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ORIGINAL RESEARCH

Examining commonly used perceived and objective measures of fruit and vegetable access in low-income populations and their association with consumption

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Abstract

Perception-based and objective food access measures are often examined as factors influencing individuals' shopping decisions and dietary habits, but the relative influence of these two factors on behaviors needs further examination. This study sought to (a) determine if perception-based and objective measures of fruit and vegetable (F&V) access were related and (b) examine perception-based and objective access measures as predictors of F&V consumption. Participants were recruited as part of a larger intervention study from 12 sites across three urban North Carolina counties. Perception-based food access measured included self-reported perceptions of convenience, variety, and quality of F&V within a neighborhood. Food outlet density was used as the objective measure. This was derived by summing the total number of geocoded convenience stores, grocery stores, supermarkets, and supercenters located within 1 road network mile of participants' home address. Associations between perception-based and objective measures were examined using Pearson's correlations, and associations of F&V access and intake were examined using linear regression models. Pearson correlations between perception-based and objective measures revealed that F&V variety was associated with supermarkets. Regression results show that perception-based barriers to F&V access were not significantly associated with intake, but supercenter density within 1 mile was significantly associated with decreased F&V intake. Common measures of perception-based and objective measures of food access may not be the best predictor of F&V intake. Understanding the relationships of these factors for lower-income populations can offer guidance for future policies and programs.

Keywords

Food access, Geographic information systems, Diet, Low-income populations

Implications

Practice: Researchers should think carefully about how the term "convenience" is conveyed to participants when discussing food access.

Policy: Policymakers working to improve fruit and vegetable (F&V) access should continue working with researchers to identify specific factors that link F&V access and consumption and determine the direction and magnitude of their association.

Research: Distance to food outlets matters, but there may be other factors at play that have a stronger effect on F&V intake, so future research should examine perceived distance measures as a comparison to a convenience measure.

INTRODUCTION

Accessibility to and type of food stores may influence individuals' diets for low-income populations [1]. Grocery stores and supermarkets are more likely to offer fresh and less processed food, which is associated with better health, than food outlets, such as convenience stores, corner stores, or gas stations [2]. Over the past several years, the term "food desert" has become prevalent in nutrition and food policy and is used to describe areas that lack access to grocery stores. The U.S. Department of Agriculture (USDA) defines food deserts as "urban neighborhoods and rural towns without ready access to fresh, healthy, and affordable food" [3]. Low-income census tracts qualify as food deserts if they have at least one-third of the census tract's population living more than 1 mile from a supermarket or large grocery store in urban areas or 10 miles in rural areas [4].

Communities identified as food deserts using the USDA's definition may receive public or private funding to improve access to healthy food, whereas communities that lack the food desert definition may have greater difficulty in qualifying for the same opportunities [5–7]. Recently, public policies increasing access to healthy food have focused on placing grocery stores in food deserts [8,9]. However, living closer to food stores that sell fruit and vegetable (F&V) may only be one component of improving F&V consumption among low-income individuals [10]. Literature suggests that both geographic proximity to food stores (i.e., measured objectively using mapping software) and perceived access (convenience of purchasing and preparing

fresh F&V, affordability, quality, and variety of F&V), along with an individual's knowledge and skills for cooking and preparing F&V, influence individuals' shopping decisions and diets [11–13]. Therefore, access to and consumption of fresh F&Vs should be viewed as a multidimensional issue that can be explained using a socio-ecologic framework, which includes various individual, interpersonal, community, and policy-level influences [11]. These factors can interact with each other to influence F&V access and, in turn, F&V consumption.

Many studies on F&V access focus on objective measures of F&V access, including distance to and/or density of food outlets in an area using geographic information systems (GIS) [14–16]. When assessing the impact of the food environment on diet, GIS is used to measure individuals' proximal store density and/or distance to the closet store [15]. One common shortcoming of many GIS studies is that they lack important store characteristics as they are more difficult to derive from secondary sources. For example, many GIS studies do not differentiate discount grocery stores from high-end grocery stores, which may be unaffordable and, therefore, inaccessible to lower-income individuals. Also, few GIS-based studies incorporate information about the quality of the produce at the stores or the store's ability to accommodate customer needs [13,16].

