Development of the Perceived Nutrition Environment Measures Survey

Sarah H. Green, MPH, Karen Glanz, PhD, MPH

Introduction: Objective, observational measures of nutrition environments are now well established and widely used. Individuals' perceptions of their nutrition environments may be equally or more important, but are less well conceptualized, and comprehensive measures are not available. This paper describes the development of the Perceived Nutrition Environment Measures Survey (NEMS-P), its test–retest reliability, and its ability to discern differences between lower- and higher-SES neighborhoods.

Methods: This research involved five steps: (1) development of a conceptual model and inventory of items; (2) expert review; (3) pilot testing and cognitive interviews; (4) revising the survey; and (5) administering the revised survey to participants in neighborhoods of high and low SES on two occasions to evaluate neighborhood differences and test–retest reliability. Data were collected in 2010 and 2011 and analyzed in 2011 and 2012.

Results: The final survey has 118 items. Fifty-three core items represent three types of perceived nutrition environments: community nutrition environment, consumer nutrition environment, and home food environment. Test–retest reliability for core constructs of perceived nutrition environments was moderate to good (0.52–0.83) for most measured constructs. Residents of higher-SES neighborhoods reported higher availability scores in stores, stronger agreement that healthy options were available in nearby restaurants, and higher scores for accessibility of healthy foods in their homes.

Conclusions: The NEMS-P has moderate to good test–retest reliability and can discriminate perceptions of nutrition environments between residents of higher- and lower-SES neighborhoods. This survey is available and ready to be used.

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Introduction

The complex relationships among nutrition environments, diet, and health outcomes have been conceptualized and widely studied.[1–3] There has been a substantial increase in research to better document, measure, and explain these relationships using a range of methods, including observations, surveys, and geographic analyses.[4–6] One of the most widely used observational measures of the nutrition environment, the Nutrition Environment Measures Survey (NEMS), developed by our team, is widely disseminated, well established,[7–9] and adapted[10–12] to study a range of food environments and contexts (urban, rural, different institutional environments) for description,[11,13,14] associations with diet and health outcomes,[15–18] and to evaluate policy and environment interventions.[19–22] NEMS data have been collected throughout the U.S. and internationally by trained researchers, nutritionists, and public health professionals.[7,23]

Objective measures of the nutrition environment are useful for assessing the availability of healthy and unhealthy foods, which is believed to be an important influence on food choice and dietary intake.[24] Several well-designed studies have shown that nutrition environments and proximity of healthy foods are correlated with food intake[25,26] and BMI.[27,28] Less studied are people's perceptions of their nutrition environments—which are likely as important to the relationship between nutrition environments and obesity.[29] Perceived nutrition environments include "reports" (e.g., Where are the nearest stores?) and "opinions" or "attitudes" (e.g., Are healthy

From the Perelman School of Medicine (Green, Glanz) and School of Nursing (Glanz), University of Pennsylvania, Philadelphia, Pennsylvania

Address correspondence to: Sarah H. Green, MPH, Center for Health Behavior Research, University of Pennsylvania, 802 Blockley Hall, 423 Guardian Drive, Philadelphia PA 19104. E-mail: shgreen@upenn.edu.

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foods too expensive? Are the stores convenient?).[24] Cummins et al.[29] examined the impact of a new grocery store on perceptions of the nutrition environment, BMI, and fruit and vegetable intake. The new grocery store had a positive impact on perceptions of food availability; however, it did not lead to increased fruit and vegetable intake or decreased BMI. More research is needed on the relationship between perceptions and health behaviors.

Recent research evaluating the perceived food environment[30–34] has been qualitative[34] or focused on a small number of items, limiting interpretation.[30–33] There are few published measures on the perceived food environment, with the most-often cited measure being brief and limited in scope.[35] With the exception of one study[36] that used a three-item measure of perceived food environments, current measures have not been examined in relation to objective nutrition environment measures; neighborhood differences; health behaviors (fruit and vegetable intake); or health outcomes (BMI). In addition, the impact of the home food environment on health behaviors and health outcomes has been studied, but has focused on children.[37–39]

There is a clear need for a reliable and valid measure that comprehensively assesses key dimensions of perceived food environments. This paper describes the development of the Perceived Nutrition Environment Measures Survey (NEMS-P). A systematic process was used to develop the survey, examine test–retest reliability and internal consistency reliability, and test the tool's ability to discriminate between different nutrition environments by comparing perceptions in low- and high-SES neighborhoods.

