Differences in a Chain Supermarket's Sales to SNAP Shoppers Before and Since the COVID-19 Pandemic

Amy Elizabeth Lo, BSPH; Emily Welker Duffy, MPH, RD; Shu Wen Ng, PhD

ABSTRACT

Objective: This study 1) compares grocery sales to *Supplemental Nutrition Assistance Program* (SNAP) shoppers in rural and urban grocery stores and 2) estimates changes in sales to SNAP shoppers in North Carolina (NC) since the pandemic.

Design: Weekly transaction data among loyalty shoppers at a large grocery chain across NC from October 2019 to December 2020 (n = 32; 182 store weeks) to assess nutritional outcomes.

Setting: North Carolina large chain grocery stores.

Participants: Large chain grocery store/SNAP shoppers.

Intervention: Rural/urban status of the stores and COVID-19 pandemic onset.

Main Outcome Measures: Share of total calories sold from fruits, vegetables, nuts, and legumes (FVNL) with and without additives, sugar-sweetened beverages (SSB), less healthful foods (LHF), and processed meats (PM).

Analysis: Multivariate random effects models with robust standard errors to examine the association of rural/urban status before and since coronavirus disease 2019 with the share of calories sold to SNAP shoppers from each food category. We controlled for county-level factors (eg, sociodemographic composition, food environment) and store-level factors.

Results: We did not find significant rural-urban differences in the composition of sales to SNAP shoppers in adjusted models. There was a significant decrease in the mean share of total calories from sugar-sweetened beverages (−0.43%) and less healthful food (−1.32%) and an increase in the share from processed meats (0.09%) compared with before the pandemic ($P < 0.05$).

Conclusions and Implications: Urban-rural definitions are insufficient to understand nuances in food environments, and more support is needed to ensure healthy food access.

Key Words: *Supplemental Nutrition Assistance Program,* rural, urban, food environment, grocery store (*J Nutr Educ Behav.* 2023;55:343−353.)

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INTRODUCTION

In the US, a major social support program is the *Supplemental Nutrition Assistance Program* (SNAP), previously known as *Food Stamps,*[1] which has existed since 1939 and is overseen by the US Department of Agriculture (USDA).[1] *Supplemental Nutrition Assistance Program* provides nutrition benefits to help individuals and families with low incomes buy food to move toward self-sufficiency.[2] As of 2022, SNAP provided benefits to approximately 41 million Americans with low incomes at the cost of $70 billion.[3] An early goal of SNAP was to address food insecurity, defined as being unable to provide food for oneself or one's family, which increases the risk for diet-related outcomes such as chronic disease, obesity, and depression.[4] In addition to the health-related arguments to tackle food insecurity, there are also clear economic arguments, as food insecurity in the US has been linked to economic losses of at least $160 billion annually.[5]

Beyond decreasing food insecurity, SNAP aims to improve access to healthy foods and diet quality.[6] This expands on the *Food Stamps'* original purpose of aligning post-Great Depression hunger and growing food surpluses.[1] *Supplemental Nutrition Assistance Program*'s dual goals have been reflected in the program's name change to include a focus on the nutritional quality of food and the new commitment to improve nutrition security by the USDA.[7] Nutrition security has become a new focus to build on food insecurity that highlights the importance of equal access to safe, healthy, and affordable foods that promote well-being and optimal health.[7]

Department of Nutrition, Gillings School of Global Public Health and School of Medicine, and Carolina Population Center, University of North Carolina at Chapel Hill, Chapel Hill, NC

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Address for correspondence: Shu Wen Ng, PhD, Department of Nutrition, Gillings School of Global Public Health and School of Medicine, and Carolina Population Center, University of North Carolina at Chapel Hill, CB# 8120, 123 W Franklin St, Chapel Hill, NC 27516; E-mail: shuwen@unc.edu

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Evidence on the effectiveness of SNAP in improving diet quality compared with income-eligible nonparticipants is mixed, and differences vary across age, region, and gender.[8] Regardless, efforts to support structural and environmental factors that promote healthier diets in SNAP participants are needed.[8]

One major factor affecting purchase behavior and diet is the food environment, which has been observed to influence diet-related disease risk.[9] Both urban and rural residents with low incomes suffer from a higher prevalence of diet-related morbidity and mortality.[10] Urban and rural settings can vary considerably in terms of ease of access to public transport, distance to grocery stores, housing value, average socioeconomic status, income level, and economic stability, which can, in turn, influence food access and the food environment.[10] Because of these challenges in some rural areas, fewer food businesses can flourish, and the existing retailers face these obstacles of supplier adequacy. Consequently, fewer businesses establish themselves in rural areas than in urban settings.[10,11] All these factors may adversely impact the healthy vs unhealthy food landscape and hence purchasing patterns, quality of diet, and health outcomes of rural residents.[4,12]

Supplemental Nutrition Assistance Program participants in rural areas may also face large barriers to meeting dietary recommendations because of structural factors such as income inequality or social factors.[13] The rurality and economic stress on SNAP shoppers and retailers may contribute to a lack of support for recommended diet-related behaviors, ultimately leading to health disparities.[13] In addition, despite an international urban advantage to accessing healthful foods, people with low incomes living in urban areas still face obstacles to healthy eating, considering the lack of resources and income to achieve an adequate healthy lifestyle.[14] These factors highlight the need to understand the food purchasing patterns of SNAP participants in rural areas compared with urban areas.

Rural areas in North Carolina are facing general economic and population decline, whereas North Carolina's urban centers are experiencing rapid economic growth.[15,16] More specifically, 54 of North Carolina's 100 counties are rural, with 1 in 5 rural residents vs 1 in 8 urban residents participating in SNAP in North Carolina.[17,18] In addition, current research states that lower-income and rural neighborhoods are typically located in food deserts and food swamps, limiting physical access to nutrient-dense foods.[4] This economic decline and lower store availability may contribute to differences in SNAP participants' diet quality and purchase patterns in rural and urban areas.

