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Socioecological Path Analytic Model of Diet Quality among Residents in Two Urban Food Deserts

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Author Contributions

All authors were involved in the conception and design of the study, data interpretation, and writing, reviewing, and approving the manuscript; Rouse and Pike assisted with data acquisition; and Bell conducted data analysis.

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Abstract

Background: Diet is critical to chronic disease prevention, yet there are persistent disparities in diet quality among Americans. The socioecological model suggests multiple factors, operating at multiple levels, influence diet quality.

Objective: The goal was to model direct and indirect relationships among healthy eating identity, perceived control of healthy eating, social support for healthy eating, food retail choice block scores, perceptions of healthy food availability, and food shopping behaviors and diet quality measured using Healthy Eating Index-2010 scores (HEI-2010) for residents living in two urban communities defined as food deserts.

Design: A cross-sectional design was used including data collected via self-reported surveys, 24-dietary recalls, and through objective observations of food retail environments.

Participants/setting: Data collection occurred in 2015–16 in two low-income communities in Cleveland (n=243) and Columbus (n=244), Ohio, USA.

Main outcome measure: HEI-2010 scores were calculated based on the average of three 24-hour dietary recalls using the Nutrition Data System for Research.

Analysis: Separate path models, controlled for income, were run for each community. Analysis was guided by a conceptual model with 15 hypothesized direct and indirect effects on HEI-2010 scores. Associations were considered statistically significant at $p < .05$ and $p < .10$ because of modest sample sizes in each community.

Results: Across both models, significant direct effects on HEI-2010 scores included healthy eating identity ($\beta=0.295$, Cleveland; $\beta=0.297$, Columbus, $p<.05$) and distance traveled to primary food store ($\beta=0.111$, Cleveland, $p<.10$; $\beta=0.175$, Columbus, $p<.05$). Perceptions of healthy food availability had a significant, inverse effect in the Columbus model ($\beta=-0.125$, $p<.05$). The models explained greater variance in HEI-2010 scores for the Columbus community compared to Cleveland ($R^2=.282$ and $R^2=.152$, respectively).

Conclusions: Findings highlight the need for tailored dietary intervention approaches even within demographically comparable communities. Interventions aimed at improving diet quality among residents living in food deserts may need to focus on enhancing healthy eating identity using culturally relevant approaches while at the same time addressing the need for transportation supports to access healthy food retailers located farther away.

INTRODUCTION

There are persistent and growing disparities in diet quality among Americans, particularly among low-income and non-Hispanic Black populations.¹ These disparities have contributed to an increased risk for preventable nutrition-related chronic diseases and highlight the need for population-based interventions to improve diet quality.² Interventions to reduce dietary disparities will be more effective if they are able to target specific factors that are making the greatest contributions to variation in dietary quality among racial and ethnic minority and low-income populations. The goal of this research was to model direct and indirect relationships of modifiable factors influencing diet quality among residents living in two urban communities defined as food deserts. These factors (e.g., healthy eating identity, social support for healthy eating, food retail choice block score) may be targeted in future interventions for urban residents living in contexts with high rates of poverty and low access to healthy food retailers (i.e., food deserts).

This study was informed by the socioecological model, a framework that highlights multiple levels of influence contributing to dietary patterns.³ Individual level factors such as identity,⁴ self-efficacy,⁵ perceived control,⁶ and behavioral capabilities⁷ are key drivers of diet. These are tempered by social and built environments that facilitate or constrain food shopping and dietary choices. Factors at the social environmental level include culture^{8, 9} and social norms⁶ as well as socially mediated interpersonal support related to food habits.^{10–12} Factors at the built environmental level, such as access and availability of healthy foods, also shape diet.^{13, 14}

