food environment of a rural community: baseline findings from the heart of New Ulm project, Minnesota, 2010-2011. *Prev Chronic Dis.* 2014;11:E36. doi:10.5888/pcd11.130291.

13. Martínez-Donate AP, Riggall AJ, Meinen AM, et al. Evaluation of a pilot healthy eating intervention in restaurants and food stores of a rural community: a randomized community trial. *BMC Public Health.* 2015;15:136. doi:10.1186/s12889-015-1469-z.

14. Nieto FJ, Peppard PE, Engelman CD, et al. The Survey of the Health of Wisconsin (SHOW), a novel infrastructure for population health research: rationale and methods. *BMC Public Health.* 2010;10:785. doi:10.1186/1471-2458-10-785.

15. Rural Urban Commuting Area Codes Data. WWAMI Rural Health Research Center website. http://depts.washington.edu/uwruca/ruca-codes.php. Accessed September 29, 2016.

16. Reitzel LR, Okamoto H, Hernandez DC, Regan SD, McNeill LH, Obasi EM. The Built Food Environment and Dietary Intake Among African-American Adults. *Am J Health Behav.* 2016;40(1):3-11. doi:10.5993/AJHB.40.1.1

17. Prior HHS Poverty Guidelines and Federal Register References. Office of the Assistant Secretary for Planning and Evaluation website. https://aspe.hhs.gov/prior-hhs-poverty-guidelines-and-federal-register-references. Accessed September 29, 2016.

18. Paeratakul S, Ferdinand DP, Champagne CM, Ryan DH, Bray GA. Fast-food consumption among US adults and children: Dietary and nutrient intake profile. *J Am Diet Assoc.* 2003;103(10):1332-1338. doi:10.1016/S0002-8223(03)01086-1.

19. Pereira MA, Kartashov AI, Ebbeling CB, et al. Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. *Lancet.* 2005;365(9453):36-42. doi:10.1016/S0140-6736(04)17663-0

20. Richardson AS, Boone-Heinonen J, Popkin BM, Gordon-Larsen P. Are neighbourhood food resources distributed inequitably by income and race in the USA? Epidemiological findings across the urban spectrum. *BMJ Open.* 2012;2(2):e000698. doi:10.1136/bmjopen-2011-000698.

21. Hilmers A, Hilmers DC, Dave J. Neighborhood disparities in access to healthy foods and their effects on environmental justice. *Am J Public Health.* 2012;102(9):1644-1654. doi:10.2105/AJPH.2012.300865.

22. Krukowski RA, Eddings K, West DS. The children's menu assessment: development, evaluation, and relevance of a tool for evaluating children's menus. *J Am Diet Assoc.* 2011;111(6):884-888. doi:10.1016/j.jada.2011.03.018.

23. Menu and Vending Machines Labeling Requirements. U.S. Food and Drug Administration website. http://www.fda.gov/Food/IngredientsPackagingLabeling/LabelingNutrition/ucm217762.htm. Accessed September 29, 2016.

advancing the art & science of medicine in the midwest

WMJ

WMJ (ISSN 1098-1861) is published through a collaboration between The Medical College of Wisconsin and The University of Wisconsin School of Medicine and Public Health. The mission of *WMJ* is to provide an opportunity to publish original research, case reports, review articles, and essays about current medical and public health issues.

Visit www.wmjonline.org to learn more.