Methods

Overview and Context

This research involved five steps: (1) development of a conceptual model and inventory of items; (2) expert review; (3) pilot testing and cognitive interviews; (4) revising the survey; and (5) administering the revised survey to participants in neighborhoods of high and low SES on two occasions to evaluate neighborhood differences and test–retest reliability. Primary data collection for the study took place in four neighborhoods in the Philadelphia area. The neighborhoods were selected to (1) be non-contiguous so food sources would not overlap across neighborhoods and (2) contrast disadvantaged and affluent neighborhoods, based on the well-established finding that healthy food access and health risk status are poorer in lower-income areas.[2] Census data were used to classify neighborhood SES; two neighborhoods were predominantly low SES and two were higher SES. The Healthy Food Financing Initiative (HFFI) defines low-income census tracts as having a poverty rate of $\geq$20%,[40] and this definition was used in identifying the low-SES neighborhoods. The IRB of the University of Pennsylvania approved the study protocol.

Conceptual Model and Inventory of Items

The conceptual model for this research is an extension of the Model of Community Nutrition Environments described by Glanz and colleagues[1] in 2005 (Figure 1). Based on the literature, this model expands on core concepts from the original model. This model is rooted in the hypothesis that community and consumer nutrition environments influence eating behaviors and these effects are moderated by individual characteristics, including sociodemographic factors, health status, health behaviors, and psychosocial factors. Community nutrition environments include type, location, and accessibility of stores and restaurant; consumer nutrition environments include availability of healthy food options (low-fat products, fruits, vegetables), price, promotion, and nutrition information within the stores and restaurants.[1] In this model, psychosocial factors are defined as the perceived importance of nutrition, food insecurity, and food motivations.[41] The background characteristics include health behaviors, sociodemographic variables, self-reported health status, BMI, and dieting history/status.

The model posits that perceived and objectively measured nutrition environments are correlated. It further suggests that the interaction of the perceived and observed nutrition environments influences eating behaviors both directly and indirectly through food shopping behaviors (e.g., shopping frequency, grocery planning)[42,43] and the home food environment. The home food environment includes items on the availability and accessibility (e.g., ready-to-eat foods in the refrigerator or counter) of healthy and unhealthy foods in the home. This conceptualization suggests there is a relationship between food shopping behaviors and the home food environment, and in turn, the home food environment directly influences eating behaviors.

Using the conceptual model as a guide, an extensive search for questionnaire items in published reports, government sources, and peer-reviewed research was conducted (Appendix shows a list of sources) to measure concepts related to the following constructs: community nutrition environments, consumer nutrition environments, home food environments, shopping behaviors, eating behaviors, psychosocial factors, and background characteristics. The search yielded an inventory of 278 items that were classified into categories and constructs based on agreement across three study staff members. Although the survey includes a range of items representing the constructs in the conceptual model, three core "perceived nutrition environment" constructs were particularly important to measure: community nutrition environment, consumer nutrition environment, and home food environment.

Expert Review

Twelve experts working in obesity prevention and nutrition research were invited to review the inventory and assess the face and content validity of the items. Suggestions from the experts included eliminating questions about corner stores (focus on stores and restaurants) and reducing the number of psychosocial factors and background characteristic questions. Based on the experts' guidance and after removing duplicate and near-duplicate items, 118 items were selected for inclusion in the pilot survey. Some items were modified to improve consistency of wording and response choices.

