DEPARTMENT OF ECONOMICS

How Does Food Insecurity Relate to Food Purchase Behaviors in New Mexico?

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Executive Summary:

In fiscal year 2023, New Mexico spent $29.9M on programs supported through the Food Initiative. Most of these programs are focused on improving access to food, thus reducing food insecurity. However, improved access to food does not guarantee increased purchasing and consumption of higher quality, more diverse foods. This research develops the measures of purchasing behavior necessary to assess whether efforts to improve access to high quality food translate into households purchasing healthier foods.

This study develops several measures necessary that go beyond assessing simply access to food to assessing actual food purchasing behavior. The Dietary Diversity Scores focus on ensuring variation in foods purchased, the Food Consumption Score introduces a weighted measure of food purchase variation, emphasizing high quality nutritional sources, and the fruit and vegetable purchase measures directly focus on a key component of a healthy diet, unprocessed produce.

After developing five measures of food purchase quality, this study compares these measures with measures of food insecurity, and finds that, while food desert measures were developed by the USDA and used extensively in food policy nationwide, these measures are unable to explain differences in purchasing behaviors in New Mexico, especially after controlling for basic differences across households, such as income, household size, and the presence of children. In NM, the measure of food insecurity or a lack of access to high quality food sources most highly correlated with differences in purchasing behaviors is whether a household resides in an urban or rural setting. Urban households purchase more diverse foods and more produce than rural households, even after controlling for basic household characteristics.

This white paper marks the end of the first year of this project. In the coming year, the project team will assess two important factors related to access, particularly in rural New Mexico, dollar stores and rural transit systems, and how they impact food purchasing behaviors in New Mexico and the rural Southwest.

This work will help New Mexico policymakers better target food-related assistance programs by providing the outcome variables necessary to assess these programs. Better targeted policies should focus on not just improving access to quality food sources but also ensure that increased access translates into improvements in the quality of foods purchased, with implications for overall dietary quality and associated health outcomes.

1. Introduction

Food insecurity, or access to nutritious foods is a primary policy target for food assistance programs, as it is easily measurable and directly relates to the supply of food available to households. However, food insecurity measures access to food, not whether households actually purchase and consume more healthy foods in response to increased access. This study assesses food insecurity in New Mexico and its relationship with the quality of food purchased by households.

The US Department of Agriculture (USDA) defines food insecurity as "the limited or uncertain availability of nutritionally adequate and safe foods," arising from geographic and income barriers to obtaining nutritious foods. In 2022, 12.8 percent of households in the US lived with food insecurity, affecting 44.15 million individuals, and exceeding levels of food insecurity in 2020 and 2021. A similar trend exists for food insecurity among children. In 2022, 8.8 percent of households with children faced food insecurity, affecting almost 13.5 million children, nearly 1 million more households than in 2021, and 400,000 more households than in 2020 (Rabbit et al., 2023). These increases in food insecurity occurred despite extensive COVID-era efforts to combat the problem, including expanding nutritional assistance programs to a larger population and increasing online and mobile purchase options.

Food insecurity in New Mexico (NM) affects hundreds of thousands of individuals yearly, giving New Mexico the eighth highest food insecurity rate in the United States (US) (Feeding America, 2022). As per the 2022 food insecurity report published by Feeding America, an organization of more than 200 foodbanks across the US, 321,370 individuals were affected by food insecurity or 15.2 percent of the total NM population (as high as 21.2 percent in Luna County) as compared to the 13.5 percent overall US rate. Out of 321,370 individuals, 100,500 were children, which makes the child food insecurity rate in NM 22 percent (as high as 35.6 percent in Catron County) as compared to the 18.5 percent overall US rate.

The New Mexico legislature has recognized the prevalence of food insecurity in New Mexicans, and in 2023, announced a new initiative aimed at addressing food insecurity in the state: The New Mexico Food, Farm, and Hunger Initiative[1] to counteract high rates of food insecurity in New Mexico. With the budget of $24M for the fiscal year 2023, this initiative

[1] https://newmexicogrown.org/wp-content/uploads/2023/08/FACT-SHEET-Hunger-Initiative_FINAL-002.pdf. Accessed 06/27/2024.

directly funds local food programs such as Food Security Grants, Senior Food Boxes Program, Fruit and Vegetable Prescription Program, Summer and Afterschool Nutrition Support, College Food Security Initiative, Meal Gap Funding, Mobile Technology for WIC and for Seniors Farmers' Market Nutrition Programs, Double Up Food Bucks and more. Between fiscal years 2022 and 2023, spending on food assistance-related programs increased from $6.8M to $29.9M (See Appendix Table 1 for a list of state programs.)

Both the State of New Mexico's efforts and those at the federal level have focused primarily on reducing food insecurity, i.e., the lack of access to a supply of healthy food, e.g., such as through major food assistance programs like state and federally funded Supplemental Nutritional Assistance Program (SNAP, a.k.a. "food stamps") and school lunch and breakfast programs. Unfortunately, these efforts do not necessarily improve the nutritional value of food purchased or consumed, as increasing the supply of healthy foods alone does not ensure that demand for healthy foods exists, i.e., that healthy foods are purchased and consumed. Increased access to healthy foods does not decrease access to unhealthy foods, and poor dietary habits can be difficult to change. Thus improperly targeted policies could improve access to healthy foods without improving the quality of food purchased and consumed. Providing meals through schools is typically seen as reducing food insecurity, particularly for lower income and rural children, but a recent study found that 92 percent of school breakfasts and 69 percent of school lunches exceeded the USDA's own Dietary Guidelines for Americans of no more than 10 percent of daily caloric intake from sugars (Fox et al., 2021). Free public transit to grocery stores would reduce food insecurity by most measures but does not necessarily affect the food purchased and consumed by individuals. This study builds off existing work from around the world to create the nutrition measures necessary for evaluating the quality of food purchased by New Mexicans, allowing policymakers to go beyond just assessing whether policies improve access to quality food to assessing whether policies improve the quality of food available in the home.