The onset of the coronavirus disease 2019 (COVID-19) pandemic caused further challenges because of the major social and economic shocks and impacts that followed. School closings, the shift to online work, business closings, a rise in unemployment rates, and strains on the health care system may have exacerbated disparities between socioeconomic levels.[19] The pandemic continues to disproportionately affect low-income, food-insecure households already struggling to meet needs even before the start of the COVID-19 pandemic.[20] Before the COVID-19 pandemic, > 35 million Americans participated in SNAP in 2019. In 2021, SNAP participation rose to > 41 million people.[3] In addition, national food insecurity levels rose from 31% before the pandemic to 39% in the first 4 months of the pandemic.[19] Rural areas suffered these pandemic-related effects but may be slower to recover from them partly because of obstacles discussed earlier.[21,22] According to a recent survey study conducted in the rural American West, the pandemic had significantly increased unemployment rates to be higher than the postpandemic national average and negatively impacted overall life satisfaction, mental health, and economic outlook.[21,22]

Pressure and greater stress on low-income households started early in the pandemic. For example, the Centers for Disease Control and Prevention recommended buying 2 weeks of food at a time to combat the unpredictability of the food supply chains and closures,[20] but low-income families struggled to comply with these recommendations because of lower job flexibility, higher rates of job loss, and higher rates of food insecurity.[20] Food supply chains were also affected greatly by the pandemic. Food scarcity in grocery stores because of global labor shortages and bulk buying introduced new obstacles to nutritional food procurement.[5] Very little is known about how rural and urban environmental factors affected food supply inadequacy, but a lower variety of fruits and vegetables, poor fresh food quality, and elevated food prices in rural areas were already recognized as obstacles to food procurement.[9] With a general rise in home cooking behaviors[23] and a scarcity in the food supply,[20] magnified pandemic effects on low-income households,[20] as well as a suspected increase in the difficulty of procuring healthy foods in rural areas, we can conclude that quantifying how purchasing has changed in vulnerable populations is an important area that currently lacks investigation.

It is unknown how and if urban and rural environments affect the composition of loyalty card-associated SNAP sales from a full-service grocery stores retailer (with 496 stores statewide) in North Carolina and the separate association of sale composition with the shock of the COVID-19 pandemic. Therefore, we predict that sales to SNAP shoppers in rural stores between October 1, 2019 and December 31, 2020 will contain fewer fruits, vegetables, nuts and legumes than sales to SNAP shoppers in urban areas. In addition, we predict that sales to SNAP shoppers since the COVID-19 pandemic (from October 1, 2020 to December 31, 2020) will contain a lower percentage of less healthful food (LHF) compared with before the COVID-19 pandemic (from October 1, 2019 to December 31, 2019).

METHODS

Sample and Scanner Data

This study uses only loyalty card transaction/point-of-sales data spanning 65 weeks (from October 1, 2020 to December 31, 2020) from a large grocery chain located in North Carolina with 496 stores in 86 of 100 North Carolina counties. The transaction data includes every item sold in each shopping episode at the barcode level, including barcode/item

number, item description, item size, price, the unit of measure, quantity sold, tender types used in the transaction, as well as the date of sale, the store in which each item is sold, and the loyalty card ID used in the transaction. Although we do not have demographic information about loyalty card shoppers, there is information about the store location of every transaction/sale. Our unit of analysis for this study is at the store-week level, and the analytical data contains 32,183 observations with some stores missing data (n = 57) because of closing and opening during our study period. This study was determined not to need Institutional Review Board approval by the University of North Carolina at Chapel Hill (Institutional Review Board no. 21-1133).

Linkage to Nutrition Data and Outcome Categorization

Existing nutrition label data at the barcode level from several sources, such as USDA National Nutrient Database for Standard Reference and Mintel Global New Product Database,[24] were programmatically merged with the transaction data and used to categorize items sold as foods or nonfoods. Unpackaged items that did not have barcodes and instead had product look-up codes, such as loose fruits or vegetables, were linked to the USDA's Food and Nutrient Database for Dietary Studies database for nutrient values and appropriate categorization. Ten percent of linked records were reviewed manually to ensure appropriate linkages. We were thus able to add nutrient values (eg, calories) and categorized foods into nutritionally-relevant food groups: fruits, vegetables, nuts, and legumes with additives (FVNL all), fruits, vegetables, nuts, and legumes without additives (FVNLNA), LHF, sugar-sweetened beverages (SSB), and processed meat and processed seafood (PM) (see justifications and examples for groupings in Supplementary Table 1). We focused on sales outcomes on foods categories strongly associated with health outcomes.[4]

Identifying Sales to SNAP Shoppers

We defined a loyalty card shopper as a SNAP participant if they used SNAP as a payment type ≥ 1 time during any rolling 3-month period. We chose a 3-month rolling period because it is possible that a shopper may be a SNAP participant but did not shop at this specific retailer every month. For each store, we aggregated the sales to all SNAP shoppers in a given week for our food groups of interest (ie, FVNL all, FVNLNA, JF, SSB, and PM).

Outcome Measures

The outcome measures are the share of total calories sold from each of the 5 food groups. For example, we calculated our SSB measure by dividing the amount of SSB calories sold by the total amount of food and beverage calories sold that month. We used the share of calories purchased from each food group as our primary outcome because it is a similar unit of measure across food categories. Calorie share will tell us directly about the diet of the rural vs urban samples and allows us to control for factors such as buying in bulk that may be more common in rural stores because of the longer travel distance between residence and store. Other nutritional measures (such as sugar or sodium) would describe only a portion of the data linked to specific chronic health outcomes and can not describe overall sales.

Furthermore, our analysis is on the store level and is meant to describe the food category composition of sales rather than micronutrient/macronutrient measures of diets at the individual level. Share of sales in terms of dollars was also not the best measure because of potential price differentials by location and the inability to compare prices across food groups given different price ranges for these food groups. A sensitivity analysis was conducted on the share of sales on the basis of volume (ounces) as an alternative outcome measure but did not yield meaningfully different results.

Primary Exposures

Our exposures of interest were whether a store is located in a rural or urban county and the onset of the COVID-19 pandemic. Stores were categorized as either rural or urban on the basis of the county in which they are located, following the USDA definitions. Urban counties are defined as densely-settled urban entities with ≥ 50,000 people and outlying counties economically tied to the core counties as measured by labor-force commuting.[24] Outlying counties are included if 25% of workers living in the county commute to the central counties.[24] Rural counties are defined as outside the boundaries of metro areas.[25] The COVID-19 pandemic was defined as starting on March 10, 2020, the day North Carolina's governor Roy Cooper declared a state of emergency because of the COVID-19 pandemic,[26] thus, weeks 1−13 of our data are considered before COVID-19 and weeks 14−65 are since COVID-19 (with the corresponding weeks to 2019 covering October through December 2020 being weeks 53−65).