This research builds on a prior study that examined the influence of built environmental factors and individual food shopping behaviors on fruit and vegetable consumption.¹⁵ The study by Liese and colleagues advanced the field by modeling the direct and indirect effects of the built food environment (e.g., number of supermarkets in participants' census tracts and a self-reported measure of perception of food environment) and food shopping behaviors (e.g., frequency of food shopping and distance to store where the majority of shopping occurred) on fruit and vegetable consumption among residents in rural and urban counties in South Carolina, USA.¹⁵ This model explained about 3% of the variance in fruit and vegetable consumption,¹⁶ and the only observed direct effect on consumption was frequency of shopping at the primary food store ($\beta=0.11$).¹⁵ The Liese study was extended to include an additional individual-level factor (e.g., eating identity) and the new model explained about five times more of the variance (16%) in fruit and vegetable consumption with three significant direct effects: healthy eating identity ($\beta=0.31$), picky eating identity ($\beta=-0.16$), and frequency of food shopping at the primary food store ($\beta=0.13$).¹⁷ This finding highlighted the importance of eating identity as a key driver of fruit and vegetable intake when considered together with characteristics of the built food environment and food shopping behaviors.

Building on an existing quasi-experimental trial, the goal of this analysis was to extend prior research in several ways. First, this study included measures related to three levels of the socioecological model that were analyzed together to understand diet quality among residents living in areas with limited access to healthy food retail. Most existing research on

factors influencing dietary behaviors is limited to one or two levels of the socioecological model.^{5, 18, 19} Second, comprehensive measures were used to assess both the built food environment through objective in-store observations as well as diet quality through three 24-hour dietary recalls. A systematic review of environmental influences on diet found that few studies used in-store observations of the food retail environment and even fewer used 24-hour dietary recalls to assess diet quality.¹³ Third, the outcome focus on diet quality rather than intake of one food type (e.g., fruits and vegetables) allowed for a more complete picture of dietary behaviors. Fourth, an additional individual level factor, perceived control of healthy eating, was included in the model. The theory of planned behavior, one of the more commonly used theories for examining dietary patterns, includes perceived control as a key driver of behavioral intentions and outcomes.^{20, 21} Perceived control is a belief that “one can determine one’s own internal states and behavior, influence one’s environment, and/or bring about desired outcomes.”²²

The conceptual model for this analysis is presented in Figure 1. The model depicts 15 hypothesized direct and indirect relationships on diet quality measured using Healthy Eating Index-2010 scores.^{23, 24} Figure 1 takes into account three levels of the socioecological model related to individual, social, and built food environments. Due to baseline differences between participants from the two study communities, separate path models were estimated for each community.

METHODS

Study Area and Approach

This is an ancillary study within a rapid response longitudinal quasi-experimental natural experiment evaluating the impact of opening a food hub on dietary behaviors. Funded under a unique mechanism for time-sensitive obesity policy evaluation research,²⁵ the goal of the natural experiment was to collect baseline data as quickly as possible prior to the opening of the food hub. These analyses are derived from cross-sectional baseline data collected from residents living in two communities in Cleveland and Columbus, Ohio, USA that had comparable racial and economic composition and access to healthy food retailers. Participants were recruited from contiguous census tracts in each community, resulting in a total of 11 tracts. Resident population was 7,088 in the Cleveland community and 11,214 in the Columbus community.²⁶ Most of the census tracts within each community (5 of 7 tracts in Cleveland, 4 of 4 tracts in Columbus) were defined as low-income and low healthy food access (i.e., food deserts) per U.S. Department of Agriculture guidelines,²⁷ and identified as areas in Ohio in greatest need of food environment interventions.²⁸ Additionally, community selection focused on areas with high rates of receipt of Supplemental Nutrition Assistance Program (SNAP) benefits and non-Hispanic Black populations based on five-year (2011–2015) American Community Survey estimates.²⁶ In the Cleveland community, 42.9% of the households received SNAP benefits and 72.2% of the residents were African American.²⁶ In the Columbus community, 37% of the households received SNAP benefits and 62.5% of the residents were African American.²⁶

