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Rural and Urban Differences in the Associations between Characteristics of the Community Food Environment and Fruit and Vegetable Intake

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INTRODUCTION

The consumption of fruits and vegetables (FV) is a key indicator of a healthy diet associated with positive health outcomes such as the reduction in incidence of cardiovascular disease and cancer.[1, 2] The 2005 Dietary Guidelines for Americans call for 4.5 cups (9 servings) of FV daily based on a 2,000 calorie level.[3] This compares unfavorably to a nationwide assessment of total FV consumption that indicates mean per-capita consumption of FV is roughly 2.6 cups, not accounting for losses resulting from cooking or other factors.[4] The majority of Americans do not meet the 4.5 cup minimum, making the increase of FV intake a key target for healthy eating interventions.[5, 6]

Research on health promotion often frames explanations for individual health decisions within an ecological context.[7] In the case of food choices such as FV consumption, the ecological context has been conceptualized as the nutritional or food environment.[8-12] The food environment, specifically the accessibility of healthy foods, has been determined to influence a range of dietary health indicators including obesity rates, and the consumption of FV and low-fat dairy products.[13-18]

Research on food access often examines spatial disparity, which refers to the unequal distribution of goods among different spatially embedded populations.[19] These studies often focus on urban rather than rural environments.[9] Spatial disparity in access to essential goods and services is exacerbated by living in a rural rather than an urban setting.[19-21] However, little work has been done on the spatial distribution of food resources in rural communities.[13-17, 22, 23] Even less work has been conducted on comparisons between urban and rural food environments. One exception is the work of Pearce et al. who found that more-deprived urban and semi-urban neighborhoods in New Zealand had better access to community resources than better off neighborhoods, but that access was worse for the more-deprived rural environments.[24]

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FV intake is also influenced by the ecological context of food choice. Both household and retail food environments influence food choice and FV intake. The household food environment, also referred to as the household food setting, has been characterized as the linkage between the retail food environment and individual consumption.[25] In work on food access among rural low income populations, Smith and Morton describe aspects of the household food environment, including food security and household economic concerns, as principal factors constraining food choice.[26] Food security is not only tied to overall household food supplies, but directly linked to greater FV intake.[27–29]

The household food environment is, in turn, framed by the availability of food resources which is in part determined by elements of the retail food environment.[25, 30] The retail food environment is composed of a variety of food store types such as supercenters, supermarkets, small grocery stores, convenience stores, dollar stores, mass merchandisers or discounters, and pharmacies with food areas.[31, 32] The following are 3 retail food environment characteristics which serve as barriers or facilitators to food purchase: variety, quality or freshness, and price. Variety has been characterized as a structural constraint based on food store size that limits the range of food choice options.[26] One finds greater variety in larger stores which are more often located in urban centers.[16, 26] Greater variety has been associated with increased FV intake.[33] Food quality or freshness is another such constraint with higher food quality a strong predictor of food choice.[33] In focus group research, Smith and Morton identified poor food quality including spoiled FV as a factor that limited food choices for rural populations. Furthermore, food in the smaller food stores typical of rural environments is often of lower quality than the food available in the larger grocery stores found mainly in urban settings, reducing the access of rural populations to higher quality fresh and frozen foods.[26, 34] Price also influences food choice; and larger food stores in urban centers are understood to have better food prices.[26, 34] The perception that FV are relatively expensive in comparison to alternative food choices has been linked to overweight among parents and children, and lower FV consumption.[35, 36]

Another structural aspect of the retail food environment is the spatial accessibility of retail food outlets to homes. Residents of neighborhoods with relatively poor access to supermarkets (often referred to as food deserts) tend to eat fewer FV and have greater BMIs.[30, 33, 37–40] Disparities in food access are the greatest in rural communities. These disparities arise from the distance and method of transportation involved in access. Transportation may be problematic as public transportation is especially lacking in rural settings, forcing rural residents who do not own vehicles to rely on family members, friends, and others for their transportation or shopping.[39, 41] Furthermore, residents may travel much greater distances than urban residents to shop for food.[26] For example, Connell et al. discovered a disparity in levels of physical access in the Mississippi Delta with more than 70% of low income households located at distances greater than 30 miles from a supermarket or large food retailer.[22]