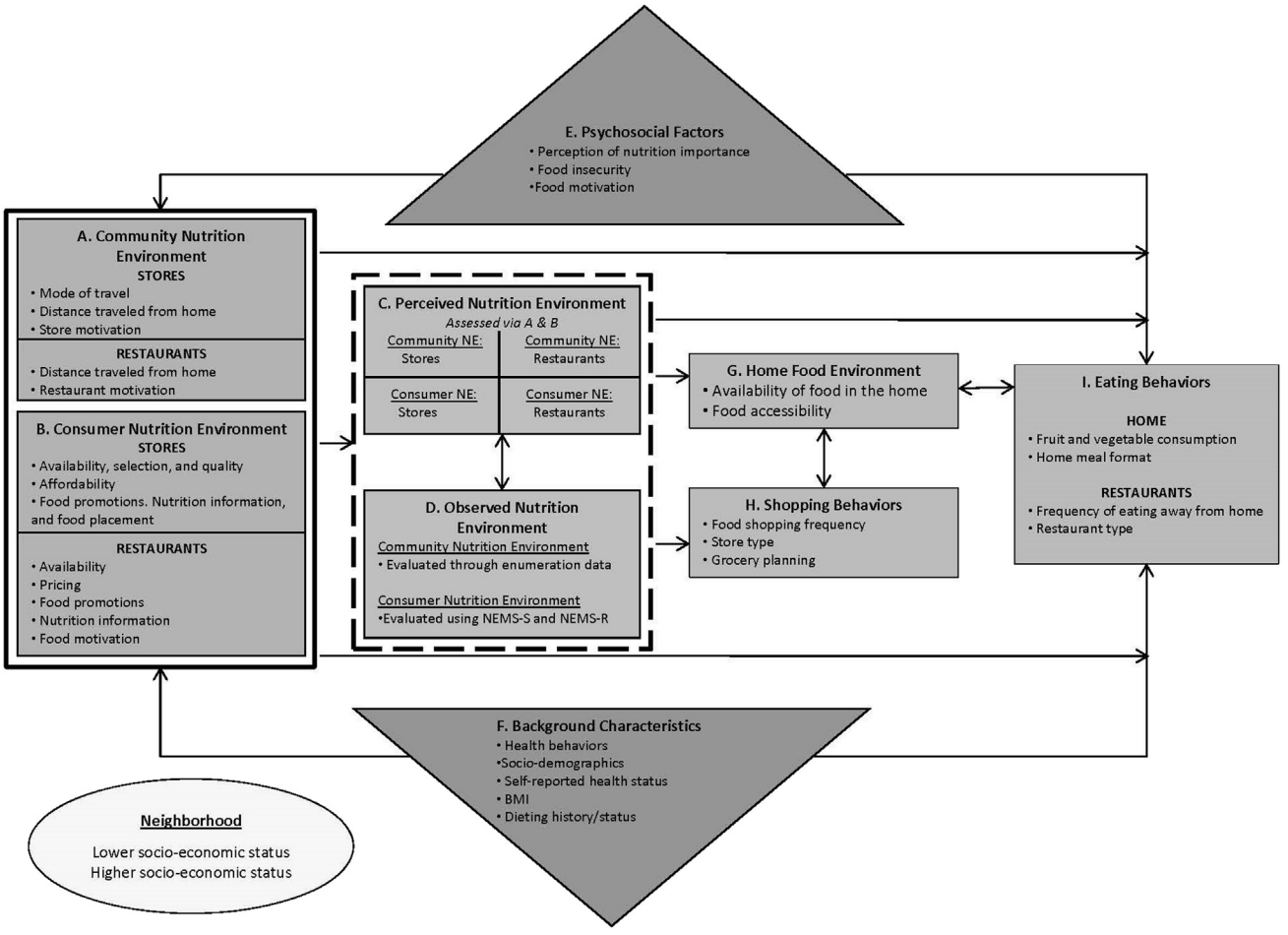

Figure 1. Nutrition Environment Measures Survey–Perceived (NEMS-P): conceptual model.
NE, nutrition environment.

Pilot Testing and Cognitive Interviews

Participants from each neighborhood were recruited to complete the pilot survey and a cognitive interview[44] with trained research staff. Eligible participants lived in designated neighborhoods (determined by ZIP code) for at least 6 months and planned to live there for the next month; were aged 18–65 years; were able to read and speak English fluently; and did some or all of the household food shopping. Quota sampling was used to balance participation across neighborhoods. Respondents were recruited through flyers posted in community centers, libraries, train stations, and other high-traffic areas. Informed consent was obtained from all participants. Participants received gift cards to thank them for their time and participation.

Pilot testing was completed in person, at a location convenient for the participant. All cognitive interviews were audio recorded. Before completing the survey, participants were told that they would be asked to "think aloud" about how they answered particular questions. After the participants completed the survey, they were queried about each item (e.g., how they came up with the answer, whether the items were difficult to answer). Participants were also asked to define certain words or phrases throughout the survey. For example, participants were asked how they would define "neighborhood" in the context of the statement: *It is easy to buy fresh fruits and vegetables in my neighborhood.* On average, participation lasted 62 minutes: 22 minutes to complete the survey (range, 9–34 minutes) and 40 minutes to complete the cognitive interview (range, 25–55 minutes). Fifteen participants completed the pilot test and cognitive interview.