A community-based recruitment approach was used to identify, screen, and enroll potential participants from August 2015 to July 2016 using mailings, flyers, public presentations, and

word-of-mouth. A total of 1,395 people expressed interest and were screened to determine eligibility. Eligibility criteria included: at least 18 years old, English speaking, living in targeted census tracts, plan to live in current neighborhood at least 12 months, and responsible for more than half of household food shopping. Study enrollment was limited to one person per household. Ineligibility was primarily due to living outside the geographic target area. All individuals who were eligible reviewed the consent form verbally in person or over the phone, had an opportunity to ask questions, and then, if interested, provided written or verbal (over the phone) informed consent. A copy of the signed consent form was provided to all participants. Among those eligible and provided informed consent (n=655), 516 completed three 24-hour dietary recalls at baseline (78.8%), which was required for inclusion in the present analysis. The most common reason for not enrolling was because participants could not be reached by phone or mail after expressing initial interest.

Data Collection

Data were collected via closed-ended phone-based surveys administered by trained research assistants that took about 60 minutes to complete. Data collection for each participant involved three phone surveys during a 30-day timeframe. All three calls included a 24-hour dietary recall. In addition, the first call included a psychosocial survey. Materials needed to support data collection (e.g., food amounts booklet with standardized information about reporting portion sizes, response options for Likert scales) were mailed to participants prior to their phone surveys. Participants were compensated \$35 after calls 1 and 2 and \$40 after call 3. The study was reviewed and approved by the Case Western Reserve University Institutional Review Board.

Individual Factors

The survey assessed two individual-level factors influencing diet quality. *Healthy eating identity* was measured as the mean of an existing 3-item measure ($\alpha=.86$).⁴ Participants rated agreement with the following statements: (a) I am a healthy eater, (b) I am someone who eats in a nutritious manner, and (c) I am someone who is careful about what I eat. *Perceptions of control of healthy eating* were assessed as the mean of a 4-item measure modified from an existing scale ($\alpha=.72$).²¹ Participants were asked to rate agreement with the following statements: (a) I have enough time to shop for fresh and healthy foods, (b) It is convenient for me to purchase fresh and healthy foods, (c) Eating a fresh and healthy diet is affordable, and (d) It is easy to eat a fresh and healthy diet. Participants were instructed that “fresh and healthy foods” included fresh fruits and vegetables, fresh meats and dairy, and unprocessed foods. Responses to both measures were coded on a 4-point Likert scale (1=strongly disagree; 4=strongly agree).

Social Food Environment

Measurement of the social food environment was assessed by asking questions related to *social support for healthy eating*. This was assessed using the mean score of an 8-item measure ($\alpha=.82$) adapted from two existing measures.^{29, 30} Participants were asked, separately for family and neighbors, how often in the past 12 months family and neighbors: (a) ate fresh and healthy foods with you, (b) encouraged you to eat fresh and healthy foods, (c) told you about fresh and healthy foods and how to prepare them, and (d) prepared fresh

and healthy foods with you. Responses were coded on a 5-point Likert scale (1=never; 5=most of the time).

Built Food Environment

Measurement of the built food environment included objective observations of food stores in the study area and self-reported perceptions of healthy food availability. An objective *retail choice block score* was calculated for all study area census blocks and then assigned to participants based on their home address.³¹ The block scores were based on two components. First, given the high rate of convenience stores, objective measures of the food environment were measured using an adapted Nutrition Environment Measures Survey in Convenience Stores (NEMS-CS), a standardized tool for evaluating availability, price, and quality of healthy food options.³² Second, to evaluate healthy and unhealthy advertising on store exteriors, an adapted Food Store Observation Form from the Bridging the Gap Community Obesity Measures Project (BTGCOMP) was used.³³ Two trained auditors completed each store observation with high inter-rater reliability (97% agreement). Using both the NEMS-CS and the BTG-COMP tools, a score for each store was calculated. Data included in this analysis represent 53 food stores located within the study area, plus the two nearest supermarkets resulting in 55 stores (Cleveland = 34, Columbus = 21). Each census block was then assigned a mean retail choice block score based on the NEMS-CS/BTG-COMP score of each store that was within ½ mile network distance from the centroid of that block (score range: -13 to 65).