Across a limited number of studies, a range of methods have been used to successfully confirm the association between dietary intake and the accessibility of the retail food environment. Zenk, *et al*. determined the suburban or urban (city of Detroit) location of the most important source of groceries, and found an indirect effect of location on FV intake.[33] Rose, *et al*. found self-reported accessibility variables such as easy access or distance from home to food store were related to fruit use.[40] Laraia, *et al*. found proximity of supermarkets measured in objective distance was positively associated with diet quality.[38] Inagami, *et al*. calculated accessibility as residents' distance from the census block group (CBG) where they reported shopping for groceries, and Morland *et al*. determined accessibility as the number of food store types in a resident's neighborhood.[37, 39]

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Although previous research has examined the association between accessibility measures of the local food environment and measures of dietary health, few studies have compared these associations across urban and rural settings. This study aims to extend research in this area by 1) determining the extent of inadequacy of household and community food resources, and 2) identifying the varying sociodemographic, household, and community characteristics that influence FV intake in both the urban and rural food environments.

METHODS

This study used data from the 2006 Brazos Valley Health Assessment (BVHA) and 2006 Brazos Valley Food Environment Project (BVFEP). Data on residents of the Brazos Valley were obtained from the 2006 BVHA, and data on the objective measure of access to the retail food environment were obtained from the 2006 BVFEP. Each data set includes the 1 urban and 6 rural counties of the Brazos Valley Economic Development District, located in central Texas. The Institutional Review Board at Texas A&M University approved both studies.

The BVFEP is a ground-truthed description of the Brazos Valley food environment (land area of 11,567 km^2). Details on ground-truthing and the Brazos Valley food environment are reported in an earlier study.[32] Ground-truthed methods entail performing an on-site survey of all locations within the area where one can purchase food by driving each navigable road, conducting a windshield survey of food establishments, and obtaining on-site geographic coordinates for each location. Data on the network distance via road from each study participant to the nearest supermarket or superstore was obtained from the BVFEP.

Participants and Recruitment

A survey research firm at Texas A&M University identified BVHA respondents through random-digit dialed telephone screening. Telephone coverage was estimated by the 2000 Census at 96.8% for the Brazos Valley with 95.2% for rural counties (U.S. Bureau of the Census, 2000). As the survey was initially conducted to assess the health of the entire adult population of the Brazos Valley, the sampling was not stratified by age, race/ethnicity, or location. The sampling process identified 3,501 respondents with a response rate of 73.8% (2,584 respondents). The initial mail out included the survey booklet, cover letter, small monetary incentive, and postage paid envelope, followed at 2 weeks with a postcard reminder. A complete description of the methodology has been published elsewhere.[17, 32] Respondents who did not answer items used in the three regression analyses were dropped from the sample leaving an analytic sample of 2,260 respondents. All participants were geocoded to their residence.

Measures

The BVHA questionnaire included a broad range of items measuring health behaviors and conditions, including self reported FV intake, subjective measures of the retail food environment, the adequacy of household food resources, and demographic characteristics.