Food insecurity is measured using retrospective surveys as in the Current Population Survey Food Security Supplement data (CPS-FSS)[2] or using geographic distance and income thresholds as in the USDA's food desert database,[3] with the former more common in the

[2] https://health.gov/healthypeople/objectives-and-data/data-sources-and-methods/data-sources/current-population-survey-food-security-supplement-cps-fss. Accessed 06/27/2024.
[3] https://www.ers.usda.gov/data-products/food-access-research-atlas/. Accessed 06/27/2024.

academic literature. USDA's food desert database, The Food Access Research Atlas, provides Census-Tract-level information on access to healthy food, demography, income level, access to public transportation, and more. The CPS-FSS asks households about skipping meals and ability to afford meals. The literature finds that households that report limited access to food in the CPS-FSS experience significant negative health outcomes and these effects can vary between children and adults. For children, food insecurity is associated with an increased risk of congenital disabilities, lower birth weights, iron deficiency, and asthma. (Borders et al., 2007; Eicher-Miller et al., 2009; Mangini et al., 2015). A study using its own 5-question survey on food insecurity found similar results (Carmichael et al., 2007). The literature has also found that food insecurity is also associated with a higher risk of behavioral and cognitive issues, including poor academic progress, social skills, and mental health problems (Kimbro & Denney, 2015; Ziliak & Gundersen, 2014; Jyoti et al., 2005; McLaughlin et al., 2012). For adults, food insecurity is associated with an increase in the risk of diabetes and chronic kidney disease (Crews et al., 2014; Seligman et al., 2007), unhealthy dietary patterns and obesity (Martin & Lippert, 2012; Pan et al., 2012) and mental health problems such as depression, anxiety, insufficient sleep and even cigarette smoking (Leung et al., 2015; Liu et al., 2014; Kim & Tsoh, 2016). While looking into the effect of living in areas with food desert status on health, past studies have found that people living in such areas tend to have less time for exercise (Dubowitz et al., 2012; Dubowitz et al., 2015), and they have higher chances of suffering from high BMI, are more likely to smoke and have hypertension (Kelli et al., 2017), and experience a higher risk of cardiovascular diseases (Kelli et al., 2019). All these findings show that food insecurity, either measured through CPS-FSS survey responses or the USDA’s food desert measures, have significant effects on the health and wellbeing of an individuals.

Most of these health issues are presumed to arise from a lack of high-quality food consumption resulting from access or resource constraints. Research has shown that high-caloric, non-nutritive food is cheaper and more geographically accessible than healthier food such as fresh produce, quality protein sources, and foods high in fiber (Drewnowski, 2004; Dietz, 1995; Jetter & Cassady, 2006.) Furthermore, due to the resource constraints, households may substitute nutritious food for foods that are cheaper and more easily accessible. Reduced fruit and vegetable consumption is associated with lower nutrient intake (Kendall et al., 1996; Mello et al., 2010), increased consumption of low-nutrient foods such as fast-foods, pre-made foods and

snacks (Leung et al., 2014) and skipped meals, all of which can lead to significant nutritional imbalance and caloric deficiency (Zizza et al., 2018; Lee & Kim, 2018).

Several studies in the US have shown that a household's dietary choices are significantly correlated with its access to food and resource constraints. These studies use the Healthy Eating Index (HEI), a scoring system designed by the National Cancer Institute and USDA to evaluate diet quality per Dietary Guidelines for America (DGA) and to measure nutritional choices, and found lower HEI among food-insecure individuals and households. Studies by Bhattacharya, Currie, & Haider (2004) and Leung and Tester (2019) combined the National Health and Nutrition Examination Survey with HEI and CPS-FSS food security data and found that food-insecure adults had lower HEI on average by around 2.4 points. Children's HEI was not affected by food insecurity measures (Bhattacharya, Currie, & Haider, 2004.) Basiotis et al. (2002) and Champagne et al. (2007) found that lower HEI scores were associated with significantly lower intake of vegetables, fruits, milk, and cholesterol, and decreased food variety.

This study introduces to the U.S. literature on food insecurity two dietary quality measures, widely used in studies of nutrition sufficiency in the developing world, but which have not yet been utilized in the US, despite commonalities between many developing countries and lower income US regions. More specifically, we use USDA food desert to generate food insecurity measures, which we combine with NielsenIQ Homescan Data on grocery purchases by 1,100 New Mexican households using 201,624 New Mexican household-by-week observations from 2004-2020 to construct two measures of the nutritional content of food purchased by households: the Dietary Diversity Score (DDS) and Food Consumption Score (FCS). The DDS and FCS measures are then used to examine the trends in the quality of food purchased over our study period of 2004 to 2020, overall and by various socio-economic and geographical characteristics of the households.

Both DDS and FCS have been widely used in the development literature (see, for example, Langer et al., 2024; Hoddinott & Yohannes, 2002; Wiesmann et al., 2009). The US literature has thus far focused on the USDA-developed Healthy Eating Index (e.g., Reedy et al., 2018; Hu et al., 2020; Guo et al., 2004.) Although a validated measure of the quality of food consumed, the HEI is less useful than the DDS and FCS because few researchers have access to the sub-macronutrient level information required (e.g., fatty acids and refined grains) and the results cannot be readily compared with the much more extensive work from the developing

world, which uses the DDS and FCS indices that are more inclusive of culturally-specific foods less common in the standard US diet (Bersamin et al., 2006; Guenther, Reedy & Krebs-Smith (2008).