Results of Pilot Testing and Survey Revisions

Descriptive survey data were compiled to examine response distributions, in particular, the possible lack of variation across respondents. Cognitive interviews were transcribed, and comments were aligned with survey items. The responses were reviewed by the study team to identify necessary revisions to the survey.

Most participants found the survey easy to read and understand. Participants defined "neighborhood" slightly differently, so a definition of how to think about one's "neighborhood" (the area within about a 20-minute walk or 10–15-minute drive from one's home) was added to the survey. Some participants mentioned that the store where they shop most often and the store where they buy the most food are not necessarily the same. Thus, for greater clarity, questions were reworded to refer to the store where the respondent buys most of their food. Several response options were expanded throughout the survey to ensure that items captured the actual shopping or eating behaviors in question.

The revised survey contained all items included in the pilot version of the survey (118 items). The items that assess the core construct of "perceived nutrition environment," defined as community and consumer nutrition environments and home food environments (Table 1).

The community nutrition environment describes access to stores and restaurants within the neighborhood,[1] defined as the area within about a 20-minute walk or 10–15-minute drive from one's home. The seven recommended items to operationalize this construct included store/restaurant mode of travel, the distance traveled to a store/restaurant from home, and store/restaurant motivation. Store motivation was measured by querying the importance of store proximity to home and other places where time is spent. Restaurant motivation was measured by asking about the importance of convenience.

The store consumer nutrition environment construct included 17 recommended items on availability and affordability of healthy foods, nutrition information, food placement and promotion, and food motivation.[1] There were six items about the availability and selection of fresh produce and low-fat products (e.g., low-fat milk, lean meat) in one's neighborhood. All items were asked on a 5-point scale of *strongly disagree* to *strongly agree*. Food motivation includes the importance of selection, quality, and price of food in one's decision to shop at a particular store and all items were asked on a 4-point scale of *not at all important* to *very important*. Affordability in stores was evaluated by asking, *At the store where you buy most of your food, how would you rate the price of fresh fruits and vegetables?* Response choices ranged from *very inexpensive* to *very expensive*. Food placement and promotion included items about signs and displays promoting healthy and unhealthy items and the location of food items in the store (e.g., near the cash register, end of the aisle, eye level on the shelf). All food placement and promotion items were asked on a 5-point scale of *strongly disagree* to *strongly agree*.

The restaurant consumer nutrition environment included seven recommended items on availability of healthy options, promotions, and the cost of healthy options at restaurants. Participants were asked about the availability of healthy options and healthy fruit and vegetable choices at restaurants. Restaurant promotions included items about signs and displays encouraging healthy and unhealthy food choices. The item *It costs more to buy the healthy options* was included in reference to restaurant costs. All items were asked on a 5-point scale of *strongly disagree* to *strongly agree*.

The home food environment included 22 recommended items on the availability and accessibility of healthy and unhealthy food at home. Participants were asked to indicate which foods were available at home in the past week from a list of 18 items that included fruits (e.g., bananas, apples, grapes); vegetables (e.g., carrots, tomatoes, dark leafy greens); healthy foods (e.g., low-fat milk, whole-grain bread); and unhealthy foods (e.g., candy, cookies, snack chips). Participants were also asked how often ready-to-eat healthy and unhealthy foods were available at home (e.g., foods in refrigerator or on the counter) on a 4-point scale of *never/rarely* to *almost always* (Table 1).

Main Measurement Study

The main measurement study was conducted between November 2010 and June 2011. A convenience sample of 233 participants was recruited to complete the survey twice, approximately 2–3 weeks apart (mean=19.7 days, SD=8.3 days). Half of the participants lived in the lower-SES neighborhoods and half lived in the higher-SES neighborhoods; recruitment strategies were the same as during pilot testing. The response rate for the first survey was 94.8% (n=221) and 97.3% of those who completed a first survey also completed a second survey (n=215). There were no significant differences between those who completed the first survey and those who completed the survey at both time points.

Participants were invited to complete the surveys in person or receive the survey in the mail to complete and return. The majority of respondents completed mailed surveys at both time points (Survey 1, 85.1%, n=188; Survey 2, 94.9%, n=204).

Statistical Analysis

All data analysis was completed using PASW Statistics, version 18 (formerly SPSS Statistics), between July 2011 and December 2012. Descriptive statistics and neighborhood comparisons were computed with chi-square tests and one-way ANOVAs for all participants (n=221). Composite scores were calculated for key constructs based on a priori item selection and the literature, and Cronbach's alpha statistics were used to assess internal consistency and guide the inclusion and exclusion of items.[45] For all participants who completed the survey at both time points (n=215), test–retest reliability was assessed on key constructs, using interclass coefficients (ICCs), kappa statistics, and percentage agreement.