Individuals' perceptions about the convenience of purchasing and preparing fresh F&V, as well as the affordability, quality, and variety of fresh F&V available in stores, have been cited as factors influencing F&V access and consumption [12]. Thus, understanding perceptions of the food environment may be just as important as objectively measuring the food environment. For example, one study by Dubowitz et al. used a matched control design to determine whether opening a grocery store in a new community improved diet. While residents of the community with the new grocery store did show some improvements in diet, they were not related to shopping at the store [10]. However, those who used the store were more likely to report increased perceived access to healthy food.

While some studies have begun to assess more complex relationships between F&V access and intake [13,16], there are still a limited number of existing studies. This study builds on previous methodology for examining F&V access by including both perception-based and objective (GIS-based) measures of the food environment. A review of the literature examining the association between food environment and diet suggests that perceived access to F&V may be more likely to influence F&V intake than store proximity [13]. Additionally, perception-based and objective measures do not always coincide—for example, in Gustfason's study, as the number of healthy food items decreased in a store, the probability of perceiving the store as having healthy food increased by participants [17]. Other studies have found that perception-based and objective measures are associated, but further validation is needed [18].

Thus, there is a need for a clearer understanding of the impact of using two common measures of perception-based and objective measures of the food environment and the impact that perceived and objective access have on dietary behaviors. Given this need, the purpose of this study is to (a) to examine the convergent validity of perception-based and objective measures of F&V access and (b) examine the associations of perception-based and objective F&V access measures with F&V consumption.

METHODS

Sample and data sources

Data used in this study comes from the Green Cart Evaluation study [18]. The Green Cart Evaluation was a 12-site randomized controlled trial conducted in three North Carolina counties to examine the efficacy of using mobile produce markets to increase F&V consumption in low-income communities. The Green Cart Study team identified potential research partners through established community relationships and targeted organizations that would potentially meet selection criteria. Organizations serving the target population (e.g., low-income, limited access to F&V, and interest in a mobile market program) were prioritized for enrollment. Sites were deemed eligible if they provided resources, services, or programs for low-income populations, had an invested site liaison, had a means for communicating regularly with members (e.g., newsletters, emails, and texting), and had a space that could serve as a weekly delivery site for the mobile market. Examples of enrolled community organizations include health clinics, libraries, recreation centers, schools, health departments, churches, and community centers. The goal was for each study site randomized to the intervention to receive the mobile market program for at least 1 year [19].

Once sites were approved by the recruitment team, an initial interest form collection phase was implemented to assess community member interest. In order to prioritize the enrollment of the target population, interest forms were used to screen and categorize participants into three blocks for recruitment: (a) self-report receipt of government assistance, (b) self-report barriers to F&V intake (but no government assistance), and (c) no self-report government assistance or barriers to F&V intake.

Individuals were eligible for the study if they were (a) the primary food purchaser for the household, (b) were at least 18 years of age, (c) were able to speak and understand English, and (d) were interested in purchasing produce from a mobile market if it were to come to their community. Participants were

administered a baseline and a 6 month follow-up survey via the telephone by trained research assistants and took approximately 30 min to complete. This study only includes data from the baseline survey.

In the baseline survey, participants were asked about their perceived access to fresh F&V within 1 mile of their neighborhood, dietary habits, cooking behaviors, transportation, and demographic information, including home address. To view a full list of all questions asked in the survey, see Leone et al. [19]. A total of 201 participants from 12 community sites were included in this study. Institutional Review Board (IRB) at the University of North Carolina-Chapel Hill approved all procedures (IRB Study #12-1689).

Food outlet information was obtained from ReferenceUSA [20], an online database of businesses, which has been used in multiple food access studies [21–23]. Using the North American Industry Classification System (NAICS), the following NAICS codes were used to identify grocery stores (445110), supermarkets (445110), supercenters (452311) convenience stores (445120), and convenience stores with gas stations (447110). To verify food outlets, ReferenceUSA continuously updates business information using more than 5,000 public sources annually. ReferenceUSA verifies businesses by ensuring (a) that they are still operating, (b) the location is correct, and (c) that all of the information about the business they collect is accurate. For this study, convenience stores with and without gas stations were combined into a single category.

Participant and food store addresses were batch geocoded using the Google Application Program Interface via the BatchGeo website, verified using Internet listings and satellite imagery, and then uploaded to ArcMap version 10.1 (ESRI 2012. ArcGIS Desktop: Release 10.1. Redlands, CA: Environmental Systems Research Institute). A total of 201 participant addresses were obtained from the Green Cart Study.