FV intake—FV intake was measured by a validated self report 2-item screener used previously by Resnicow *et al*. and Campbell *et al*. that was scaled 0, 1, 2, 3 to 4, 5 to 6, and more than 6.[42, 43] Respondents were asked "how many servings of fruit do you usually eat each day (a serving= ½ cup of fruit or ¾ cup of fruit juice)?" and "how many servings of vegetables do you usually eat each day (a serving= ½ cup of cooked or 1 cup raw vegetables)?" Both items were summed to derive an overall measure of FV intake. This summed measure was constructed as the chief dependent variable because an increase in combined FV intake is a common goal among interventions such as the CDC's Fruits and

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Veggies Matter campaign.[44] Furthermore, many public health recommendations combine fruit and vegetable intake. It is also a common dependent variable among research publications aimed at evaluating educational efforts and other interventions to increase the public's consumption of FV to treat FV intake as a combined measure.[45-47]

Subjective characteristics—The subjective characteristics of the retail food environment were measured by 3 items. Respondents were asked to think of the store where they buy most of their groceries, then asked how they would rate: "the variety of FV at this store," "the freshness of FV at this store," and "the price of FV at this store?" These items were scaled excellent, very good, good, fair, and poor. Items were recoded so that excellent, very good and good=0, and fair and poor=1.

Adequacy of household resources—Adequacy of household food resources was measured by 3 items taken from a validated short version of a previously validated scale.[48] Respondents were asked to think about the food they bought for their household last month. They were then given 2 statements: "the food that we bought didn't last and we didn't have enough money to buy more," and "we couldn't afford to eat balanced meals." They were asked to assess if these statements were often true, sometimes true, and never true. These 2 items were recoded so that often and sometimes true=1 and never true=0. They were then asked: "now, thinking about the food you bought in the last 12 months, did you and/or other adults in your household ever cut the size of your meals or skip meals because there wasn't enough money to buy food? This item was scaled no, never; yes, 1 or 2 months; yes, 3 to 5 months; yes, 6 or more months. This item was then recoded so that no = 0 and all other responses = 1.

Demographic Items—Demographic items used in this analysis included age, measured in years; gender, male or female; household size; and income, with a 16-category range from less than $9,570 to greater than $80,000. Using the categories from the 2006 Health and Human Services Poverty Guidelines and the measure of household size, income was recoded to 3 new variables, poverty for less than the federal poverty level, low income for the range between poverty and 199% of the federal poverty level, and above low income for the remaining categories.[49]

Objective retail food environment—The objective measurement of the retail food environment consisted of 1 item. ESRI's Network Analysis extension in ArcInfo 9.2 was used to calculate network distance in miles from respondent's residence to nearest supermarket or supercenter via the road network based on BVFEP data.

Procedures

Analyses were conducted with Release 11 of Stata Statistical Software and $P<0.05$ was considered statistically significant. Descriptive statistics for sociodemographic characteristics, subjective characteristics of the retail food environment, adequacy of household food environment, the objective measure of retail food environment, and FV intake were calculated for rural and urban samples using Chi-square analysis and 2-sample t-tests. A 2-stage process was used to construct multivariate models. Pearson's product moment correlation was used to estimate bivariate correlations between FV and theoretically salient variables for the combined sample (urban and rural combined sample). Associations with $P<0.10$ were reserved for the construction of an initial multivariate model for FV intake for the combined sample. Using backwards elimination of all variables with $P>.05$, a multivariable linear regression model was individually estimated for the correlates of fruit and vegetable intake in the combined sample. Separate models were then estimated for the urban and rural samples. The urban and rural models were constructed by inputting all variables that were significant in the model for the combined sample into the model for each sample, with the exception of urban or rural residence which was used to stratify the 2 samples. Following regression analyses, the variance inflation factor (VIF) test in STATA was used to examine possible problems with multicollinearity. The objective measure of the retail food environment is a linear variable measured in miles and presents a larger range of responses than the other independent variables. Lincom, a regression post estimation command in STATA that allows one to calculate new coefficients and confidence intervals for a linear combination of coefficients was used to compare the objective measure of the retail food environment to other independent variables.

RESULTS

Total FV intake was significantly different between the urban and rural samples. See Table 1 for characteristics of the BVHA sample. Urban respondents reported a daily FV intake of 3.6 servings and rural respondents reported 3.3 servings. Urban participants were younger in comparison with participants who resided in the rural county. A greater proportion of rural participants was female and was from households with poverty level incomes.