Results

Participants averaged 45.1 years of age (SD=11.1 years), with no significant differences in age across neighborhoods. More participants in the higher-SES neighborhoods were white, had more formal education, were employed full-time, were married or living with a partner, and had an annual household income > $50,000 ($p \leq 0.001$ for all differences) (Table 2).

The survey included 118 items with a total of 60 items to measure the key constructs of perceived food environments. Of these 60 items, seven were excluded during preliminary analyses owing to redundancy, resulting in 53 recommended items. Additional survey items addressed psychosocial factors (nine items); health behaviors (seven items); sociodemographic factors (18 items); shopping behaviors (11 items); and eating behaviors (ten items). The full survey is available upon request.

Table 1 lists the Cronbach's alpha values for the recommended perceived food environment composite indexes (n=53). Most Cronbach's alpha coefficients were good to very good, ranging from 0.6 to 0.7. However, there was some variability, with alphas ranging from 0.41 (placement/promotion of healthy items and nutrition information) to 0.94 (store availability).

Table 3 summarizes perceptions of the community and consumer nutrition environment by neighborhood. Ratings of store and restaurant community nutrition environments did not differ significantly across neighborhoods.

Table 1. Survey Items, Cronbach Alpha Values, and Possible Ranges for Composite Items Assessing Perceived Nutrition Environments

Composite item	Survey item(s)	Item range	No. of items	Total possible range	α
Community nutrition environment					
Store access	Thinking about the store **where you buy most of your food**, how do you usually travel to this store? [car or other form of transportation]	1–2	3	1–16	na
	About how long would it take to get from your home to the store **where you buy most of your food**, if you walked there?	1–4[a]			
	How important are each of the following factors in your decision to shop at the store where you **buy most of your food**? – Near your home – Near or on the way to other places where you spend time	1–4[b]			
Restaurant access	About how long would it take to get from your home to the fast-food restaurant **where you go most often**, if you walked there?	1–4[a]	3	1–12	na
	About how long would it take to get from your home to the sit-down restaurant **where you go most often**, if you walked there?	1–4[a]			
	When you eat out at a restaurant or get take-out food, how important to you is convenience?	1–3[c]			
Store consumer nutrition environment					
Store availability of healthy food choices	Please mark whether you agree or disagree with the following statements: – It is easy to buy fresh fruits and vegetables in my neighborhood. – The fresh produce in my neighborhood is of high quality. – There is a large selection of fresh fruits and vegetables in my neighborhood. – It is easy to buy low-fat products, such as low-fat milk or lean meats, in my neighborhood. – The low-fat products in my neighborhood are of high quality. – There is a large selection of low-fat products available in my neighborhood.	1–5[d]	6	1–5	0.94
Store motivation	How important are each of the following factors in your decision to shop at the store where you **buy most of your food**? – Selection of foods – Quality of foods – Prices of foods	1–4[b]	3	1–4	0.67
Price of fruits and vegetables	At the store **where you buy most of your food**, how would you rate the price of fresh fruits and vegetables?	1–4[e]	1	1–4	na

(continued on next page)

Table 1. Survey Items, Cronbach Alpha Values, and Possible Ranges for Composite Items Assessing Perceived Nutrition Environments *(continued)*