Perceptions of healthy food availability was assessed using the mean score of a 3-item measure ($\alpha=.83$).^{15, 34–36} Participants were asked to think about the area within a 20-minute walk or one mile from their home and rate agreement with these statements: (a) A large selection of fruits and vegetables is available in your neighborhood, (b) The fresh fruits and vegetables in your neighborhood are of high quality, and (c) A large selection of low-fat products is available in your neighborhood. Responses were coded on a 4-point Likert scale (1=strongly disagree; 4=strongly agree).

Behavioral Measures

The main outcome of the path analysis was diet quality assessed using the *Healthy Eating Index (HEI-2010)*, a measure of diet quality based on conformity to 2010 dietary guidelines.^{23, 24} HEI-2010 scores were calculated based on data collected and processed using the Nutrition Data System for Research, a standardized and comprehensive 24-hour dietary recall method.³⁷ Three dietary recalls per person were collected, reflecting two nonconsecutive weekday and one weekend day within a 30-day window to limit within subject seasonal variability.^{38–40} HEI-2010 scores were calculated based on the average of three 24-hour dietary recalls with higher average scores (maximum=100) indicating greater adherence to dietary guidelines.

Frequency of food shopping was derived by asking participants to name the store where they buy most of the food for their household, and then report frequency of visits in either times per day, week, month, or year during the past 12 months. Responses were recoded into times per month. *Distance traveled to primary food store* was calculated using Google Maps for

the shortest distance from a participant's home address to their indicated primary store. The distributions of shopping frequency and distance to primary store were skewed, therefore variables were winsorized at the 95th percentile.

Sociodemographic Measures

Sociodemographics were measured based on self-report using questions adapted from the Behavioral Risk Factor Surveillance System.⁴¹ Questions assessed race, age, sex, level of education, annual household income, receipt of Supplemental Nutrition Assistance Program (SNAP) benefits in the past 12 months, and self-reported diet-related chronic disease such as high blood pressure, heart disease, diabetes, obesity, cancer, kidney disease.

Statistical Analysis

This analysis was conducted 2017–18 and limited to 487 participants who (a) completed three dietary recalls and (b) had valid responses for all exogenous variables in the path model. Missing data were examined and no patterns were noted, therefore listwise deletion was used.⁴² Descriptive and bivariate statistics were estimated to examine the distribution of variables and if the two communities differed on the path model variables.⁴³ Both communities differed on most variables included in Table 1 except for HEI-2010 scores, education level, and diet-related chronic disease. Accordingly, two contextual path models were estimated.⁴⁴ These included the Cleveland model ($n = 243$) and the Columbus model ($n = 244$). Each path model examined the conceptual relationships shown in Figure 1. Figures 2 and 3 depict results with standardized beta coefficients and R^2 values for statistically significant associations at the $p < .05$ and $p < .10$ levels because of the modest sample sizes in each community.

For both path models, the default option in Mplus was used for handling missing data.⁴⁴ Income, race, and sex were controlled when estimating the HEI-2010 scores portion of the path models. Because income had a significant direct effect on HEI-2010 scores, income was controlled throughout the path models (see Figures 2 and 3).