Secondary Exposure: 2016 Food Environment Index (FEI)

The urban and rural status of a county encompasses many different factors of the environment and is an important predictor of food access in North Carolina. However, it is a binary indicator and may miss the nuance in relevant factors related to county-level food access. Therefore, we chose to explore FEI as a secondary exposure of interest. The FEI is an index calculated using 2013−2016 data across the country and factor analysis to measure food accessibility at the county level.[27] The 3 components are labeled unhealthy access, healthy food access, and socioeconomic status.[27] Each component score comprises factors indicating their respective category.[27] The socioeconomic status component considers the SNAP participants as a percentage of the total population, food insecurity level, percentage of the total unemployed population, and a very low food insecurity level.[27] The unhealthy access

component considers the percentage of lack of car access, convenience stores per 10,000, and SNAP-eligible stores per 10,000 population.[27] The healthy access component considers the number of grocery stores, full-service restaurants, and farmers' markets per 10,000.[27] A higher score in any of the components indicates a healthier food environment to conserve directionality.[27] Each component's numeric score is reported in standard deviations away from the mean national score of 0, with a negative/positive value denoting a category score in standard deviations below/above the national average.

Covariates

Because we did not have demographic information on shoppers and the unit of analysis is at the store-week level, county-level demographic composition measures were used as covariates in our model. These data were sourced from the North Carolina Office of State Budget and Management website and published by the North Carolina Office of State Budget and Management and the State Demographer for 2020.[28] The data were projections that included estimates from 2010 to 2020 and population projections from 2021 to 2050.[28] Age, education, race (American Indian or Alaska Native, Asian or Pacific Islander, Black, White, or other), sex, employment, and ethnicity were measured as continuous percentages of a county's total population.[28] Race and ethnicity are social constructs and were estimated by the North Carolina State Demographer on the basis of 2000, 2010, and 2020 censuses using a time series forecast model.[28] The State Demographer defines the race category other as those who self-identify as 2 or 3 different races.[28] They were used only to control for differences between counties.

In addition, store-level characteristics were computed from our dataset to control for time-varying differences between stores. These included the mean number of SNAP and non-SNAP transactions, the percent of total transactions involving SNAP, and the percent of loyalty cards that belong to SNAP participants. The number of shopping episodes may have been impacted by SNAP and non-SNAP status because of accessibility differences as SNAP participants may have fewer means of transportation, so the mean number of SNAP transactions per week, as well as the mean number of non-SNAP transactions, were included. We also controlled for the percentage of total transactions and loyalty cards that belong to SNAP participants.

Statistical Analysis

All analyses were conducted in StataSE (version 16, StataCorp LLC, 2019). Linear regression with random effects accounted for clustering and repeated measures at the store level (xtreg, re). Robust standard errors were used because predictors are heteroskedastic. Our primary exposure was the urban or rural status of the county. Covariates in our models included FEI by county, store-level characteristics, week indicators (the week was a categorical variable), and demographic compositions by county. Because FEI and rural/urban status are important confounders in the other's relationship between the exposure and outcome, we used one model with rural/urban, FEI, and other relevant covariates to get estimates for our primary and secondary exposures (see Supplementary Figure 6). We omitted a group for county demographic composition measures, given that the categories would sum to 100%. The group we chose to omit was based on which group is perceived to have the highest socioeconomic standing. For example, among race covariates, White was selected as the omitted group). To examine before and since COVID-19 pandemic differences in sales within rural and urban counties, we compared predicted margins percentages of SNAP sales from each food category from the adjusted random effects models from weeks that were one year apart to account for seasonality differences. Specifically, weeks 1-13 (from October 1, 2019 to December 31, 2019) were compared with weeks 53-65 (from October 1, 2020 to December 31, 2020). We also considered another method in which we stratified the models by rural and urban status and compared resulting predictive margins to examine the effects of the COVID-19 pandemic. This method did not yield significantly different results (see Supplementary Table 2). A 2-tailed test for significant differences was applied using 1 degree of freedom and an α level of 0.05.

RESULTS

County and Store-Level Characteristics

Table 1 presents the average county demographics, FEI scores, and store-level characteristics of rural and urban status. In total, 125 stores were classified as rural, and 371 stores were classified as urban. Rural counties have an overall older and lower educated demographic makeup compared with urban counties and a higher percentage of Black, American Indian, or Alaska Native populations. All other county-level demographic characteristics were similar between urban and rural counties. Rural North Carolina counties, on average, scored higher than the national average in the unhealthy access and socioeconomic status FEI components but lower in the healthy access FEI component. Urban North Carolina counties, on average, scored lower in all 3 FEI components compared with the national average.[27] Rural counties had a higher percentage of total transactions, and loyalty cards from SNAP shoppers compared with urban counties but had a similar mean number of SNAP and non-SNAP transactions per shopper per week compared with urban counties.

Regression Results

Rural vs urban store location. The rural and urban status of a county interacted significantly with time in weeks and cannot be interpreted as significant on its own in our regression. Instead, model-adjusted means are used to determine any significant outcomes. Model-adjusted means for the entire period (from October 1, 2019 to December 31, 2022) do not show any significant differences between rural and urban county status (Table 2).

Table 1. Chain Grocery Store Characteristics and North Carolina County Food Environment and Demographic Breakdown by Rural/Urban Status

Characteristics	Rural[a]	Urban[b]
Total population (in 2020)	N = 2,089,997	N = 8,163,122
Age, y		
0–5	6.8	7.0
6–19	17.1	18.2
20–34	18.6	20.2
35–54	23.7	26.0
55–64	13.6	12.7
≥ 65	20.2	15.9
Education		
High school diploma or less	43.3	32.3
Some college	36.8	33.2
Bachelor's degree	13.7	23.1
Greater than a bachelor's degree	6.2	11.4
Race		
White	68.4	70.5
Black	23.9	22.1
Asian	1.1	3.4
American Indian or Alaska Native	4.3	1.1
Other race	2.3	2.7
Mean Food Environment Index[c]		
Unhealthy Access[d]	0.6	−0.3
Socioeconomic status[e]	0.1	−0.05
Healthy access[f]	−0.04	−0.2
Hispanic ethnicity	9.2	11.3
Unemployment	7.6	7.4
Sex		
Male	49.2	48.4
Female	50.7	51.6
Participating retailer's store-level characteristics		
Percent of total transactions that involve SNAP	26.3	24.4
Percent of total loyalty cards that make purchases with SNAP	24.6	23.0
No. of SNAP transactions/shopper/wk, mean ± SD	1.5 ± 0.1	1.5 ± 0.1
No. of non-SNAP transactions/shopper/wk, mean ± SD	1.3 ± 0.09	1.4 ± 0.07
Mean no. of participating retailer's stores per county	2.3	8.1
No. of participating retailer's stores per 10,000	0.6	0.5