As also documented by Feeding America[4] (Gundersen et al., 2022), this study uses the USDA food desert and CPS-FSS data to show that NM residents experience more food insecurity than the average US resident. Matching the USDA food desert data and information on urbanicity with the NielsenIQ Homescan data, this study finds worse nutritional quality for both DDSs, FCS, and fruit and vegetable purchase as compared to US averages. The underlying connection between food insecurity and nutritional quality is more nuanced than can be concluded from looking at state-level averages; this study documents significant heterogeneity in both measures of food insecurity and dietary quality across New Mexico. Regression results show that the USDA's food desert measure based on geographic access alone and urban/rural distinctions explain a significant amount of variation in dietary quality of foods purchased, but the USDA's food desert variable based on low access and low income does poorly in explaining differences. After controlling for household characteristics, including income, only urban versus rural consistently explains differences in dietary quality across all dietary quality measures. Further variation in nutritional intake exists that cannot be identified using solely food insecurity measures, i.e., information on geographic access and income. For example, more educated households, larger households, and households with children typically exhibit better nutritional diversity. Low-income households and households with a single household head fared worse than those with two household heads, regardless of the sex of the household head. A respondent's racial identification has some effect on dietary quality for their household, but a respondent's ethnicity does not; those categorized as Other Race rather than Black, Asian, or White were more likely to report purchasing lower quality food, but no statistically significant differences existed between households with Hispanic versus Non-Hispanic respondents.

This study contributes to the academic literature and informs policymakers by introducing and evaluating new measures of dietary quality, assessing common measures of food insecurity including identifying major weaknesses in common measures, and identifying significant heterogeneity in dietary quality at the county, Census Tract, and zip code levels in New Mexico.

[4] https://map.feedingamerica.org/county/2022/overall/new-mexico. Accessed in 07/01/2024.

2. Data

This study uses three primary data sources: food desert data from the USDA, self-reported food insecurity measures from the CPS Food Security Supplement, and household-level food purchase data from the NielsenIQ Household Scanner Data to compare how food insecurity measures compare with the quality of food purchased by households. More specifically we compare four food insecurity measures (food insecurity from CPS-FSS, food desert based on geographic access, food desert based on access and income, and urban v. rural) with five measures of dietary diversity (DDS-12, DDS-14, FCS, fruit purchased, vegetables purchased).

2.1 Measuring Food Insecurity

The USDA defines food security as having access to enough food for an active, healthy life. At a minimum, nutritionally adequate and safe foods are readily available, and individuals are able to acquire acceptable foods in socially acceptable ways. The USDA uses two primary approaches to measuring food insecurity. The first, based on survey responses to the CPS-FSS, measures self-reported food insecurity, and the second measures food insecurity based on geographic proximity to grocery retailers and income. Both approaches are limited by their focus on access and availability of food rather without accounting for the quality of food purchased and consumed (Rabbit et al., 2023; Ashby et al., 2016). The CPS-FSS-based food insecurity measures, although widely used in the academic literature, are only consistently available at the state level and do not allow for analysis of substate heterogeneity, crucial for our analysis of food insecurity in New Mexico.

We begin by creating state-level food insecurity measures using the Current Population Survey Food Security Supplement (CPS-FSS), which collects data on national and state-level food security. Every December, the CPS-participating households are asked questions about their access to and spending on food and their participation in federal and community-based food assistance programs (Rabbit et al., 2023, USDA). A household without children answers ten questions that reflect various aspects of food insecurity and the capacity to meet food needs in the household. There are eight additional questions for households with children. Based on the responses to the series of questions, USDA categorizes households into four categories: high food security, marginal food security, low food security, and very low food security. For our trend analysis using the CPS-FSS, we define food security as either high food security or

marginal food security. (See Appendix B for the specific questions and response coding.) The food security measure is constructed on an annual basis and focuses primarily on financial hardship. Using data from 2004-2020, our analysis sample consists of 71,599 observations from households living in New Mexico. Due to data confidentiality requirements of the CPS, we are only able to identify four counties in CPS data (Bernalillo, Dona Ana, San Juan, and Santa Fe). We use these data to track trends in food insecurity in New Mexico over time, but rely on the food desert data from the USDA for our sub-state analyses.

The USDA maintains the publicly available Food Access Research Atlas (FARA), which calculates Census Tract-level information on geographic proximity to grocery retailers both with and without accounting for income. We use the food desert variables "Low Access" and "Low Access and Low Income" to capture areas experiencing food insecurity. FARA defines "Low Access" as living in a Census Tract where at least 500 people, or 33 percent of the population, live one mile or more from the supermarket in urban areas and ten miles or more away for rural areas. A Census Tract is designated as “Low Income” based on the Department of Treasury’s New Markets Tax Credit Program, which considers as low income tracts with poverty rates 20 percent or greater, tracts with median family income less than or equal to 80 percent of the statewide median family income, and tracts in metropolitan areas with median family incomes less than or equal to 80 percent of the metropolitan area’s median family income.[5]

To further explore food insecurity, or a lack of access to quality food, we use rural and urban status. We define whether a household is located in rural or urban areas in two ways. First, for our regression analyses, we use information from the Rural-Urban Commuting Area Codes file from USDA, which provides urban versus rural categorization at the zip code level.

2.2 Measuring the Quality of Food Purchased

Our data on household purchases come from NielsenIQ Homescan Consumer Panel data maintained by the University of Chicago Booth School of Business and the NielsenIQ Company. The Consumer Panel data contains information about the purchasing patterns of a geographically balanced sample of panelists. Each year, approximately 40,000-60,000 households are included in the sample. These panelists are asked to record all purchases intended for personal use using in-home scanners or mobile apps immediately after taking the purchased items home. Therefore,

[5] https://www.ers.usda.gov/data-products/food-access-research-atlas/documentation/. Accessed 06/30/2024.

the dataset contains rich information about the date of purchase and detailed product information (brand, Universal Product Code, quantity, and price) for each purchased item, and information about the characteristics of the household (geographic location down to the zip code level, household composition, race, educational attainment, and income).

For the purposes of this study, we restrict the analyses sample to the 1,100 households living in New Mexico in years 2004-2020. Because our primary focus is on food purchase patterns, we convert individual purchase information into weekly purchases, under the assumption that grocery shopping usually happens on a weekly basis. While the vast majority of households in a given year had some food purchases in a given week, there are a small number of weeks in which a household did not report any food purchases. We exclude those household-by-week observations from our analyses sample. For each observation, we have detailed information on the food items purchased by the household. Using this information, we construct three measures of the nutritional quality of the food purchased, DDS (two versions), FCS, as well as fruit and vegetable consumption, a component thought to be less well captured by the DDS and FCS than other types of foods. Our primary analyses sample consist of 201,624 household-by-week observations, covering households from 29 counties in the state.