Composite item	Survey item(s)	Item range	No. of items	Total possible range	α
Placement/promotion of unhealthy items	Please mark whether you agree or disagree with the following statements for the store **where you buy most of your food** and your shopping habits at that store. – I often buy food items that are located near the register. – The unhealthy foods are usually located near the end of the aisles. – I often buy items that are at eye level on the shelves. – There are lots of signs and displays encouraging me to buy the unhealthy foods. – The foods near the cash register are mostly unhealthy choices.	1–5[d]	5	1–5	0.54
Placement/ promotion of healthy items and nutrition information	Please mark whether you agree or disagree with the following statements for the store **where you buy most of your food** and your shopping habits at that store. – I notice signs that encourage me to purchase healthy foods – I see nutrition labels or nutrition information for most packaged food at the stores.	1–5[d]	2	1–5	0.41
Restaurant consumer nutrition environment					
Availability of healthy options	Please mark whether you agree or disagree with the following statements: – There are many healthy menu options at the restaurant. – It is hard to find a healthy option when eating out at a restaurant. – It is easy to find healthy fruit and vegetable choices at the restaurant.	1–5[d]	3	1–5	0.63
Restaurant promotes healthy options/ nutrition information	Please mark whether you agree or disagree with the following statements: – The restaurant provides nutrition information (such as calorie content) on a menu board or on the menu. – Signs and displays encourage overeating or choosing unhealthy foods from the menu. – The menu or menu board highlights and promotes the healthy options at the restaurant.	1–5[d]	3	1–5	0.56
Costs more to buy healthy option	Please mark whether you agree or disagree with the following statement about the restaurant **where you go most often**: – It costs more to buy the healthy options.	1–5[d]	1	1–5	na
Home food environment					
Availability of fruits and vegetables in the home	Please indicate whether each of these food items were available in your home in the past week: – Bananas, apples, grapes, carrots, tomatoes, dark leafy greens (spinach, collards, kale, etc.)	0–6	6	0–6	na
Availability of healthy food in the home	Please indicate whether each of these food items were available in your home in the past week: – Bananas, apples, grapes, low-fat milk, diet soda, carrots, tomatoes, dark leafy greens (spinach, collards, kale, etc.), reduced-fat hot dogs, whole-grain bread	0–11	11	0–11	na

(continued on next page)

Table 1. Survey Items, Cronbach Alpha Values, and Possible Ranges for Composite Items Assessing Perceived Nutrition Environments *(continued)*

Composite item	Survey item(s)	Item range	No. of items	Total possible range	α
Availability of unhealthy food in the home	Please indicate whether each of these food items were available in your home in the past week: – Candy or cookies, snack chips (potato chips, corn chips, tortilla chips, etc.), regular whole milk, regular (non-diet) soda, regular hot dogs, white bread	0–7	7	0–7	na
Accessibility of healthy food in the home	In your home, how often do you… – have fruits and vegetables in the refrigerator? – have fruit available in a bowl or on the counter?	1–4[f]	2	1–4	0.73
Accessibility of unhealthy food in the home	In your home, how often do you… – have candy or chips available to eat? – have ice cream, cake, pastries, or ready-to-eat sweet baked goods (cookies, brownies, etc.)?	1–4[f]	2	1–4	0.76

[a]Response options: 4=10 min or less; 3=11 to 20 min; 2=21 to 30 min; 1=More than 30 min.
[b]Response options: 1=not at all important to 4=very important.
[c]Response options: 1=not at all important to 3=very important.
[d]Response options: 1=strongly disagree to 5=strongly agree.
[e]Response options: 1=Very expensive to 4=Very inexpensive.
[f]Response options: 1=never or rarely to 4=almost always.

Table 2. Demographic Characteristics of Participants by Neighborhood[a]

	Total (n=221)	Neighborhood A (n=54)	Neighborhood B (n=58)	Neighborhood C (n=54)	Neighborhood D (n=55)	
	% or M (SD)	% or M (SD)	% or M (SD)	% or M (SD)	% or M (SD)	p-value
Age (in years)	45.1 (11.1)	43.1 (11.9)	47.1 (9.7)	43.4 (11.0)	46.7 (11.3)	0.117
Gender						
Female	70.1 (155)	72.2 (39)	51.7 (30)	74.1 (40)	83.6 (146)	**0.002***
Male	29.1 (66)	27.8 (15)	48.3 (28)	25.9 (14)	16.4 (9)	
Race						
Black/African American or other	51.8 (113)	77.8 (42)	100.0 (56)	15.1 (8)	12.7 (7)	≤**0.001****
White/Caucasian	48.2 (105)	22.2 (12)	0.0 (0)	84.9 (45)	87.3 (48)	
Education						
≤High school graduate or GED certificate	25.0 (55)	33.3 (18)	45.6 (26)	13.0 (7)	7.3 (4)	≤**0.001****
Some college or technical school	29.1 (64)	44.4 (24)	40.4 (23)	7.4 (4)	23.6 (13)	
College graduate or more	45.9 (101)	22.2 (12)	14.0 (8)	79.6 (43)	69.1 (38)	
Marital status						
Married or living with a partner	40.9 (90)	29.6 (16)	8.8 (5)	55.6 (30)	70.9 (39)	≤**0.001****
Separated/divorced or widowed	20.0 (44)	16.7 (9)	35.1 (20)	18.5 (10)	9.1 (5)	
Never been married	39.1 (86)	53.7 (54)	56.1 (32)	25.9 (14)	20.0 (11)	
Employment status						
Full-time employment	30.5 (67)	27.8 (15)	15.8 (9)	38.9 (21)	40.0 (22)	**0.006***
Part-time employment	27.7 (61)	31.5 (17)	21.1 (12)	25.9 (14)	32.7 (18)	
Unemployed, actively seeking employment	15.9 (35)	14.8 (8)	31.6 (18)	9.3 (5)	7.3 (4)	
Unemployed, not seeking employment	25.9 (57)	25.9 (14)	31.6 (18)	25.9 (14)	20.0 (11)	
Annual household income						
<$50,000	62.4 (121)	80.4 (37)	100.0 (50)	44.0 (22)	25.0 (12)	≤**0.001****
≥$50,000	37.6 (73)	19.6 (9)	0.0 (0)	56.0 (28)	75.0 (36)	