A smaller percentage of rural participants provided a favorable rating of the retail food environment and the freshness, variety and price of FV in their regular grocery store. Rural participants reported greater inadequacy of household food resources in all 3 measures: food did not last, they could not afford balanced meals, or reduced meal size or skipped meals. In the combined sample, the distance to the nearest supermarket or supercenter ranged from 0.07 to 29.6 miles. As expected, the average distance to the nearest supermarket or supercenter was considerably greater for rural participants.

In data not shown, Pearson's product moment correlations between FV intake and all conceptually salient measures described above were significant at the <0.001. All variables were entered into the combined, urban, and rural regression models. VIF scores ranged well within the bounds of acceptability from as low as 1.02 to no higher than 2, indicating no problems with multicollinearity. The following variables remained in the combined sample after backwards elimination: demographics (age, gender and rural county), retail food environment (price), and household food environment (food lasts, balanced meals, cut or skipped meals). The borderline significance of the measure of the objective retail food environment was thought sufficient to include it in the urban and rural models.

For the urban sample, the following variables were significant: demographics (age, gender), and retail food environment (price). For the rural sample, the following variables were significant: demographics (age, gender), retail food environment (price), household food environment (balanced meals, cut or skipped meals), and the objective measure of retail food environment (miles to superstore or supermarket).

Findings from the regression analyses are shown in Table 2. For all models, female gender and increased age were associated with greater FV intake. Perceived fair or poor price of FV was associated with lower FV intake. In the combined sample of urban and rural participants, rural residence, food not lasting, not being able to afford balanced meals and cutting or skipping meals were associated with lower FV intake.

In addition to the variables that were significantly associated with FV intake in all 3 models, lower FV intake among rural participants was associated with inability to afford to eat balanced meals, cutting or skipping meals, and increased distance to the nearest supercenter or supermarket. As distance had a range of approximately 29 miles, it is difficult to compare its coefficient to the 2-level categorical variables in the model. An exponent of one-half of the range was used with the lincom command to calculate a new coefficient of −0.182 with

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a confidence interval of −0.331 to −0.033, indicating a smaller, but not dramatically smaller effect on FV intake than other variables.

DISCUSSION

The combined measure of FV intake for combined, urban and rural samples fell far below the daily recommended allowance of 9 servings suggested by the USDA Daily Dietary Guidelines. In comparison to a 2005 estimate that the national mean consumption of FV was 2.6 combined cups or 5.2 servings,[4] the combined sample consumed approximately 1.6 cups or 3.4 servings. A small, but statistically significant difference does exist between the self reported FV intake of urban and rural dwellers reached by this community health assessment. As the 0.3 mean servings difference between urban and rural populations is minimal, it would be unfruitful to consider this statistically significant difference as direct evidence of a disparity between urban and rural populations. However, other findings do demonstrate definite urban and rural disparities, evidenced by the greater percentages of rural individuals who report inadequate household food resources, and a poorer subjectively evaluated retail food environment, as well as the notably greater distance this rural sample must travel to purchase their groceries.