SNAP indicates *Supplemental Nutrition Assistance Program*.
[a]Rural is defined as any county that does not fulfill standards specified in the urban definition; [b]Urban is defined by the US Department of Agriculture as metropolitan, which includes central counties in which at least 50% of the population resides within urban areas of ≥ 10,000 population or contain at least 5,000 people residing within a single urban area of ≥ 10,000 population and metro/micro statistical areas if they meet specified requirements of commuting to or from the central counties; [c]The Food Environment Index factors indicated are interpreted as SDs above a mean national value of 0. A higher (positive) score in any component indicates a healthier environment; [d]The Unhealthy Access Food Environment Index component is calculated based on a county's percentage of lack of car access, convenience stores per 10,000, and SNAP-eligible stores per 10,000 population; [e]The Socioeconomic Status Food Environment Index component is calculated based on a county's SNAP participants as a percentage of the total population, food insecurity level, percentage of the total unemployed population, and a very low food insecurity level; [f]The Healthy Access Food Environment Index component is calculated based on a county's number of grocery stores, full-service restaurants, and farmer's markets per 10,000.
Note: Values are presented as percentages unless otherwise noted.

Food Environment Index score. For the 2 food groups, FVNLNA and FVNL all, an increase in the healthy access FEI component score was associated with a $P < 0.001$ percentage point increase in the percent of total calories sold to SNAP shoppers coming from that food group (Table 3). An increase in the healthy access FEI score was also significantly associated with a decrease in the percent of calories sold to SNAP shoppers from SSB ($P < 0.001$) (Table 3). An increase in the unhealthy access FEI component score was significantly associated with an increase in the percent of total calories sold to SNAP shoppers

Table 2. Model[a] Adjusted Mean Share of Calories by Food Category and Rural/Urban Status

Food Category	Rural	Urban
Fruits, vegetables, nuts, and legumes without additives[b]	8.06 (7.96–8.16)	8.06 (8.01–8.12)
All fruits, vegetables, nuts, and legumes with and without additives[b]	13.25 (13.06–13.45)	13.22 (13.13–13.31)
Sugar-sweetened beverages	9.25 (8.98–9.50)	9.74 (9.62–9.86)
Less healthful food*	30.41 (30.19–30.62)	30.45 (30.35–30.56)
Processed meats and seafood	5.72 (5.63–5.82)	5.63 (5.59–5.67)

[a]The model used was a linear regression with random effects and robust standard errors to account for clustering and repeated measures at the store level using data from October 1, 2019 to December 31, 2020. Models controlled variables included in Table 3; [b]Additives refer to any salt, sugar, or fats that work to preserve or flavor food; *Association of these food categories with rural status was statistically significant ($P < 0.05$ based on a 2-tailed $\alpha = 0.05$) according to our linear regression model (see Table 3).

Note: Values are presented as mean percent (95% confidence interval).

from SSB ($P < 0.001$) (Table 3). A 1-point increase in the socioeconomic FEI component score was significantly associated with increased calories sold from SSB ($P = 0.002$) (Table 3). No other food category was found to be significantly associated with FEI components.

Store-level characteristics. An increase in the mean number of non-SNAP transactions per week per shopper was associated with an increase in the percentage of total calories sold to SNAP shoppers from FVNLNA, FVNL all, and PM. An increase in the percentage of total SNAP transactions per week was associated with a decrease in total calories sold to SNAP shoppers coming from SSB and an increase in the percentage of total calories sold to SNAP shoppers coming from PM (Table 3). Percent of total loyalty cards that are SNAP and the mean number of SNAP transactions and associations between other food categories and these store-level characteristics were not found to be significant (Table 3).

Before and since the COVID-19 pandemic. Because we did not find a statistical difference between rural and urban settings, we looked at changes in sales to SNAP shoppers before and since the COVID-19 period across all stores. The model-adjusted outcomes show that all food categories significantly changed between before the COVID-19 pandemic (from October 1, 2019 to December 31, 2019) and since the COVID-19 pandemic (from October 1, 2020 to December 31, 2020) except for FVNLNA and FVNL all (see Supplementary Figures 1 and 2). Sugar-sweetened beverages and LHF sales decreased during post-COVID-19 pandemic onset compared with their before-COVID-19 pandemic estimated average share of total caloric sales ($P < 0.001$) (Table 4; Supplementary Figures 3 and 4). However, PM increased after the pandemic's onset compared with the pre-pandemic estimated average share of total caloric sales ($P < 0.001$) (Table 4; Supplementary Figure 5). We also conducted stratified analyses for rural and urban stores separately and found consistent results (see Supplementary Table 2).

As a robustness check, we used the share of sales on the basis of volume (rather than calories) as a unit of measure in a sensitivity analysis. Results did not substantively differ in this analysis.

DISCUSSION

The *Supplemental Nutrition Assistance Program* is a major social support program that aims to mitigate the effects of food insecurity and provide nutrition security to its beneficiaries.[4,6,7] Although the SNAP program has proved effective in these areas under certain circumstances and in certain demographic groups, many participants still do not meet dietary recommendations.[8] The food environment has been found to affect diet-related disease risk, purchasing patterns, and diet quality.[9,10] Rural food environments have presented challenges for food retailer success, food supply adequacy, and economic stability.[10,11] When evaluating the barriers to purchasing healthy foods, examining the intersection of SNAP participation and the rural food environment is important. Therefore, we investigated whether and to what extent there were differences in sales to SNAP participants from a large grocery chain with stores in urban vs rural counties in North Carolina between October 2019 and December 2020. We found that stores located in rural counties, according to USDA definitions, were not significantly associated with any food category. Increases in unhealthy access and the socioeconomic status FEI component measures (meaning a more healthful environment) were associated with an increased share of total calories from SSBs. An increase in the healthy access FEI component was associated with an increase in total calories from FVNLNA and FVNL all and a decrease in the share of total calories from SSBs. Statistically significant changes associated with the societal shock of the COVID-19 pandemic were observed in the SSB, LHF, and PM food categories.