Note: Boldface indicates statistical significance (*$p \leq 0.01$; **$p \leq 0.001$).
[a]Neighborhoods A and B are lower SES, and neighborhoods C and D are higher SES.
GED, General Educational Development test.

There were significant differences in healthy food availability between neighborhoods, with residents of the higher-SES neighborhoods reporting higher availability scores within the store consumer nutrition environment ($p<0.001$). There were no significant differences by neighborhood for other dimensions of the store consumer nutrition environment. Within the restaurant consumer nutrition environment, respondents in the higher-SES neighborhoods reported stronger agreement that healthy options were available in nearby restaurants ($p=0.005$) and greater disagreement that it costs more to buy the healthy options ($p=0.017$). Participants from lower-SES neighborhoods reported that they observed more promotion of healthy options and nutrition information at restaurants ($p \leq 0.001$).

Table 3. Perceptions of Community, Consumer, and Home Nutrition Environments, by Neighborhood[a]

	Possible range	Total M (SD)	Neighborhood A M (SD)	Neighborhood B M (SD)	Neighborhood C M (SD)	Neighborhood D M (SD)	*p*-value
Community nutrition environment							
Store access	1–16	8.9 (3.3)	9.3 (3.6)	8.1 (3.1)	8.8 (3.4)	9.6 (3.3)	0.089
Restaurant access	1–12	6.3 (3.1)	6.4 (3.3)	6.5 (2.8)	5.7 (2.8)	6.6 (3.5)	0.470
Store consumer nutrition environment							
Store availability of healthy items	1–5	4.1 (1.1)	3.8 (1.1)	3.6 (1.1)	4.4 (0.8)	4.5 (0.9)	**≤0.001****
Store motivation	1–4	3.7 (0.4)	3.8 (0.4)	3.6 (0.6)	3.8 (0.4)	3.8 (0.3)	0.123
Price of fruits and vegetables	1–4	2.4 (0.1)	2.5 (0.6)	2.6 (0.7)	2.6 (0.6)	2.7 (0.7)	0.343
Placement/ promotion of unhealthy items	1–5	2.8 (0.7)	2.8 (0.9)	2.8 (0.8)	2.8 (0.7)	2.9 (0.5)	0.899
Placement/ promotion of healthy items and nutrition information	1–5	3.5 (1.0)	3.3 (1.1)	3.4 (1.1)	3.7 (0.9)	3.7 (0.8)	0.121
Restaurant consumer nutrition environment							
Availability of healthy options	1–5	3.2 (0.1)	3.4 (1)	3.1 (0.8)	3.6 (0.9)	3.7 (1)	**0.005***
Restaurant promotes healthy options and nutrition information	1–5	2.7 (0.2)	2.9 (1.2)	2.9 (1.0)	2.4 (0.9)	2.3 (0.8)	**≤0.001****
Costs more to buy healthy option	1–5	3.2 (1.4)	3.3 (1.5)	3.7 (1.3)	2.9 (1.3)	2.9 (1.4)	**0.017***
Home food environment							
Availability of fruits and vegetables in the home	0–6	4.1 (1.5)	4.1 (1.4)	3.8 (1.7)	4.3 (1.5)	4.3 (1.4)	0.250
Availability of healthy food in the home	0–11	6.5 (2.3)	6.5 (2.1)	5.6 (2.6)	7.1 (2.1)	7 (2.1)	**≤0.001****
Availability of unhealthy food in the home	0–7	3.9 (1.8)	4.2 (1.8)	5.0 (1.6)	3.2 (1.4)	3.2 (1.8)	**≤0.001****
Accessibility of healthy food in the home	1–4	3.2 (0.8)	3.1 (0.8)	2.6 (0.8)	3.4 (0.7)	3.7 (0.5)	**≤0.001****
Accessibility of unhealthy food in the home	1–4	2.6 (0.8)	2.6 (0.8)	2.7 (0.8)	2.6 (0.8)	2.5 (0.9)	0.632

Note: Boldface indicates statistical significance ($p \leq 0.05$; $p \leq 0.001$).
[a]Neighborhoods A and B are lower SES, and neighborhoods C and D are higher SES.