RESULTS

Study Context and Sample

The Cleveland community sample included a greater proportion of African Americans, people of lower income, and SNAP recipients compared to the Columbus community sample (Table 1). These trends align with differences in census tract demographics between the two communities. The average retail choice block score was significantly higher in Columbus (12.2) compared to Cleveland (10.4) even though more census tracts in the Columbus community were defined as food deserts per U.S. Department of Agriculture guidelines compared to the Cleveland community.²⁷ However, food retail choice block scores in both communities were relatively low given that stores with high access to a wide variety of healthy foods at affordable prices have a score of 30.³¹ The Columbus sample shopped at their primary food store significantly more often (5.8 times per month) compared to Cleveland (4.0). The average distance traveled from the home to the primary food store was shorter in Columbus (1.9 miles) than Cleveland (2.4). The Columbus sample had

significantly higher scores for all socioecological variables indicating more positive conditions related to the built, social, and individual food environment.

Community Results: Cleveland

In totality, this model explained 15.2% of the variance in HEI-2010 scores (Figure 2). Healthy eating identity ($\beta = 0.295$) and distance to primary store ($\beta = 0.111$) were the only direct variables positively associated with higher HEI-2010 scores. Perceived control of healthy eating was a significant predictor of frequency of food shopping ($\beta = 0.160$). Distance traveled to the primary store and frequency of food shopping were negatively correlated ($r = -0.117$).

The path model explained 28.6% of the variance in perceived control of healthy eating, which was the highest variance explained in the Cleveland model. There were direct, positive relationships between perceived control of healthy eating and both healthy eating identity ($\beta = 0.311$) and perception of healthy food availability ($\beta = 0.437$). There also were positive relationships between healthy eating identity and social support for healthy eating ($\beta = 0.246$, $R^2 = .061$) as well as between food retail choice block score and perception healthy food availability ($\beta = 0.109$). There were no significant indirect effects in the model.

Community Results: Columbus

In totality, the Columbus community model explained 28.2% of the variance in HEI-2010 scores (Figure 3). Similar to the Cleveland community model, healthy eating identity ($\beta = 0.297$) and distance traveled to the primary food store ($\beta = 0.175$) were positively associated with HEI-2010 scores. The perception of healthy food availability was negatively associated with HEI-2010 scores ($\beta = -0.125$).

In relation to the food shopping behaviors, perception of healthy food availability had a significant negative effect on distance traveled to primary store ($\beta = -0.199$). Distance traveled to primary store and frequency of food shopping were negatively correlated ($r = -.207$).

The path model explained 22.7% of the variance in perceived control of healthy eating. Perceived control of healthy eating was associated with two statistically significant positive direct effects: healthy eating identity ($\beta = 0.245$) and perception of healthy food availability ($\beta = 0.355$). The relationship between healthy eating identity and social support for healthy eating was also positive ($\beta = 0.276$, $R^2 = .080$), as was the relationship between food retail choice block score and perception of healthy food availability ($\beta = 0.128$).

The Columbus community model included one significant indirect effect. The total effect of perception of healthy food availability on HEI-2010 scores was -0.176 ($p = .002$). Of this total effect, -0.125 was the direct relationship between perception of healthy food availability and HEI-2010 scores. However, through its relationships with other variables in the model, perception of healthy food availability also had a -0.051 ($p = .064$) indirect effect on HEI-2010 scores (Table 2). Sixty-eight percent of this indirect effect ($-0.035/-0.051 \times 100$) was accounted for by the relationship that perception of healthy food availability had on distance to the primary food store ($\beta = -0.035$).

DISCUSSION

Findings offer an in-depth examination into two urban food desert communities illuminating some variability related to the pathways influencing diet quality within these relatively similar contexts. This study extends the field by testing a model of the collective influence of individual, social, and built food environment factors on diet quality using robust measures. The models explained 28.2% and 15.2% of the variance in HEI-2010 scores among participants living in communities defined as food deserts in Columbus and Cleveland, Ohio, respectively. Results of a meta-analysis of the theory of reasoned action found that on average it explained 27% of the variance in health behaviors.⁴⁵ Studies focused on modeling dietary behaviors such as fruit and vegetable intake explained as low as 3% of the variance¹⁵ to a high of 61%¹⁸ with many in the range of 15–30%.^{4, 5, 19} Congruent with previous research, findings of this study reveal there are other important factors, which were not measured in this analysis, influencing dietary patterns.