MEASURES

The primary outcome, F&V intake (cups per day), was assessed using the 10-item National Cancer Institute F&V screener and calculated according to the screener instructions [24]. This F&V screener asks about the consumption of fruit, juice, lettuce salad, French fries/fried potatoes, other white potatoes, cooked dried beans, tomato sauce, vegetable soups, and mixtures that included vegetables [53]. Participants are asked to indicate the daily frequency of intake over the past 30 days and usual serving size, which are then multiplied to calculate cups per day for each item. To create the F&V intake measure, we summed the responses (in cups per day) for all F&V items.

Three types of objective measures were used in this study to examine differences in estimating perception-based versus objective F&V accessibility. The first objective measure was food outlet density using the same distance value of 1 mile (the value used in the perceived access questions and which is reasonable for walking, as well as the appropriate value for an urban area as defined by the USDA's definition of food deserts). Food outlets were separated into four categories: (a) convenience stores, (b) grocery stores, (c) supermarkets, and (d) supercenters. Food outlet density was derived by summing the total number of stores within each category (convenience stores, grocery stores, supermarket, and supercenters) located within 1 road network mile buffer of participants' home address. A road network mile means traveling from the origin (i.e., the participants' home address) using the network of roads that already exist to a destination (i.e., a store) 1 mile from the origin. A road network mile buffer is a polygon zone area around an area following the network of roads that already exist from the origin to a destination 1 mile away.

Self-reported F&V access was measured using three neighborhood perceived access questions adapted from previous studies. The neighborhood perception-based access questions were: (a) it is easy to buy fresh fruits and vegetables in my neighborhood ("convenience"); (2) there is a large selection of fresh fruits and vegetables in my neighborhood ("variety"); and (3) the fresh fruits and vegetables in my neighborhood are high quality ("quality") [25]. Participants were asked to think about their neighborhood as the area within a 20 min walk or about a mile from their home. Participants chose responses from a five-point Likert scale: "Strongly Agree" = 1; "Agree" = 2; "Feel Neutral" = 3; "Disagree" = 4; and "Strongly Disagree" = 5. Due to a lack of variability in the survey results to the perception-based measures, responses were recoded to a binary scale.

Participants that reported strongly agreeing or agreeing to have access were coded as "1 = access". Participants reporting feeling neutral, disagreeing, or strongly disagreeing to having access were coded as "0 = no/neutral access."

Participant-level characteristics included gender, age, race/ethnicity, education (high school degree or less; some college; college degree; and more than college degree), and receipt of government assistance (a dichotomous "yes/no" variable derived from self-reported receipt of Supplemental Nutrition Assistant Program; the Special Supplemental Nutrition Assistance Program for Women, Infant, and Children's program; Medicaid; Temporary Assistance for Needy Families; free or reduced-price school lunch; Head Start; and/or Social Security Disability Benefits.

Statistical analysis

Descriptive statistics were examined to provide information on the characteristics of the sample.

Pearson's correlations were conducted to examine the convergent validity between perception-based and objective measures of access. Convergent validity measures constructs that theoretically are related to one another. Pearson's correlation measures the strength (low vs. high correlation) and direction (positive vs. negative association) of the relationship between two variables.

Linear regression models were used to determine whether objective measures or perception-based access F&V measures were associated with F&V intake. The following three separate models were run: (a) objective measures of food outlets within 1 mile of a participant's home, (b) perception-based F&V access measures, including quality, variety, and convenience, and (c) a full model that included both perception-based and objective measures. The full model is listed below:

$$y = \beta_0 + \beta_1 \text{Objective} + \beta_2 \text{Perceived} + \varepsilon$$

where F&V intake is represented by y; objective F&V measures include food outlet density; neighborhood perception-based F&V access measures include convenience, variety, and quality. Since neither gender, education, nor race was significantly correlated with perception-based and objective measures of F&V access, we did not include them in the final regression model. All analyses were conducted using STATA version 14.

RESULTS

Description statistics

The majority of participants were female (93.0%), an average of 45.2 years of age, had some college education or less (61.7%) and received at least one type of government assistance (62.6%; see Table 1). Daily F&V was an average of 3.38 cups per day. Convenience stores outnumbered grocery stores, supermarkets, and supercenters within 1 mile of participants' homes (2.62 vs. 0.62, 0.42., and 0.23 respectively). On average, participants did not have access to a grocery store, supermarket, or supercenter within 1 mile of their home. In terms of neighborhood perception-based access measures, the majority of participants (71.0%) reported having convenient access to F&V, 61.0% reported having access to a high variety of F&V, and 51.0% reported having access to high-quality F&V.