There were no significant differences across neighborhoods in the reported availability of fruits and vegetables in the home; however, higher-SES-neighborhood residents had more healthy items ($p=0.001$) and fewer unhealthy items ($p \leq 0.001$) available compared to those in lower-SES neighborhoods. There were no significant differences across the neighborhoods related to the convenient accessibility of unhealthy food in the home. Residents of the more-affluent neighborhoods reported significantly higher scores related to the accessibility of healthy foods at home ($p \leq 0.001$).

Kappa coefficients or ICCs were calculated for 17 key constructs, with nine items indicating good agreement (>0.60). Thirteen items indicated moderate to good agreement (0.52–0.83). Table 4 summarizes the test–retest reliability for these constructs.

Table 4. Test–Retest Reliability of Key Constructs

Constructs and number of items	Number of Items	ICC or K (95% CI)
Community nutrition environment		
Store distance	1	0.68 (0.60, 0.75)
Store convenience	2	0.53 (0.42, 0.62)
Fast-food restaurant distance	1	0.55 (0.43, 0.62)
Sit-down restaurant distance	1	0.62 (0.52, 0.70)
Consumer nutrition environment		
Store availability of healthy options	6	0.68 (0.60, 0.75)
Store motivation	3	0.28 (0.15, 0.40)
Store price of fruits and vegetables	1	0.41 (0.29, 0.51)
Store placement/promotion of unhealthy items	5	0.52 (0.42, 0.61)
Store placement/promotion of healthy items and nutrition information	2	0.52 (0.41, 0.61)
Restaurant availability of healthy options	3	0.65 (0.57, 0.72)
Restaurant promotes healthy options/ nutrition information	3	0.46 (0.35, 0.56)
Restaurant cost: costs more to buy healthy option	1	0.49 (0.38, 0.58)
Home food environment		
Availability of fruits and vegetables in the home	6	0.61 (0.52, 0.69)
Availability of healthier food in the home	11	0.70 (0.63, 0.77)
Availability of unhealthy food in the home	7	0.76 (0.69, 0.81)
Accessibility of healthy food in the home	2	0.83 (0.79, 0.87)
Accessibility of unhealthy food in the home	2	0.70 (0.62, 0.76)

ICC, intraclass correlation coefficient; K, kappa coefficient.

Discussion

The NEMS-P was developed using a multiphase systematic measurement development process. After initial revisions, the survey items were shown to be easy to understand, have good test–retest reliability, and discriminate between neighborhood food environments in disadvantaged compared to more-affluent communities. The survey, though somewhat lengthy, can be used with just the core "perceived food environment" items, which most respondents could complete within 5–8 minutes. One core construct, "store motivation," assessed the relative strength of respondents' reasons for shopping at a given food store—price, quality, and selection. This construct had weak test–retest reliability and requires further examination.

Previous studies have used small sets of questionnaire items, often asking about the availability and cost of fresh fruits and vegetables.[34,36] Research and action to improve access to healthy foods has advanced to include additional constructs, and to include restaurants and homes as key sources for obtaining food and making healthy choices more convenient. The NEMS-P is an important step forward in developing a psychometrically sound and conceptually grounded tool that can be used in a variety of communities and complement observational and geospatial assessments of nutrition environments. As with any tool, the NEMS-P has its limitations. For example, more questions about perceptions of the home food environment may be useful in future adaptations of this tool.[7]

A better understanding of individuals' perceptions of their food environments is necessary to continue developing and evaluating future policy and food access interventions to reduce health disparities, obesity, and related chronic diseases. A shorter subset of the NEMS-P might be useful for surveillance across communities and states. In addition, further analyses

from the current study should examine the relationships between perceived and observed nutrition environments and among food environments, diet, and health.

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Appendix

Supplementary data

Supplementary data associated with this article can be found at http://dx.doi.org/10.1016/j.amepre.2015.02.004.