These findings are slightly different from previous literature examining the nutritional quality of packaged food purchases bought by households in rural and urban settings.[29] This previous research found that low-income rural households bought less LHF among other foods than low-income urban households.[28] Although this previous study did not specify SNAP use, it is the most comparable study. Previous research has shown that grocery purchases made in rural areas also largely come from convenience stores and mass merchandisers (not

Table 3. Primary Model[a] Outcomes and County-Level Characteristics (n = 32,183)

	Outcomes				
Characteristics	**FVNLNA**	**FVNL all**	**SSB**	**LHF**	**PM**
Urban/rural status					
Urban[b]	–	–	–	–	–
Rural[c]	−0.03 (−0.20 to 0.14)	0.02 (−0.28 to 0.31)	−0.20 (−0.64 to 0.25)	−0.52* (−0.88 to −0.15)	0.11 (−0.04 to 0.26)
Week indicators[d]					
Rural and week interactions[d]					
Food Environment Index[b]					
Unhealthy access[c]	0.10 (−0.05 to 0.25)	0.26 (−0.03 to 0.55)	0.87* (0.42 to 1.31)	−0.19 (−0.50 to 0.12)	−0.10 (−0.24 to 0.05)
Healthy access[d]	0.24* (0.13 to 0.34)	0.41* (0.21 to 0.61)	−1.01* (−1.29 to −0.73)	0.00 (−0.19 to 0.19)	0.01 (−0.08 to 0.10)
Socioeconomic status[e]	−0.09 (−0.69 to 0.52)	−0.13 (−1.25 to 0.98)	2.68* (0.99 to 4.36)	−0.84 (−2.11 to 0.44)	−0.59 (−1.23 to 0.05)
Age, y					
1–5[a]	–	–	–	–	–
6–19	0.06 (−0.02 to 0.14)	0.11 (−0.03 to 0.25)	−0.03 (−0.26 to 0.19)	0.01 (−0.13 to 0.15)	0.01 (−0.07 to 0.08)
20–34	0.11* (0.05 to 0.17)	0.20* (0.09 to 0.31)	0.19* (0.03 to 0.36)	−0.01 (−0.12 to 0.09)	−0.03 (−0.08 to 0.03)
35–54	0.13* (0.06 to 0.20)	0.24* (0.12 to 0.36)	0.17 (−0.04 to 0.39)	−0.05 (−0.18 to 0.08)	−0.06 (−0.13 to 0.00)
55–64	0.03 (−0.04 to 0.10)	0.04 (−0.09 to 0.16)	0.04 (−0.13 to 0.21)	0.03 (−0.10 to 0.16)	0.08* (0.02 to 0.14)
≥ 65	0.13* (0.07 to 0.19)	0.24* (0.12 to 0.36)	0.09 (−0.10 to 0.27)	−0.01 (−0.13 to 0.10)	−0.04 (−0.11 to 0.02)
Employment					
Unemployment rate	−0.12* (−0.19 to −0.05)	−0.25* (−0.38 to −0.12)	−0.07 (−0.26 to 0.11)	0.02 (−0.14 to 0.18)	0.04 (−0.03 to 0.11)
Sex					
Male[a]	–	–	–	–	–
Female	−0.02 (−0.06 to 0.02)	−0.04(−0.11 to 0.03)	0.22* (0.12 to 0.32)	−0.01(−0.08 to 0.07)	−0.06* (−0.09 to −0.02)
Education					
High school diploma or less[a]	–	–	–	–	–
Some college or associate's degree	−0.02* (−0.04 to −0.00)	−0.03* (−0.07 to 0.00)	0.03 (−0.03 to 0.08)	0.03 (−0.00 to 0.06)	−0.02* (−0.04 to −0.01)
Bachelor's degree	0.01 (−0.01 to 0.03)	0.01 (−0.02 to 0.05)	−0.06* (−0.11 to −0.01)	−0.02 (−0.05 to 0.01)	−0.00 (−0.02 to 0.01)
Master's degree or more	−0.02 (−0.04 to 0.01)	−0.01 (−0.06 to 0.03)	−0.04 (−0.11 to 0.02)	0.00 (−0.04 to 0.05)	0.01 (−0.01 to 0.03)
Race					
White[a]	–	–	–	–	–
American Indian or Alaskan Native	−0.01 (−0.01 to 0.00)	−0.01 (−0.02 to 0.00)	0.06* (0.03 to 0.09)	0.01 (−0.00 to 0.03)	−0.02* (−0.02 to −0.01)
Asian	0.01 (−0.03 to 0.05)	0.03 (−0.04 to 0.10)	0.13* (0.03 to 0.22)	−0.09* (−0.17 to −0.01)	−0.05* (−0.08 to −0.02)
Black	0.00 (−0.01 to 0.01)	0.00 (−0.01 to 0.01)	−0.05* (−0.06 to −0.03)	−0.02* (−0.03 to −0.01)	0.01* (0.01 to 0.02)
Other	0.21* (0.12-0.30)	0.37* (0.21-0.54)	−0.23 (−0.45 to −0.02)	−0.09 (−0.26 to 0.08)	−0.04 (−0.12 to 0.04)
Hispanic Origin					
Non-Hispanic[a]	–	–	–	–	–
Hispanic	0.02* (0.00-0.03)	0.04* (0.01-0.07)	0.02 (−0.02 to 0.06)	−0.02 (−0.05 to 0.00)	−0.02* (−0.03 to −0.01)
Store-level characteristics					
Percent of total transactions that are SNAP	−0.02 (−0.06 to 0.03)	−0.03 (−0.11 to 0.05)	−0.07* (−0.14 to −0.00)	0.05 (−0.06 to 0.16)	0.04* (0.00 to 0.09)

(continued)

Table 3. (*Continued*)

Characteristics	Outcomes				
	FVNLNA	FVNL all	SSB	LHF	PM
Percent of total loyalty cards that are SNAP	0.01 (−0.04 to 0.05)	0.02 (−0.07 to 0.10)	0.07 (−0.00 to 0.14)	−0.07 (−0.18 to 0.04)	−0.04 (−0.08 to 0.01)
Mean no. of SNAP transactions	0.16 (−0.41 to 0.72)	0.30 (−0.68 to 1.28)	0.45 (−0.32 to 1.22)	−0.39 (−1.63 to 0.85)	−0.44 (−0.98 to 0.09)
Mean no. of non-SNAP transactions	0.93* (0.15-1.71)	1.35* (0.06-2.64)	−0.87 (−2.01 to 0.28)	0.60 (−1.12 to 2.32)	0.72* (0.17 to 1.27)