There are a few limitations to this research. First, the study is based on a cross-sectional design limiting capacity for causal inference. Second, the study sample included a greater proportion of people receiving SNAP compared to census data for the targeted communities, although the racial composition of the study sample mirrored census data. The study sample may be biased toward the perceptions of people receiving SNAP benefits. Third, recall bias is another risk because of the use of self-reported data collection. The use of a well-trained and consistent research team, provision of response booklets to study participants to have available for review during the interview, and multi-pass and repeated methods for collecting 24-hour dietary recall data were implemented to reduce recall bias. Fourth, although psychosocial measures were adapted from prior studies, the rapid response data collection approach constrained opportunities to assess reliability and validity of the psychosocial measures prior to use. Nevertheless, reliability for these measures was acceptable or good (Chronbach's α range: .72–.86). Finally, findings may not be generalizable to residents who are not living in urban food deserts.

Given different findings from the two path models, results reveal that residing in a food desert context may not have the same influence on diet quality. For example, in Cleveland, perceptions of healthy food availability was not significantly related to diet quality whereas in Columbus it had a significant inverse relationship with diet quality. In both communities, participants who more strongly endorsed a healthy eating identity had better diet quality and income was not a significant covariate of this effect. Given the cross-sectional design of this research, findings do not reveal the causal nature of the relationship between healthy eating identity and diet quality. It could be that better diet quality shapes healthy eating identity. Findings corroborate prior research that found healthy eating identity is positively associated with healthy eating behaviors.^{17, 46, 47} Results of this study align with recent evidence highlighting that diet is influenced by both demand-side consumer factors such as healthy eating identity and supply-side factors such as supermarket availability.⁴⁸ Demand characteristics related to healthy eating identity were important contributors to diet quality in this study context of ubiquitously low access to healthy food retailers and relatively low-income among participants.

Viewing oneself as a “doer” of an action, such as being someone who eats in a nutritious manner, has been found to help people maintain goal-directed behaviors despite obstacles.^{49, 50} Having a “self-as-doer” identity (i.e., I am a veggie eater, I am a fruit eater) may facilitate performance of social prescriptions, such as conforming to dietary guidelines.⁵⁰ However, caution is warranted because these identities do not operate in a vacuum. Dietary patterns are entwined in multiple identities shaped by social positions related to race, class, and gender.^{9, 51, 52} Prominent food studies scholar Claude Fischler once stated, “Clearly, the eater’s life and health are at stake whenever the decision is taken to incorporate, but so too are his [sic] place in the universe, his essence, his nature, in short his identity.”⁵³ Future research is needed to understand what it means to be a healthy eater for diverse populations, unpack the relationship between identity and structural barriers, and develop culturally relevant approaches to promote healthy eating identities among heterogeneous populations.

Whereas eating identity may be an important target for interventions, results also add greater depth to finding solutions for improving the built food environment as a strategy to promote healthy diet quality. In both communities, participants who were able to travel a greater distance from home to their primary food store, and thus leave their current food environment for food shopping, had better diet quality. Income was a significant covariate of this relationship in both communities indicating transportation supports such as convenient public transit or food delivery approaches may be particularly important for dietary interventions intended to reach low-income populations. This finding illuminates the potential role for developing transportation infrastructure, along with the necessary resources to obtain transportation, as an upstream target for dietary interventions.