Similarities across the urban and rural models confirm earlier research on FV intake. The 3 regression models support earlier observations of an age-cohort effect with the older cohorts eating more FV.[48, 50–54] Gender provides one of the most powerful effects in the model, especially in the urban case, confirming previous observations based on survey work that women are more likely to eat FV than men.[6, 46, 47, 52–55] Although this study did not find a direct relationship between level of income and FV intake, more direct measures of resources available for obtaining food such as the adequacy of household food resources were significantly associated with FV intake in the combined and rural models. Cutting or skipping meals was present in both combined and rural models, supporting the previously observed relationship between limited economic resources and limitations on FV intake. The importance of the relationship between the perception of price in the retail food environment and FV intake was also confirmed by the presence in both urban and rural models of FV price at the respondent's regular grocery store.[27–29] Regression analyses provide different models for FV consumption in the urban and rural samples. An ecological argument explains these differences. FV intake is a behavior that occurs within an ecological context consisting of household and local food environments which take on distinct characters in urban and rural food environments. Although the in-store price of food impacts both contexts, extra dimensions of the environment play a role in the rural setting. This study finds that distance matters, especially for rural residents. This finding builds on those of previous studies based on survey and focus group data that revealed associations between accessibility measures of the retail food environment and measures of dietary health such as FV intake, thus confirming the importance of the accessibility of the retail food environment. [33, 37–41] Furthermore, unlike previous studies, this study determines the importance of distance using a ground-truthed measurement, finding that accessibility measured in distance is a problem for rural but not urban residents.

Further differences in food environment are evidenced by the household food resource measures. Food did not last, which is present in the combined model but absent from the stratified subsamples, captures the worst cases of food insecurity and speaks to the importance of economic insecurity in predicting FV intake. The inability to afford balanced meals is indicative of economic privation, but skipping meals is a more dire form of food insecurity. The significance of these measures of food insecurity in the rural but not in the urban model suggests a heightened role for food security in rural settings.

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A different ecological frame exists within the rural setting where dimensions beyond the perceived in-store price of food and basic food insecurity have an impact on FV intake. Here, the greater variation in spatial access to grocery stores weighs against the opportunity of rural populations to affordably access the means to eat balanced meals. These findings confirm earlier quantitative research that examines the ecological framing of healthy eating.[33, 37–40] For example, Morland et al. found that individuals within neighborhoods that had greater access to certain food amenities reported greater intake of a range of healthy foods.[39] These findings also confirm qualitative accounts of food access and food intake based on focus group work which demonstrate that rural settings are especially burdened by deprivation.[56, 57] Within the literature on accessibility, urban and rural comparisons are rare. A notable example is that of Pearce *et al*. who observed greater distances to supermarkets and other food shops in rural settings in New Zealand.[24] The findings of Pearce et al. are confirmed by our research. Furthermore our findings extend the ecological account by linking the disparity between urban and rural settings in accessibility to supermarkets and supercenters to healthy eating behaviors.

It is important to note study weaknesses. As the data is cross sectional, the causal direction of the relationships between FV intake and perceptions of price, quality and variety are unknown. Following upon the directional uncertainty suggested by Zenk et al., these perceptions may have been influenced by the importance for the study participants.[33] Methodological weaknesses for this study arise from the 2-item measure of FV intake. Although the 2-item measure of FV intake has been verified in an earlier study against a 7-item and 36-item FV measure, it does not produce as high a correlation with serum carotenoid levels as the 36-item instrument.[42] Nevertheless, items which are suited for more focused research projects are impractical for inclusion in community health assessments designed to meet the diverse needs and interests of multiple community partners.[17]

A further limitation arises from the subjective measures of the retail food environment. While it is possible that the subjective measure of FV freshness could refer to the freshness of frozen, canned or dried items, it is likely that respondents would only have considered the freshness of raw FV in their regular store's produce aisle when answering this item. Thus, this measure does not evaluate the freshness of all FV products in their regular grocery store and should only be taken as representing the respondents' evaluation of fresh produce. Furthermore, respondents were not asked if the store in which they buy most of their groceries was the same store as the one where they purchase most of their FV. It is possible that FV sources may have been different, especially for rural residents who may have access to FV from alternative sources such as gardens.

IMPLICATIONS FOR RESEARCH AND PRACTICE

This study emphasizes the importance of examining ecological or environmental aspects of the home and retail food environments in studies of FV intake, and more generally of food choice. It also points to the importance of these factors in the design of interventions meant to improve FV intake, especially if these interventions are implemented in regions which incorporate urban and rural areas. If these interventions are to be appropriately designed and implemented across urban and rural food environments, they must account for the differences between these distinct contexts, especially in regards to the role of distance in food access.