2.2a Dietary Diversity Score (DDS):

The Dietary diversity score DDS is an indicator introduced by USAID Food and Nutrition Technical Assistance that captures the household's access to high-quality, diverse food by focusing on variation in food groups (diversified diets) in a specific time (Swindle & Bilinsky, 2006). The DDS is typically constructed in the literature as follows:

- Food items are classified into twelve food groups based on nutritional content (Swindale & Bilinsky, 2006). It is recommended that the number and composition of the food groups be modified depending on local food availability (Kennedy et al., 2011 FAO guidelines).
- Households are asked to recall their food consumption in the past 24 hours using a survey instrument. If a certain food group was consumed during the reference period, a score of 1 is assigned to that group, and a score of 0 is assigned otherwise.
- The DDS is then calculated by adding the scores of all food groups. Here, the score ranges from 0-12.

The DDS is a popular measure widely used primarily in developing countries, although two studies exist involving several Europeans countries (Mertens et al., 2019; Moraeus et al., 2020). Consisting of simple and straightforward questionnaires, the DDS allows researchers and policymakers to examine the household food consumption and assess the overall diet quality (Hoddonott & Yohannes, 2002). A household with a higher DDS shows improved nutritional adequacy and overall diet quality through a higher intake of fruits, vegetables, protein, and other macronutrients as compared with households with a lower DDS (Vandevijvere et al., 1965; Zhong et al.,2022; Azadbakht et al., 2005). Improvements in DDSs have been shown to contribute to the improved health condition, such as a lower risk of obesity (Oldewage-Theron et al., 2013; Azadbakht et al., 2005). Various studies in the past have established a positive association between DDSs and per capita food consumption, dietary energy consumption (Hoddinott & Yohannes, 2002; Wiesmann et al., 2009), and household total food expenditure (Thorne-Lyman et al., 2010).

Based on data availability, we made a couple of modifications to the standard DDS. First, we use purchase data rather than food consumption recall data. Most of the work with the DDS uses data on food items consumed by asking respondents to retrospectively recall past consumption of specific food types. For example, FAO (2011) uses questions such as: “In the last 24 hours, did you consume any meat?” By using purchase data, this study adds to the literature by using the DDS to measure dietary diversity in foods available at home, an important component in understanding the link between food insecurity measured based on general food availability or grocery store access and negative health outcomes. Does the positive correlation between food insecurity and negative health outcomes arise because healthy food is not available, because healthy food is not purchased, or because healthy food, even though freely available, is not consumed? Purchases based on scanner data should also suffer less from recall bias than the survey data typically used. The data are, however, limited in that they capture purchase of food, but not when food items were eaten, allowing this study to investigate an important link between food insecurity and dietary quality, food purchases, but without the data to assess consumption. Nonetheless, most grocery purchases, especially of staple foods, are intended for a household’s own consumption within a limited time. To create the DDS from the NielsenIQ data, we first grouped the food types into the specific food groups used in calculating the DDS. A total of 865 food items purchased by the households in our sample were assigned to

twelve groups as recommended by the Food and Agriculture Organization of the United Nations (Kennedy, Ballard & Dop, 2011). The groups are Cereals, White Roots/Tubers, Vegetables, Fruits, Meat, Eggs, Fish/Seafood, Legumes/Nuts/Seeds, Milk/Dairy Products, Oils/Fats, Sweets, Spices/Condiments/Beverages, with the number of food items categorized in each group reported in Table 1.

Another important modification we made relates to the classification of composite food items. Of the 865 food items in our sample, 106 food items were classified as composite foods and could not be readily classified in the original twelve groups. Hence, we created two extra groups, Snacks and Pre-made food, and assigned such composite foods to these groups. As such, we created two versions of DDS based on the inclusion/exclusion of these two additional food groups. The first version of DDS includes the 12 food groups mentioned above and excludes the composite food groups: snacks and pre-made food. Moraeus et al. (2020) used a similar approach, excluding composite/mixed foods while developing a DDS for Swedish adolescents. For the second version of our DDS calculation, we included the additional two food groups, calculating the DDS on the basis of 14 groups rather than the original 12. The two versions of the DDS are referred to as DDS-12 and DDS-14 hereafter.

Table 1: DDS food groups and number of food items included in each food group

DDS Food Groups	Number of Food Items
12 Groups as per FAO guidelines	
Cereals	65
Roots and tubers	7
Vegetables	78
Fruits	51
Meat	60
Eggs	3
Fish and seafood	26
Legumes, Nuts and Seeds	32
Milk	69
Oil/Fat	11
Sugar/honey	174
Miscellaneous	183

Additional Groups	
Snacks	37
Premade food	69
Total	865

Notes: First 12 food groups are created as per the FAO guidelines accessible at: https://www.fao.org/fileadmin/user_upload/wa_workshop/docs/FAO-guidelines-dietary-diversity2011.pdf. The last two food groups are created to include multiple-ingredient foods that were purchased but could not be easily classified into the original 12 food groups on the basis of primary ingredients.

2.2b Food Consumption Score (FCS):

While the DDS measure provides important insights regarding the diversity of a household's diet, it does not account for the relative nutritional value of each food group. For example, food groups that are considered healthier, such as diary and protein, are weighted the same as food groups that are considered less heathy, such as starch or prepared meals. To address this concern, we use FCS as another measure.