One unexpected finding from the Columbus community model was the inverse relationship between perceptions of healthy food availability (i.e., an indicator of how participants perceived local food retail infrastructure) and diet quality. However, the relationship between food environment perceptions and diet has been found to be mixed.¹³ A prior Canadian study found an inverse relationship between income and perceptions of the food environment.⁵⁴ Similarly, in this study lower income was associated with better perceptions of the food environment, and better perceptions were associated with worse diet quality. There are several possible explanations for this finding. People who have higher income may be more likely to travel outside of their neighborhood (e.g., for work) resulting in a different frame of reference for evaluating their local food environment.⁵⁵ There also is a chance that people who eat less healthy diets were more satisfied with the food choices found within food desert contexts. Future studies using longitudinal designs are needed to assess causal relationships between perceptions of the food environment and dietary patterns.

Finally, two of the variables unique to the model used in this study (i.e., social support for healthy eating, perceived control of healthy eating) were not directly related to diet quality yet warrant examination in the future. Social support has been found to be a driver of dietary behaviors such as fruit and vegetable consumption.⁵⁶ In this study, levels of social support for healthy eating were low overall. Research is needed to better understand factors that promote social support for healthy eating among low-income populations living in food desert contexts and the value of this support for improving diet. Additionally, perceived control of healthy eating was not directly related to diet quality yet the models explained

substantial variance (22.7–28.6%) in this outcome. Perceptions of control of healthy eating was at the nexus of perceptions of the built food environment and individual identity as a healthy eater. Given the high magnitude of the relationship between perceptions of control of healthy eating and these factors as well as the high amount of variance explained in both models, findings suggest future research is warranted to unpack the role of perceived control of healthy eating as a lever for improving diet.

Conclusion

In conclusion, the socioecological model provided a framework for illuminating some variation in diet quality among residents living in low-income communities with low access to stores selling a variety of healthy foods. Further, it was found that similar food environments (e.g., food deserts) are perceived and utilized differently suggesting the need for dietary intervention approaches that take into account heterogeneity within demographically comparable communities. In both models, results of the path analysis found healthy eating identity and distance traveled to the primary food store had a statistically significant, positive, and direct effect on diet quality. Interventions aimed at improving diet quality among residents living in food deserts may need to focus on enhancing healthy eating identity using culturally relevant approaches while at the same time addressing the need for transportation supports to access healthy food retailers located farther away.

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RESEARCH SNAPSHOT**Research Question:**

What are the direct and indirect effects of individual factors as well as social and built food environments on diet quality among residents living in areas with limited access to healthy food retailers?

Key Findings:

Two path models (one per community) were tested in this cross-sectional study that included 487 residents living in two urban communities defined as food deserts. In both models, results of the path analysis found healthy eating identity and distance traveled to the primary food store had a statistically significant, positive, and direct effect on diet quality measured using the Healthy Eating Index-2010 scores.

Figure 1.

Conceptual path model with hypothesized socioecological influences on Healthy Eating Index-2010 (HEI-2010) scores. Signs indicate hypothesized direction of relationships between individual factors, built, and social food environments, and food shopping behaviors with HEI-2010 scores. Three hypothesized control variables related to HEI-2010 scores included in the conceptual model were race, income, and sex.

Figure 2. Socioecological influences on Healthy Eating Index-2010 scores among residents living in a food desert neighborhood in Cleveland, Ohio (n=240), 2015–16. Statistically significant standardized beta coefficients and R^2 values are presented with ^a representing $p < 0.05$ and ^b representing $p < 0.10$.

Figure 3.

Socioecological influences on Healthy Eating Index-2010 scores among residents living in a food desert neighborhood in Columbus, Ohio (n=242), 2015–16. Statistically significant standardized beta coefficients and R^2 values are presented with ^a representing $p < 0.05$ and ^b representing $p < 0.10$.

Table 1.

Descriptive characteristics of 487 participants living in two food desert communities in Cleveland and Columbus, Ohio, 2015–16.