FVNL all indicates fruits, vegetables, nuts, and legumes with additives; FVNLNA, fruits, vegetables, nuts, and legumes without additives; LHF, less healthful foods; PM, processed meats and seafood; SNAP, *Supplemental Nutrition Assistance Program*; SSB, sugar-sweetened beverages.
[a]The model used was a linear regression with random effects and robust standard errors to account for clustering and repeated measures at the store level; [b]The Food Environment Index (FEI) factors indicated are interpreted as standard deviations above a mean national value of 0. A higher score in any of the components indicates a more healthy environment; [c]The unhealthy access Food Environment Index component is calculated on the basis of a county's percentage of lack of car access, number of convenience stores per 10,000, and number of SNAP-eligible stores per 10,000 population; [d]The healthy access Food Environment Index component is calculated on the basis of a county's number of grocery stores, full-service restaurants, and farmers' markets per 10,000; [e]The socioeconomic status Food Environment Index component is calculated on the basis of a county's SNAP participants as a percentage of the total population, food insecurity level, percentage of the total unemployed population, and a very low food insecurity level; [f]Urban/rural status of a county and its association with outcome measures is not considered significant because it interacts significantly with time in weeks. *Statistically significant ($P < 0.05$ based on 2-tailed $\alpha = 0.05$).

included in this work), so this dataset did not capture a notable share of rural shoppers' food purchases.[29] More differences between rural and urban stores might have surfaced if a variety of retailer data were included since in-store environments were kept the same in our dataset.

The overall share of calories from SSB, LHF, and PM categories was large compared with food categories such as FVNLNA and FVNL all. These results are similar to that of a study by Grummon et al[30] that examined national household purchases from 2012 to 2013 that examined SNAP-participating households' purchases. They found that SNAP-participating households' purchases across the US averaged 29.74% of total calories per person per day attributed to LHF.[30] This is similar to our analysis (limited to North Carolina) that found 30.41% and 30.45% of rural and urban (respectively) total calories per store per week were attributed to LHF. In addition, the share of total calories per person per day of SNAP participants from fruits, vegetables (starchy and nonstarchy), legumes, and nuts from the Grummon et al[30] amounted to approximately 6.24%, lower than our comparative result of 13.25% and 13.22% of rural and urban (respectively) total calories per store per week from FVNL all. Regardless, a minimal share of calories came from healthy foods, whereas a larger share of total calories was attributed to foods linked to chronic disease risk. Though these results may differ because of the breadth of the data (Grummon et al[30] covered packaged food purchases from all retailers rather than loose and packaged chain grocery store purchases and is from a national sample) and time frames (our data spanned the COVID-19 pandemic which may have affected purchasing and sale patterns), both studies found that the overall makeup of SNAP purchases was made up of SSBs and LHF, which was not unlike the current average American diet. Reasons for the imbalance cannot be made clear through these studies, but these results can support SNAP policy changes that support participants in purchasing more fruits, vegetables, nuts, and legumes. Strengthening current SNAP vendor

Table 4. Before and Since COVID-19 Pandemic Differences of Model[a] Adjusted Means by Share of Total Calories by Food Category

Food Category	Pre-COVID-19[b]	Since COVID-19[c]	Difference
Fruits, vegetables, nuts, and legumes without additives	8.27 (8.23–8.32)	8.27 (8.23–8.31)	−0.00 (−0.03 to 0.03)
All fruits, vegetables, nuts, and legumes with and without additives	13.56 (13.48–13.64)	13.52 (13.45–13.59)	−0.04 (−0.09 to 0.01)
Sugar-sweetened beverages	9.58 (9.48–9.67)	9.24 (9.15–9.32)	−0.34* (−0.38 to −0.30)
Less healthful food	31.17 (31.09–31.26)	29.73 (29.65–29.80)	−1.44* (−1.50 to −1.40)
Processed meats and seafood	5.45 (5.42–5.48)	5.53 (5.50–5.56)	0.08* (0.06–0.10)

COVID-19 indicates coronavirus disease 2019.
[a]The model used was a linear regression with random effects and robust standard errors to account for clustering and repeated measures at the store level using data from October 1, 2019 to December 31, 2020. The controlled variables for models are included in Table 3; [b]Predicted outcomes limited to the 13 weeks before COVID-19 from October 1, 2019 to December 31, 2019; [c]Predicted outcomes limited to the 13 weeks since COVID-19 from October 1, 2020 to December 31, 2019; *Statistically significant ($P < 0.05$ based on a two-tailed $\alpha = 0.05$).
Note: Values are presented as mean percent (95% confidence interval).

standards and the ability to stock more frozen, shelf-stable or fresh vegetables, fruits, nuts and legumes and SNAP incentive programs for such products for participants may lead to increased fruits and vegetable sales to SNAP participants regardless of where they live.[31] Although we could not include every product that is conducive to health, the stark differences in the proportion of calories bought between the FVNL categories and LHF and SSB categories illustrate the importance of programs such as the *Healthy Food Financing Initiative* and the *Gus Schumacher Nutrition Incentive Programs* that support stocking of healthier products and providing financial support to increasing fruit and vegetable purchasing.[32–36]

It is unclear why there were associations between increases in each FEI[27] component measure and increases in the share of calories from SSBs in our study. Because an increase in FEI[27] component scores would indicate an environment more conducive to healthy eating and healthy food access, food categories that include products linked to chronic disease were expected to decrease. However, an increase in unhealthy access and socioeconomic status were associated with an increase in the share of calories from SSBs. Possible explanations for these results may include the ubiquity of unhealthy food advertising and its detrimental effects regardless of the level of access and socioeconomic status.[37] The FEI and its components were calculated using measures that may not completely reflect a healthy or unhealthy food environment, such as the number of SNAP-eligible stores per 10,000 population.[27] Further investigation into these measures and repeated analyses may clarify these findings. However, an increase in the healthy access FEI score was associated with an increase in the share of total calories from FVNLNA and FVNL all, which did align with expectations. Results indicate that the FEI score and its specifications may be more informative than using rural and urban indicators.