FCS is a measure of dietary diversity and access to food that was introduced by the World Food Program (WFP) in 1996. They define FCS as a weighted diversity score calculated using a household's frequency of consumption of different food groups in a week. Similar to the DDS, the FCS calculation is based on recall questionnaires in which respondents are asked how many days the household has consumed certain food items in the past week. The main difference between the two measures is that FCS uses weights and frequency for the food groups (Weisman et al., 2009), while DDS focuses only on whether or not the food was consumed. Food items are grouped together in a food group based on the similarity of their caloric and nutrient content. Weights are assigned to food groups based on the WFP recommendation. The weights range from 0-4 and the highest weight is assigned to food groups with food items high in energy, quality protein, and higher micronutrient content (Weismann et al., 2009). As per the WFP's Vulnerability Analysis and Mapping guidelines, the FCS is constructed through the following steps:

- Food items are classified into nine food groups, each assigned with their weights in parentheses: main staples (2), pulses (3), vegetables (1), fruit (1), meat and fish (4), milk (4), sugar (0.5), oil (0.5), and condiments (0).

- Each respondent is asked about whether they consumed a certain food group in the past 7 days, and if so, how many time were the food group consumed (food group score). If a food group was consumed more than 7 times, the food group score is capped at 7.
- The food group score is multiplied by the weight assigned to that food group, hence creating a weighted food group score.
- FCS is calculated by adding weighted food group scores for all nine food groups. The FCS can range from 0-112. Three household food consumption statuses are set based on the FCS: Poor (FCS: 0–21), borderline (FCS: 21.5–35), or acceptable (FCS: > 35) food consumption (WFP VAM, 2009).

Past research supports the use of the FCS to measure dietary diversity as it captures both the quantity and quality of the diet. Weismann et al. (2019) and Lovon & Mathiassenin (2014) find a positive association of FCS with overall household caloric consumption.

We made an important modification in the construction of FCS. In particular, we are only able to observe the purchase of each type of food item, but not whether or when the item was eaten. As such, we are unable to observe the frequency of consumption in the reference week in order to calculate the food group score. To address this data limitation, we only apply the weights to each food group, but assume that the frequency of consumption is one as long as the food group was purchased. Weights were assigned for each food group in accordance with the WFP VAM guideline. Table 2 lists the food groups, the number of food items included in each group, and the associated weights. Only 501 food items could be classified into the FCS, because unlike the DDS, it does not include a miscellaneous category for items consumed in small quantities, like condiments and spices. Because of our modification, our FCS ranges from 0-16, as opposed to 0-112 in the literature.

Table 2: Food groups with total food items in each group and weights assigned to each group.

Food groups	Food items included	Weights
Staple	105	2
Meat	75	3
Pulses	28	1

Vegetables	61	1
Fruits	51	4
Milk	33	4
Sugar	139	0.5
Oil	9	0.5
Total	501	

Note: Food groups and weights are assigned as per the WFP VAM 2009 guidelines accessible at: https://resources.vam.wfp.org/data-analysis/quantitative/food-security/food-consumption-score.

A remaining concern with our modified FCS measure is that the weighting scheme commonly used in the literature imposes a high weight on protein but a relatively low weight on fruits and vegetables. While the choice of weights commonly used in the literature are consistent with the nutritional status of individuals living in poverty and/or developing countries, these weights may not be properly calibrated to capture a major challenge faced by New Mexicans, particularly those living in rural areas, which is the lack of access to produce. To further account for this, we construct additional measures specifically focusing on whether the household purchased any vegetables or any fruit in the week. We include fresh produce as well as boxed, canned, or frozen fruits and vegetables.

2.2c Fruits and Vegetables

The DDS and FCS are focused on the importance of dietary diversity as well as sufficient total caloric intake but the latter is less of an issue in the US than in most developing countries. As such, this study created an additional measure to capture explicitly vegetable and fruit consumption, of particular concern in the US given the wide availability of highly processed foods. Due to the lack of a standard fruit and vegetable consumption measure, various approaches have been used in the literature to measure the intake of fruits and vegetables. Pessoa et al. (2015) calculated fruit and vegetable scores by asking individuals about their daily frequency of fruit and vegetable intake and weekly consumption of at least one type of fruit and vegetable. They found that the fruit and vegetable score was higher in men, and the score increased with age, education, income, activity level, and for areas with a higher density of

healthy food outlets. The score was lower for smokers and those who drank sweet drinks more than five days a week. Pastori et al. used a 24-hour recall approach and classified fruits and vegetables into six subgroups. A score of 1 was given for each subgroup consumption, making the score range 0-6. Thompson et al. (1999), in their study with 15,060 individuals from seven study centers around the USA, calculated food and vegetable consumption through seven food frequency questions in which they asked about fruit and vegetable consumption in the past month. They found that the vegetable score was lower than the fruit score, higher education was associated with higher scores for fruits and vegetables, blacks had higher scores than whites, and Hispanics had lower scores than Non-Hispanics.

In this study, we create a measure of fruit consumption and a measure of vegetable consumption by assigning a household-week observation a value one if there are any fresh, boxed, canned, or frozen fruits or vegetables in their weekly purchase list and zero otherwise.

2.3 Descriptive statistics

In Table 3, we present the descriptive statistics of the variables used in our analysis from household-by-week NielsenIQ Homescan data for New Mexico from 2004 to 2020. We use the projection factor from the NielsenIQ Homescan data as a sample weight for national representation. We have 201,624 household-by-week observations. The average household level FCS, DDS-12, and DDS-14 were 8.51, 5.57, and 6.43, respectively. For fruits and vegetables, 43% of the households purchased at least one fruit and 51% of the households purchased at least one vegetable in an average household week. Over 50% of the households had at least one household head who had attended some college, and 35% of the households had at least one household head who has a college degree. Only one percent had less than a high school education. Twelve percent of households were low-income households, defined as household income at or below 150% of FPL.[6] The average household consisted of 2.3 individuals and 22% of households reported having a child younger 18 in the household. Eighty percent of the households identified as White, 4% identified as Black, 1% identified as Asian, and 15% of households identified as “Other Race”. Twenty-four percent of the households were Hispanic.

[6] This is calculated based on the categorical household income information and household size. The measure is a rough estimate.

Almost 27% of the households had only a female as household head, and 12% had only a male as a household head.