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Table 1

Characteristics of an Analytic Sample of 2,260 Combined, 1425 Rural and 835 Urban Respondents in 2006 Brazos Valley Health Assessment

Variable	Combined	Urban	Rural
Demographics			
Age[a]	53.36±15.94	50.00±16.44	55.33±15.31[‡]
Gender: % women (n)	70.66 (1,597)	66.47 (555)	73.12 (1,042)[†]
Income:			
% Poverty (n)	15.49 (350)	13.17 (110)	16.84 (240)[*]
% Low Income (n)	13.14 (297)	9.82 (82)	15.09 (215)[‡]
Attitude toward regular grocery store			
Limited variety of F&V % (n)	10.62 (240)	3.83 (32)	14.60 (208)[‡]
Not Fresh F&V % (n)	13.01 (294)	5.15 (43)	17.61 (251)[‡]
High price of F&V % (n)	38.01 (859)	25.39 (212)	45.40 (647)[‡]
Adequacy of Household Food Resources			
Food did not last % (n)	21.02 (475)	16.29 (136)	23.79 (339)[‡]
Could not afford balanced meals % (n)	18.5 (418)	13.77 (115)	21.26 (303)[‡]
Last year cut or skipped meals % (n)	12.52 (283)	9.10 (76)	14.53 (207)[‡]
Food Environment access			
Distance to nearest super market (miles)[a]	6.72±6.93	3.04±3.26	8.88±7.58[‡]
Daily fruit and vegetable intake (servings)			
Fruit[a]	1.38±0.99	1.55±0.99	1.28±0.97[‡]
Vegetables[a]	2.01±0.92	2.00±0.94	2.01±0.92
Combined F&V[a]	3.39±1.61	3.55±1.63	3.29±1.59[‡]

Poverty=≤100% Federal Poverty Level; Low Income=101 to 199% Federal Poverty Level.

[a]Mean±standard deviation.

[*]significant at P<0.05;

[†]significant at P<0.01;

[‡]significant at P<0.001,

P value results are from chi-squared and two-sample t tests. F&V=Fruits and vegetables.

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Table 2

Coefficients and 95% CI from linear regression models correlating total intake of fruits and vegetables with demographic characteristics, subjective and objective retail food-environment, and adequacy of household food-environment.

Variable	Combined Coef. (CI)	Urban Coef. (CI)	Rural Coef. (CI)
Demographics			
Age	.016‡ (.011, .020)	.016‡ (.010, .023)	.015‡ (.010, .020)
Gender	.479‡ (.340, .619)	.585‡ (.358, .813)	.411‡ (.233, .589)
Income			
Poverty	NS	-	-
Low Income	NS	-	-
Rural County	−.175* (−.321. −.028)	-	-
Subjective Retail Food-Environment			
Variety F&V	NS	-	-
Freshness F&V	NS	-	-
Price F&V	−.310‡ (−.446, −.174)	−.268* (−.521, −.016)	−.330‡ (−.492, −.169)
Adequacy of Household Food Resources			
Food lasts	−.297* (−.546, −.047)	NS	NS
Balanced meals	−.502‡ (−.775, −.229)	NS	−.515† (−.834, −.200)
Cut or Skipped meals	−.336* (−.604, −.068)	NS	−.349* (−.671, −.026)
Objective Retail Food-Environment			
Miles to SC/ SM	−.011* (−.021, −.000)	NS	−.013* (−.023, −.002)
Adjusted R^2 of model	.118	.097	.119
Prob. > F	0.0000	0.0000	0.0000
n	2260	835	1425

CI = confidence interval; NS= not statistically significant in the model; Dash (−) indicates not included in model. SC/SM=supercenter or supermarket,

* significant at P<.05,

† significant at P<.010,

‡ significant at P<.001