On COVID-19 pandemic-related sale changes, we found that since the onset of the COVID-19 pandemic, there were significant decreases in the share of calories from SSB and LHF but an increase in the share from PM. One study that found similar results analyzed a SNAP incentive program purchase data at a food cooperative before and since pandemic-related closures.[38] They found that although there were increases in discounts on fresh fruits and vegetables, there was a decrease in the mean number of fresh fruits and vegetables purchased.[38] Parallels between our studies include a similar population and time frame. *Supplemental Nutrition Assistance Program* retailers may have seen the same decline in SNAP sales of fresh fruits and vegetables for several reasons that cannot be concluded from these studies. For example, supply chain inconsistencies and extreme economic turbulence may have contributed to these changes in sales. It is unclear why the share of calories from PM increased in our results, but a study using self-reported food purchasing behavior observed an initial decrease in purchases of canned meat and a later increase in purchases of canned meat in April of 2020.[39] The self-reported study was[39] different in the sample characteristics, the timing of the surveys, and use of subjective data, but both studies saw a later increase in processed meat purchases or sales.[39] Again, we cannot draw clear conclusions on why this was observed, but we hypothesize that concerns with supply shortages and scarcity of meat and seafood products because of the pandemic may be one potential reason. Panic buying may have caused the shift in sales, but we could not obtain data on the availability of products in stores and whether they were different from before the pandemic. In the future, policies may also need to consider how to support more resilient food supply chains, particularly around healthier food options.

The transaction data we used was extremely robust spanning October 2019 to December 2020, before and since the onset of the COVID-19 pandemic. The data are also objective data from a chain grocery store that is among the most popular grocery stores in North Carolina.[40] Although we successfully identified SNAP participants through a corresponding payment type for every item sold, our data was limited to only those patrons that used a loyalty card, so most but not all transactions were recorded.

Our data was also limited to 1 chain grocery store on the basis of its total sales data, so we could not capture all the purchases made by SNAP participants who may do additional grocery shopping elsewhere. Although this analysis cannot directly account for potential changes in stocking or food options available across store locations, we included store random effects and other time-varying store-level characteristics. Finally, our data only capture sales, does not reflect dietary intake, and cannot strongly reflect population-level diet changes.

IMPLICATIONS FOR RESEARCH AND PRACTICE

As evidenced by existing literature, SNAP incentive programs may be useful in improving the purchase composition of SNAP shopper sales. The lack of results concerning the rural and urban status and significant associations in FEI results may indicate that future studies should use nuanced definitions that can account for differences in rural and urban environments instead of simple binary urban/rural measures. Exploring rural and urban definitions other than USDA may also yield new results. There are currently few datasets available for research that can accurately capture sales before and since the COVID-19 pandemic, so this data is important to address that gap in the literature. The COVID-19 pandemic exposure was associated with a general increase in the share of total calories sold attributed to foods linked to chronic disease risk. In the case of protective measures against catastrophes or emergencies such as the COVID-19 pandemic, more support is needed to ensure healthy food access through policies aimed at increasing resiliency in the food supply chain. The COVID-19 pandemic has exposed many of the fragilities of our current food system and environments and how they cannot support healthier diets among the most vulnerable.[41] It is possible to learn from the experience through the COVID-19 pandemic toward updating existing programs and policies to better achieve the USDA's goal of improving nutrition security.

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SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jneb.2023.02.006.

REFERENCES

1. Caswell JA, Yaktine AL, Committee on Examination of the Adequacy of Food Resources and SNAP Allotments. *History, Background, and Goals of the Supplemental Nutrition Assistance Program*. National Academies Press; 2013.
2. US Department of Agriculture, Food and Nutrition Service. Supplemental Nutrition Assistance Program (SNAP). https://www.fns.usda.gov/snap/supplemental-nutrition-assistance-program. Accessed April 26, 2022.
3. US Department of Agriculture, Food and Nutrition Service. *Supplemental Nutrition Assistance Program* Data Tables. https://www.fns.usda.gov/pd/supplemental-nutrition-assistance-program-snap. Accessed March 18, 2023.
4. Hardin-Fanning F, Rayens MK. Food cost disparities in rural communities. *Health Promot Pract*. 2015;16:383–391.
5. Morales DX, Morales SA, Beltran TF. Racial/ethnic disparities in household food insecurity during the COVID-19 pandemic: a nationally representative study. *J Racial Ethn Health Disparities*. 2021;8:1300–1314.
6. Gregory C, Ver Ploeg M, Andrews M, Coleman-Jensen A. *Supplemental Nutrition Assistance Program (SNAP) Participation Leads to Modest Changes in Diet Quality, ERR-147*. US Department of Agriculture, Economic Research Service; 2013. www.ers.usda.gov/webdocs/publications/45059/36939_err147.pdf. Accessed March 18, 2023.
7. US Department of Agriculture. Food and nutrition security. https://www.usda.gov/nutrition-security. Accessed April 26, 2022.
8. Andreyeva T, Tripp AS, Schwartz MB. Dietary quality of Americans by *Supplemental Nutrition Assistance Program* participation status: a systematic review. *Am J Prev Med*. 2015;49:594–604.
9. Dean WR, Sharkey JR. Rural and urban differences in the associations between characteristics of the community food environment and fruit and vegetable intake. *J Nutr Educ Behav*. 2011;43:426–433.
10. McGuirt JT, Pitts SBJ, Ammerman A, et al. A mixed methods comparison of urban and rural retail corner stores. *AIMS Public Health*. 2015;2:554–582.
11. Haynes-Maslow L, Osborne I, Jilcott Pitts S, et al. Rural corner store owners' perceptions of stocking healthier foods in response to proposed SNAP retailer rule changes. *Food Policy*. 2018;81:58–66.
12. World Health Organization. *Diet, Nutrition, and Prevention of Chronic Diseases*. World Health Organization; 2003.
13. DeWitt E, Gillespie R, Norman-Burgdolf H, Cardarelli KM, Slone S, Gustafson A. Rural SNAP participants and food insecurity: how can communities leverage resources to meet the growing food insecurity status of rural and low-income residents? *Int J Environ Res Public Health*. 2020;17:6037.