We matched the zip-code-level household data with the Census-tract-level food desert data using zip code to Census Tract crosswalk developed by the US Department of Housing and Urban Development (HUD) and the US Postal Service (USPS). Rural and urban designations were matched based on zip code. Fifty-five percent of households reported living in low-access Census Tracts, 18% in low-access and low-income Census Tracts, and over 31% live in rural zip codes.

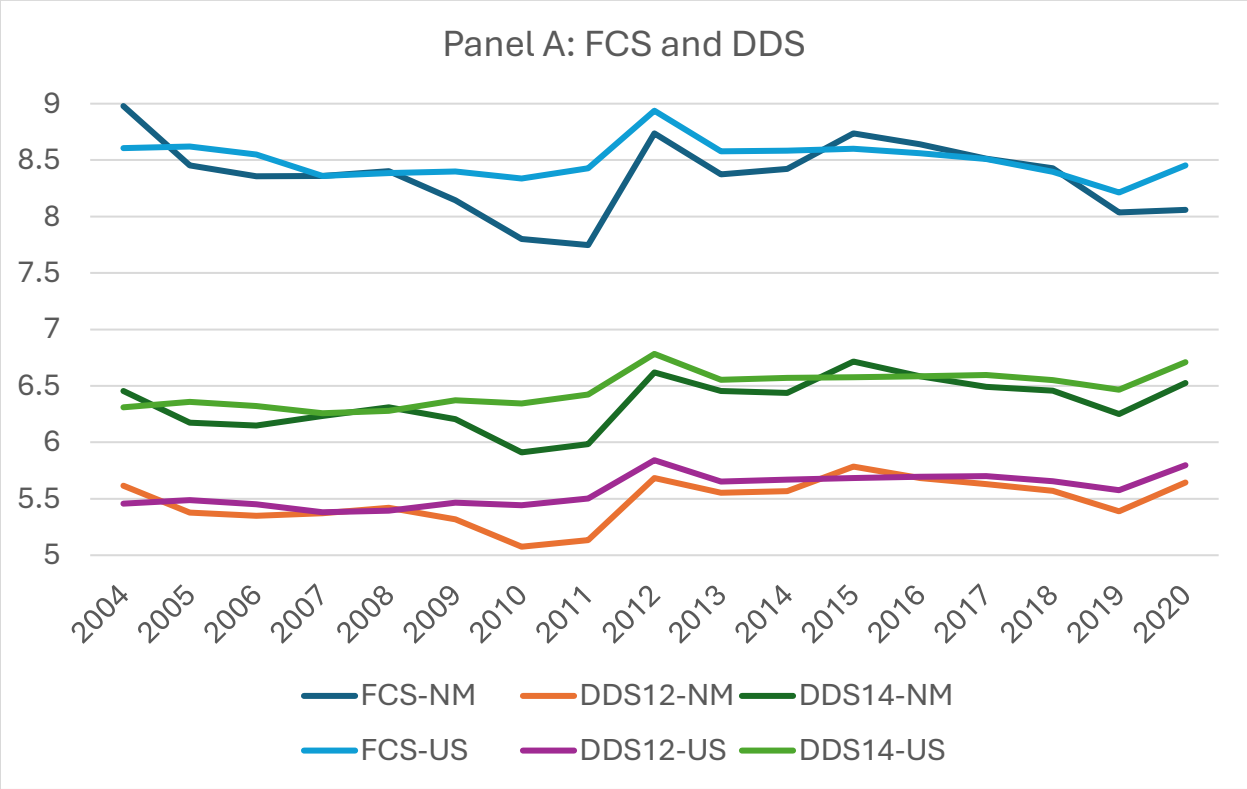
Table 3: Descriptive Statistics

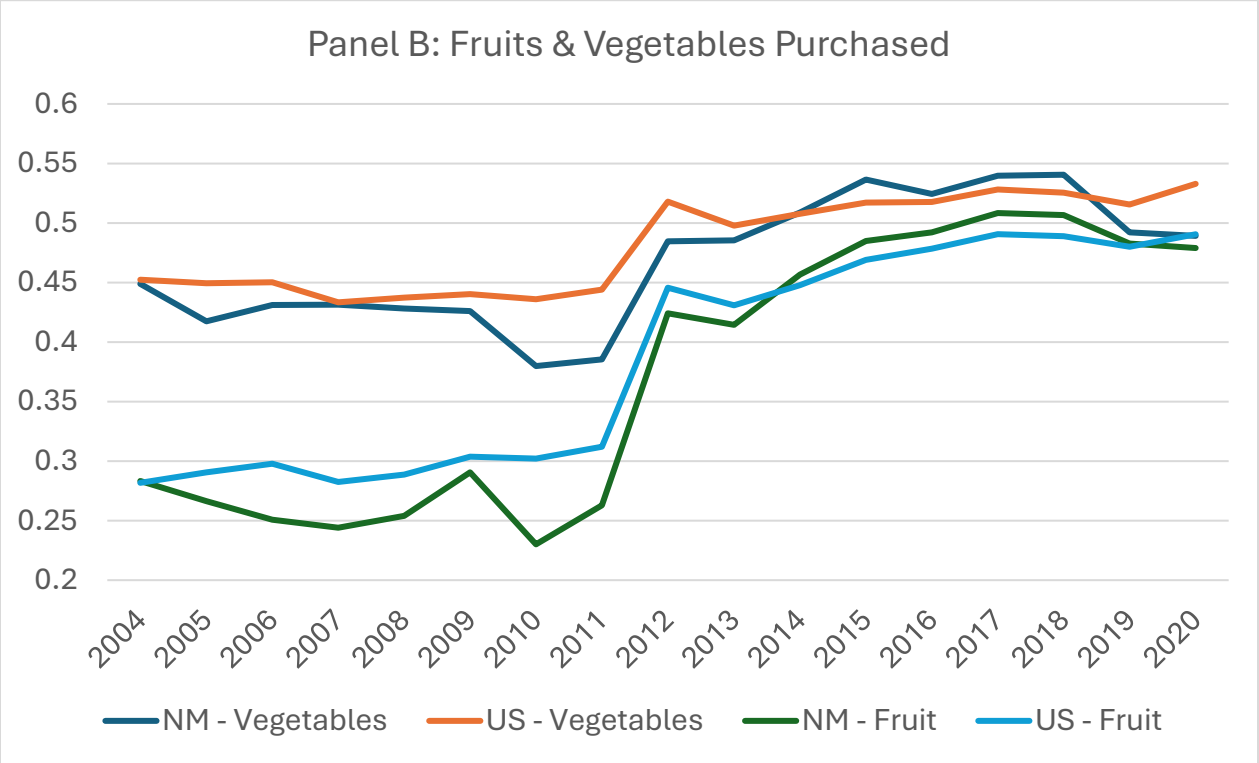
Variable	N	Mean	Std. Dev.	Min	Max
Nutritional measures					
FCS	197,368	8.51	4.95	0	16
DDS-12	180,381	5.57	2.62	0	12
DDS-14	181,289	6.43	3.06	0	14
Fruit Purchase	195,283	0.43	0.49	0	1
Vegetable Purchase	195,350	0.51	0.50	0	1
Socioeconomic					
No high school	201,624	0.01	0.09	0	1
High school graduate	201,624	0.11	0.32	0	1
Some college	201,624	0.53	0.5	0	1
College graduate	201,624	0.35	0.48	0	1
Low income	201,624	0.12	0.33	0	1
Household size	201,624	2.3	1.2	1	9
With child	201,624	0.22	0.41	0	1
White	201,624	0.8	0.4	0	1
Black	201,624	0.04	0.19	0	1
Asian	201,624	0.01	0.11	0	1
Other race	201,624	0.15	0.36	0	1
Hispanic	201,624	0.24	0.43	0	1
Female-only household head	201,624	0.27	0.44	0	1
Male-only household head	201,624	0.12	0.32	0	1
Geographic					
Low Access	200,289	0.55	0.5	0	1
Low Access and Low Income	200,289	0.18	0.39	0	1
Rural	201,624	0.31	0.46	0	1