Objective versus neighborhood perception-based F&V access measures

Pearson correlations between the self-reported neighborhood perception-based access measures and objective measures reveal that Green Cart Study participants' perception-based access aligned well with some of the objective measures (Table 2). Perception-based access to F&V variety was significantly and positively correlated with the number of supermarkets within 1 mile of a participant's home ($p < .05$). None of the other objective measures were significantly associated with perception-based F&V access measures. There were no differences

Table 1 | Characteristics of Green Cart participants ($N = 201$)

Characteristic	Participants number (%)
Gender	
Female	187 (93.0)
Male	14 (7.0)
Age	
Age (mean, *SD*)	45.2 (13.5)
Did not answer (#, %)	2 (1.0)
Race/ethnicity	
African American	123 (62.1)
White	66 (33.3)
Other	9 (7.5)
Did not answer	3 (1.5)
Hispanic or Latino	
Yes Hispanic/Latino	9 (4.5)
Did not answer	2 (4.0)
Education	
High school or less	74 (36.8)
Some college	50 (24.9)
College graduate	40 (19.9)
More than college	37 (18.4)
Did not answer	2 (1.0)
Government assistance	
Yes	124 (62.6)
No	74 (37.4)
Did not answer	3 (1.5)
Annual household income	
Less than $10,000	38 (18.9)
$10,000–29,999	58 (28.9)
$30,000–49,999	41 (20.4)
$50,000 or more	44 (21.9)
Did not answer	20 (10.0)
F&V intake (cups/day)	
Daily F&V (mean, *SD*)	3.41 (1.3)
GIS-based measures (mean, *SD*)	
Convenience stores 1 mile (mean, *SD*)	2.67 (3.0)
Grocery stores 1 mile (mean, *SD*)	0.62 (1.2)
Supermarket 1 mile (mean, *SD*)	0.42 (0.64)
Supercenter 1 mile (mean, *SD*)	0.23 (0.19)
Neighborhood perceived access measures	
Convenience ($n = 165$)	
Yes convenient	133 (19.4)
No/neutral convenient	32 (80.6)
Variety ($n = 165$)	
Yes high variety	107 (64.6)
No/neutral high variety	58 (35.2)
Quality ($n = 165$)	
Yes high quality	91 (55.2)
No/neutral high quality	74 (44.6)

F&V fruit and vegetable; *GIS* geographic information systems; *SD* standard deviation.

Table 2 | Pearson's correlation coefficients representing the association between neighborhood perceived and objective measures of fruit and vegetable (F&V) access

Objective characteristic	Neighborhood perceived F&V convenience	Neighborhood perceived F&V variety	Neighborhood perceived F&V quality
Convenience stores (1 mile)	−0.087	0.14	−0.051
Grocery stores (1 mile)	−0.047	0.13	−0.040
Supermarkets (1 mile)	0.085	0.15*	0.064
Supercenters (1 mile)	0.063	0.027	0.051

*$p < .05$.

Table 3 | Regression estimates for perception-based and objective measures of F&V access and associations between fruit and vegetable (F&V) consumption (full model), $N = 158$

Measures	F&V intake (cups/day)
Perception based	
Convenience	0.26 (0.26)
Variety	0.40 (0.28)
Quality	−0.28 (0.28)
Objective based	
Convenience stores (1 mile)	−0.067 (0.050)
Grocery stores (1 mile)	0.18 (0.15)
Supermarkets (1 mile)	0.13 (0.14)
Supercenters (1 mile)	−0.55* (0.24)
R^2	1.2
Root mean-squared-deviation	1.24
Prob > F	0.13

Robust standard errors listed in parenthesis.
*$p < .05$

in self-reported perceived access by race/ethnicity ($\chi^2 = 7.1, p = .31$), education ($\chi^2 = 0.8, p = .85$), use of government assistance ($\chi^2 = 1.17, p = .28$), or gender ($\chi^2 = 1.65, p = .20$).

Regression model estimates

To determine model fit, a plot of the full model's residuals was used to check for normality in the error term. A histogram revealed a fairly normal distribution. However, after running a skewness–kurtosis test, there was evidence of the error term being nonnormally distributed ($p < .01$). Therefore, robust standard errors were used to correct for heterskedasticity. After controlling for missing data, the sample size for the regression models was 158. Separate regression models examined (a) food outlets within 1 mile of a participant's home and (b) self-reported perception-based access to F&Vs. In both models, there were no significant associations, so only the full model is presented in this study.