14. Vilar-Compte M, Burrola-Méndez S, Lozano-Marrufo A, et al. Urban poverty and nutrition challenges associated with accessibility to a healthy diet: a global systematic literature review. *Int J Equity Health*. 2021;20:40.
15. Food Research and Action Center. *North Carolina Facts: Supplemental Nutrition Assistance Program* (SNAP). Food Research and Action Center; 2018. https://frac.org/wp-content/uploads/snap-facts-nc.pdf. Accessed March 18, 2023
16. Rash M. Rural matters. https://www.ednc.org/rural-matters/. Accessed March 18, 2023.
17. US Department of Agriculture, Economic Research Service. Food environment atlas. https://www.ers.usda.gov/data-products/food-environment-atlas/go-to-the-atlas/. Accessed March 18, 2023.
18. Public Schools First NC. The facts on rural schools. Public Schools First NC; 2020. https://www.publicschoolsfirstnc.org/resources/fact-sheets/the-facts-on-rural-schools/. Accessed December 7, 2020.
19. Ohri-Vachaspati P, Acciai F, DeWeese RS. SNAP participation among low-income US households stays stagnant while food insecurity escalates in the months following the COVID-19 pandemic. *Prev Med Rep*. 2021;24(101555).
20. Wolfson JA, Leung CW. Food insecurity and COVID-19: disparities in early effects for US adults. *Nutrients*. 2020;12:1648.
21. Mueller JT, McConnell K, Burow PB, Pofahl K, Merdjanoff AA, Farrell J. Impacts of the COVID-19 pandemic on rural America. *Proc Natl Acad Sci U S A*. 2021;118:2019378118.
22. Sano Y, Mammen S. Mitigating the impact of the coronavirus pandemic on rural low-income families. *J Fam Econ Issues*. 2022;43:227–238.
23. Flanagan EW, Beyl RA, Fearnbach SN, Altazan AD, Martin CK, Redman LM. The impact of COVID-19 stay-at-home orders on health behaviors in adults. *Obesity (Silver Spring)*. 2021;29:438–445.
24. Ng SW, Popkin BM. Monitoring foods and nutrients sold and consumed in the United States: dynamics and challenges. *J Acad Nutr Diet*. 2012;112:41–45.e4.
25. Cromartie J, Bucholtz S. Defining the "rural" in rural America. US Department of Agriculture, Economic Research Service. https://www.ers.usda.gov/amber-waves/2008/june/defining-the-rural-in-rural-america. Accessed April 26, 2022.
26. NC Department of Health and Human Services. Governor Cooper declares state of emergency to respond to Coronavirus COVID-19. North Carolina Department of Health and Human Service. https://www.ncdhhs.gov/news/press-releases/2020/03/10/governor-cooper-declares-state-emergency-respond-coronavirus-covid-19. Accessed April 26, 2022.
27. Ly C, Essman M, Zimmer C, Ng SW. Developing an index to estimate the association between the food environment and CVD mortality rates. *Health Place*. 2020;66:102469.
28. North Carolina Office of State Budget and Management. *Projected Population of the State of North Carolina and Its Counties July 1, 2022 – July 1, 2050*. NC Office of State Budget and Management; 2022. https://www.osbm.nc.gov/media/1547/download?attachment. Accessed October 6, 2022.
29. Lacko A, Ng SW, Popkin B. Urban vs. rural socioeconomic differences in the nutritional quality of household packaged food purchases by store type. *Int J Environ Res Public Health*. 2020;17:7637.
30. Grummon AH, Taillie LS. Nutritional profile of *Supplemental Nutrition Assistance Program* household food and beverage purchases. *Am J Clin Nutr*. 2017;105:1433–1442.
31. Laska MN, Caspi CE, Pelletier JE, Friebur R, Harnack LJ. Lack of healthy food in small-size to mid-size retailers participating in the *Supplemental Nutrition Assistance Program*, Minneapolis-St. Paul, Minnesota, 2014. *Prev Chronic Dis*. 2015;12:E135.
32. Singleton CR, Li Y, Odoms-Young A, Zenk SN, Powell LM. Change in food and beverage availability and marketing following the introduction of a Healthy Food Financing Initiative-supported supermarket. *Am J Health Promot*. 2019;33:525–533.
33. Cantor J, Beckman R, Collins RL, Dastidar MG, Richardson AS, Dubowitz T. SNAP participants improved food security and diet after A full-service supermarket opened in an urban food desert. *Health Aff (Millwood)*. 2020;39:1386–1394.
34. Freedman DA, Bell BA, Clark J, et al. Small improvements in an urban food environment resulted in no changes in diet among residents. *J Community Health*. 2021;46:1–12.
35. Ramos C, Johnson J, Sandalow M. *Recommendations for a Healthy Eating SNAP Pilot in North Carolina*. Center for Science in the Public Interest; 2021. https://www.cspinet.org/sites/default/files/NC%20Convening%20Report-%20Final-%20June%202021.pdf.
36. US Department of Agriculture, National Institute of Food and Agriculture. Gus Schumacher Nutrition Incentive Program. https://www.nifa.usda.gov/grants/programs/gus-schumacher-nutrition-incentive-program. Accessed April 26, 2022.
37. World Health Organization. *Food Marketing Exposure and Power and Their Associations With Food-Related Attitudes, Beliefs, and Behaviours: a Narrative Review.* World Health Organization; 2022. https://apps.who.int/iris/bitstream/handle/10665/351521/9789240041783-eng.pdf. Accessed March 18, 2023.
38. Parker M, Hedrick V, Hedges S, et al. SNAP participants' purchasing patterns at a food co-op during the COVID-19 pandemic: a preliminary analysis. *J Agric Food Syst Community Dev*. 2021:1–10.
39. Ellison B, McFadden B, Rickard BJ, Wilson NLW. Examining food purchase behavior and food values during the COVID-19 pandemic. *Appl Econ Perspect Policy*. 2021;43:58–72.
40. Suneson G, Stebbins S. Most popular grocery store in every state. 24/7Wallst.com. https://247wallst.com/special-report/2020/12/02/most-popular-grocery-store-in-every-state-2/. Accessed April 26, 2022.
41. Caspi C, Seligman H, Berge J, Ng S, Krieger J. COVID-19 pandemic-era nutrition assistance: impact and sustainability. Health Affairs. https://www.healthaffairs.org/do/10.1377/hpb20220330.534478/full/. Accessed May 23, 2022.

ORCIDs

Amy Elizabeth Lo: http://orcid.org/0000-0003-2440-9305
Emily Welker Duffy: http://orcid.org/0000-0003-0981-1291
Shu Wen Ng: http://orcid.org/0000-0003-0582-110X