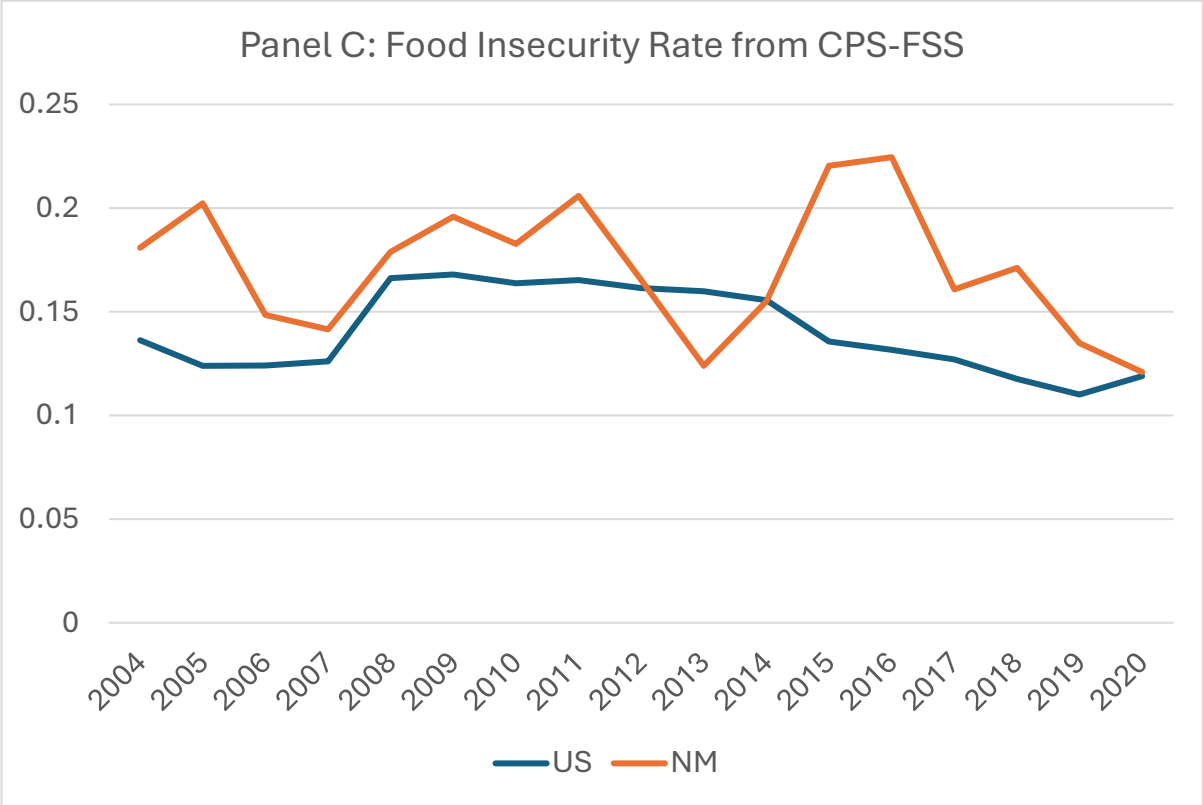
Note: This table presents descriptive statistics for variables used in our analysis from household by-week NielsenIQ Homescan data for New Mexico from 2004 to 2020. Nutritional quality measures include: Food Consumption Score (FCS), Dietary Diversity Score-12 categories (DDS-12), Dietary Diversity Score-14 categories (DDS-14), Fruit Purchase, and Vegetable Purchase. Socioeconomic variables include the household's education level, Low-income household (1=yes), Household size, With child (1=yes), Race (White, Black, Asian, Others), Hispanic (1=Yes), Female-only household head (Yes=1), Male-only household head (Yes=1). Geographic variables include household in Low Access area (Yes=1), in Low Access and Low Income area (Yes=1), and in Rural area (Yes=1). Observations are weighted using the projection factor provided in the NielsenIQ Homescan data.