Perception-based and objective measures of F&V access and intake

None of the perception-based measures (convenience, variety, and quality) were significantly associated with F&V intake (see Table 3). There was only one statistically significant finding for objective measures of F&V access and intake. Objectively measured access to supercenters within 1 mile of a participant's home was associated with lower self-reported F&V intake ($p < .01$). Each additional supermarket within 1 mile of a participant's home was associated with a decrease in F&V intake by 0.61 cups/day.

DISCUSSION

The purpose of this study was to compare two methods for measuring F&V: perception-based access measures (convenience, variety, and quality of F&V using validated self-report questions) and objective measures (distance to stores and store density by type using GIS). Results from this and other studies suggest that the relationship between perception-based and objective F&V access and intake is complex and difficult to measure unilaterally. Additionally, models examining F&V access often do not account for cultural and safety issues that might impact F&V access and intake [15]. Acknowledging that food access is complex and includes a myriad of local factors is important for policymakers to consider when addressing F&V access [26].

The weak correlations that this study found between the perception-based and objective measures may further indicate that one is not an adequate substitute for another. This is substantiated by our finding that the density measures did not correlate at all with the perceived convenience or quality of F&V. Results from the Pearson correlation showed that the neighborhood perception-based access measure of F&V variety was significantly and positively correlated with the objective measure of supermarkets within 1 mile of a participant's home. However, the correlation between F&V variety and presence of supermarkets was weak. The relationship between these two variables is challenging conceptually as they are two concepts that may not be directly comparable due to representing different factors. Thus, despite the correlation, these results may not be meaningful.

Additionally, the measure of "convenience," which was defined as "It is easy to buy fresh fruits and vegetables in my neighborhood" may be viewed differently by participants. Focusing only on neighborhood convenience may not be appropriate in terms of F&V access, since people may shop outside of their neighborhood for F&V in

locations that are convenient to frequented destinations, such as worksites, schools, or faith-based locations. Zenk et al. reported that women in their study faced several barriers to obtaining reasonably priced food in their neighborhoods. Therefore, they developed what the authors termed as "adaptive strategies" for obtaining desired foods [27]. These adaptive strategies included shopping at multiple food stores and traveling outside their neighborhood [27]. Although this illustrates that people are able to obtain food when there is limited access to high-quality foods in their local supermarkets, efforts should still be made to create equitable access, especially in rural areas where the number and type of food outlets are limited [16]. Understanding the reasons why people shop at certain food stores can help inform specific strategies and policies to improve F&V consumption.

In our full regression model that included both objective and perception-based F&V access measures, we did not find a statistically significant association between perception-based access measures and F&V consumption. Additionally, for the objective measures, the only food outlet that was significant was supercenters—which was associated with a decrease in F&V intake. This may be due to customer's attention span in that there are more distractions in terms of the number of items available to purchase at supercenters (e.g., these stores have more nonfood items than other food outlets do). Two other North Carolina studies have reported various findings with the connection between supercenters and diet. In Gustfason et al.'s study, they examined 186 low-income women's perceptions of the food environment and its association with diet. For the objective measures, they used the number and type of food stores within a census tract. Participants who lived in census tracts with a supercenter and a convenience store consumed fewer servings of F&Vs than those without a supercenter and a convenience store [17]. Another study in North Carolina examining the association between distance to food outlets and F&V consumption found that participants living closer to supermarkets had the lowest F&V intake. However, F&V intake increased when participants lived between 2 and 3 miles to a supermarket and then decreased as the distance to a supermarket increased [28].

This is in contrast to another study that found that, for each additional supermarket in a census tract, F&V consumption increased by 32% among African American residents [1]. Additionally, in Sallis and Glanz's systematic review focusing on geographic proximity, they found that the presence of grocery stores or supermarkets in communities was associated with the probability of having a healthier diet [29]. However, a longitudinal study involving over 5,000 young adults found that having geographic access to more supermarkets was unrelated to F&V consumption [30]. The fact that studies using geographic proximity to measure the association between F&V access and consumption have had mixed results suggests that living closer to food stores that sell F&V may be necessary, but not sufficient, to improve F&V intake among low-income individuals.

Although we did not find a significant association between living within a 1 mile of a convenience store and F&V consumption, another study reported that the presence of convenience stores in the community was associated with a lower F&V intake of 1.84 servings per day [31]. In terms of distance to store, on average, participants in the Green Cart study reported traveling 5.1 miles to their preferred grocery store. Given this study's findings and other studies, distance traveled to food stores might be an important variable in elucidating the association between perception-based access, objective access, and F&V intake. However, when accounting for distance to stores, researchers and policymakers should consider rural versus urban communities, as shopping patterns and habits may vary [16,21].