	<u>Total</u> (N=487)	<u>Cleveland</u> (n = 243) ^a	<u>Columbus</u> (n = 244) ^a
	Mean (SD) or %		
<u>Sociodemographics</u>			
Age, years ^b (min=19, max = 92)	49.3 (13.7)	50.5 (13.7)*	48.1 (13.5)*
Female	73.9	69.6*	78.3*
African American	70.0	72.4*	63.5*
High school graduate or less education ^b	60.6	63.8	57.4
Annual Household Income ^c (min=1, max=7)	2.3 (1.5)	2.0 (1.2)*	2.6 (1.6)*
Receipt of SNAP, past 12 months ^b	65.4	72.0*	58.9*
Self-reported diet-related chronic disease ^b	58.9	61.7	56.2
<u>Behavioral Variables</u>			
Healthy Eating Index-2010 (min=21.7, max=90.0)	49.9 (10.8)	49.4 (10.1)	50.3 (11.4)
Frequency of Food Shopping (Primary Store), times/month (min=0.5, max=16.0)	4.9 (4.4)	4.0 (3.7)*	5.8 (4.8)*
Distance to Primary Food Store, miles (min=0.1, max=10.5)	2.1 (2.6)	2.4 (3.1)*	1.9 (1.9)*
<u>Individual Factors</u> ^d			
Perceived Control of Healthy Eating (min=1, max=4)	3.1 (0.7)	3.0 (0.7)*	3.2 (0.7)*
Healthy Eating Identity (min=1, max=4)	3.0 (0.8)	2.8 (0.8)*	3.1 (0.7)*
<u>Social Food Environment</u> ^d			
Social Support for Healthy Eating (min=1, max=5)	2.5 (0.8)	2.4 (0.9)*	2.6 (0.8)*
<u>Physical Food Environment</u> ^d			
Retail Choice Block Score (min=0, max=21.3)	11.3 (2.8)	10.4 (2.1)*	12.2 (3.2)*
Perception of Healthy Food Availability (min=2, max=12)	2.8 (0.9)	2.7 (0.9)*	2.9 (1.0)*

Boldface with asterisk (*) indicates statistically significant differences ($P<.05$) between the two communities.

^aSample size for Cleveland was 243 except for frequency of food shopping (n = 241), distance to primary store (n = 242), perception of food environment (n = 240), and social support for healthy eating (n = 240). Sample size for Columbus was 244 except for receipt of SNAP (n = 243), frequency of food shopping (n = 242), distance to primary store (n = 242), perception of food environment (n = 242), and perceived control of healthy eating (n = 243).

^bVariables not included in the path models. Provided here for descriptive purposes only.

^cHousehold income categories: 1= less than \$10,000, 2 = between \$10,001-\$20,000, 3 = between \$20,001 and \$30,000, 4 = between \$30,001 and \$40,000, 5 = between \$40,001 and \$50,000, 6 = between \$50,001 and \$75,000, and 7 = \$75,000 or higher.

^dHigher score represents greater endorsement of the concept (i.e., for perceived control of healthy eating a higher score represents higher self-reported perceived control).

Table 2.

Direct and indirect effects of perception of healthy food availability on Healthy Eating Index-2010 scores among residents living in a food desert neighborhood in Columbus, Ohio (n=242), 2015–16.

	β (se)	p-value
Total Effect	−0.176 (0.057)	.002
Total Direct Effect	−0.125 (0.061)	.042
Total Indirect Effect	−0.051 (0.028)	.064
Specific Indirect Effects		
Perception ^a → Shop ^b → HEI ^c	0.004 (0.006)	.483
Perception → Control ^d → HEI	−0.024 (0.023)	.294
Perception → Distance → HEI	−0.035 (0.017)	.037
Perception → Control → Shop → HEI	−0.001 (0.002)	.705
Perception → Control → Distance ^e → HEI	0.004 (0.005)	.337

^aPerception = Perception of Healthy Food Availability

^bShop = Frequency of Food Shopping (Primary Store)

^cHEI = Healthy Eating Index-2010

^dControl = Perceived Control of Healthy Eating

^eDistance = Distance to Primary Food Store