In this study, convenience stores outnumbered grocery stores, supermarkets, and supercenters within 1 mile of participants' homes. Therefore, this may have impacted participants' F&V intake. However, even when F&V are available, low-income individuals often cannot afford them. In the past 20 years, the price of fresh F&V has increased by 190% in contrast to the price of foods having high fat and oil content, sugars and sweets, and carbonated beverages (which have increased by 70%, 66%, and 32%, respectively) [32]. Additionally, since food costs are a major contributor to food-purchasing behaviors, it would make sense that, even if F&V are available, low-income individuals may not be able to purchase them [12,21,32,33]. In 2006, Hendrickson et al. conducted focus groups in Minnesota with community residents (N = 41) about barriers to shopping for healthy food in their community; cost, quality of food, and variety of food were all listed as major barriers [34].

Another important aspect to consider is that low-income residents are more likely to be at risk for food insecurity [35]. Distance to certain store types has been found to be associated with food insecurity [36] and other studies have found that very high food insecurity is linked with decreased consumption of F&V [37,38]. In a South Carolina study, households with very low food security had lower odds of reporting access to affordable F&V in their neighborhood compared to food-secure households [38]. Additionally, very low food-secure households had less variety and poorer quality of F&V to choose from than food-secure households. Therefore, policymakers wanting to address food access should be aware of the socioeconomic constraints that food-insecure residents may face when it comes to diet quality.

Limitations

The small sample size and limited geographic diversity may reduce the generalizability of this study. The site-based recruitment methodology could also limit the generalizability of the findings since low-income communities with limited food access areas were prioritized for the mobile produce markets. We used self-reported measures of consumption, which are susceptible to bias and misreporting. More importantly, it should be noted that the F&V screener questions asked participants to report on consumption of "fresh, frozen, or canned" F&V, whereas the perceived access questions asked participants to report only on access to *fresh* F&Vs. Therefore, it might be reasonable to assume that the regression model overreports fresh F&V consumption (because the measure includes fresh, frozen, and canned), leading to null findings with perceived access measures. Although this study measured perception-based and objective access, it did not determine if participants shopped at the stores located within a 1 mile radius of other places they might frequent, such as worksites, schools, or faith-based locations. Lastly, because other studies have found mixed associations between supercenters and F&V intake, there is a possibility that the significant finding for supercenters and F&V intake for this study was due to alpha error.

Translational implications

Determining which access factors have the strongest association with F&V consumption is important for increasing policymakers' understanding of which environmental changes might have the greatest impact on the diets of lower-income populations. More importantly, taking into account the presence of food outlets in a community may not be the only factor influencing F&V consumption. This is important for funders to keep in mind when financing programs to address healthy food access. In the past several years, many local and state policymakers have introduced legislation to improve access to healthy food through grocery store development, as well as increasing affordability of fresh F&Vs through food assistance programs for low-income individuals [5–9]. Based on our study, there appear to be other factors that have a stronger association with F&V intake than perceived or objective dimensions of food access. Future studies should consider obtaining more information about where and how far participants travel to buy food, as well as their motivations for shopping there, to more accurately estimate what is considered a "local food" environment. It may also be helpful for future research to examine perceived distance measures as a comparison to a convenience measure. Policymakers and advocates working to improve F&V access should continue to partner with researchers to identify specific factors that link F&V access and consumption and determine the direction and magnitude of their association.

The findings reported in this manuscript have not been previously published and the manuscript has not been submitted elsewhere for publication. The authors have full control of all primary data and we agree to allow the journal to review our data if requested. All of the authors have reviewed and approved the complete manuscript, including tables. We do not have any conflicts of interest to report; financial support for this work is disclosed in the Acknowledgments section below.

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Compliance with Ethical Standards

Conflicts of Interest: The authors declare that they have no conflicts of interest.

Authors' Contributions: Conceptualization, L.H.M., J.M., A.S.A., G.T.; methodology, L.H.M., J.M., A.S.A., G.T., and J.A.B..; formal analysis, L.H.M. and J.M..; writing—original draft preparation, L.H.M.; writing—review and editing, L.H.M., J.M., A.S.A., G.T., J.A.B. and L.A.L.

Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

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