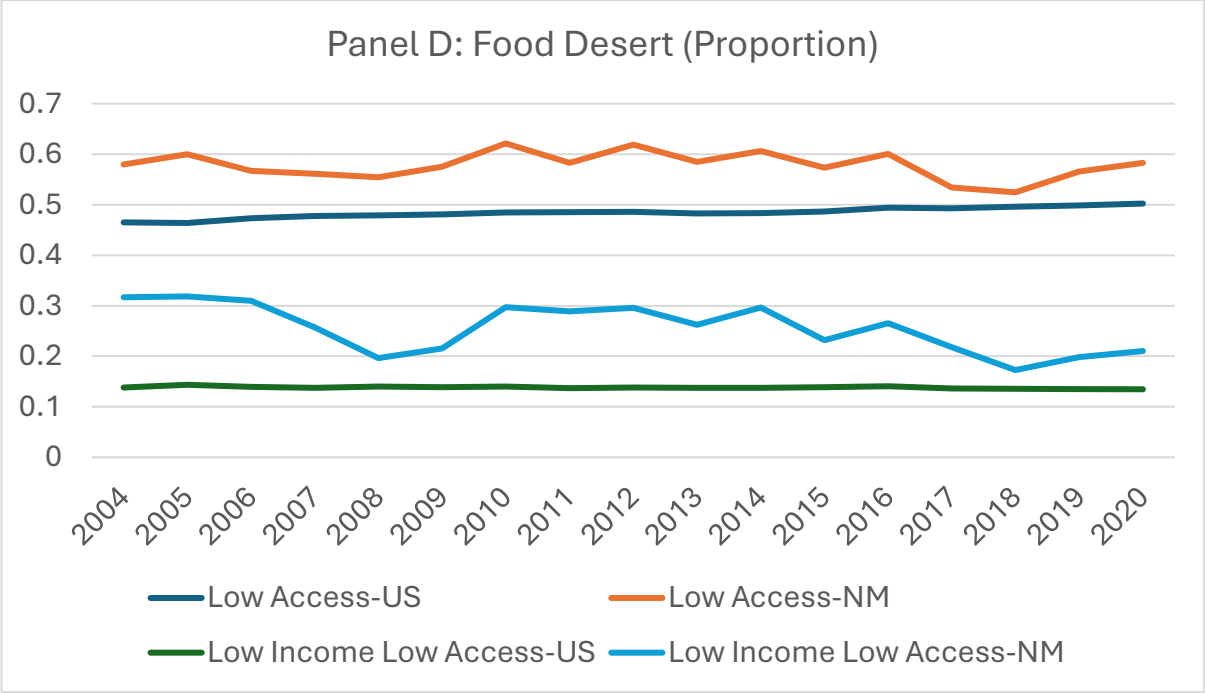
3. Statistical analyses

The goal of this study is to compare measures of the dietary quality of food purchased (DDS, FCS, and fruit and vegetable purchases) with food insecurity measures from the CPS-FSS, the Food Access Research Atlas, and by urban and rural status. We first graph the raw trends of the dietary quality and food insecurity measures over the study period (2004-2020) for New Mexico and for the rest of the US, as shown in Figure 1.




Panel B: Fruits & Vegetables Purchased
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
NM - Vegetables
US - Vegetables
NM - Fruit
US - Fruit


Panel C: Food Insecurity Rate from CPS-FSS
0.25
0.2
0.15
0.1
0.05
0
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
US
NM



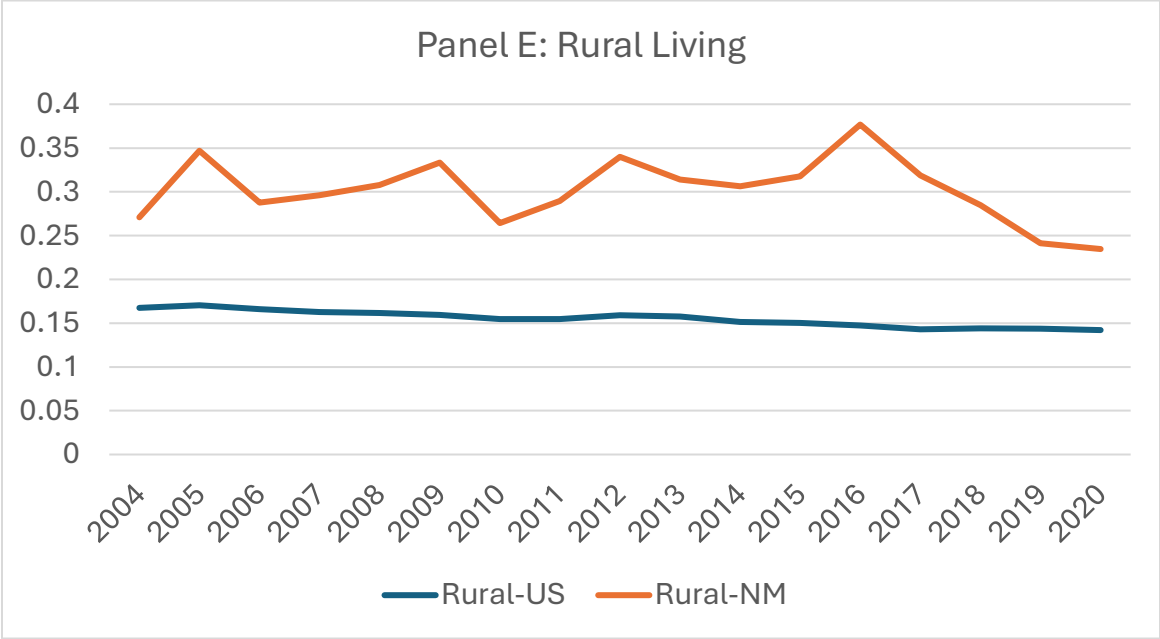
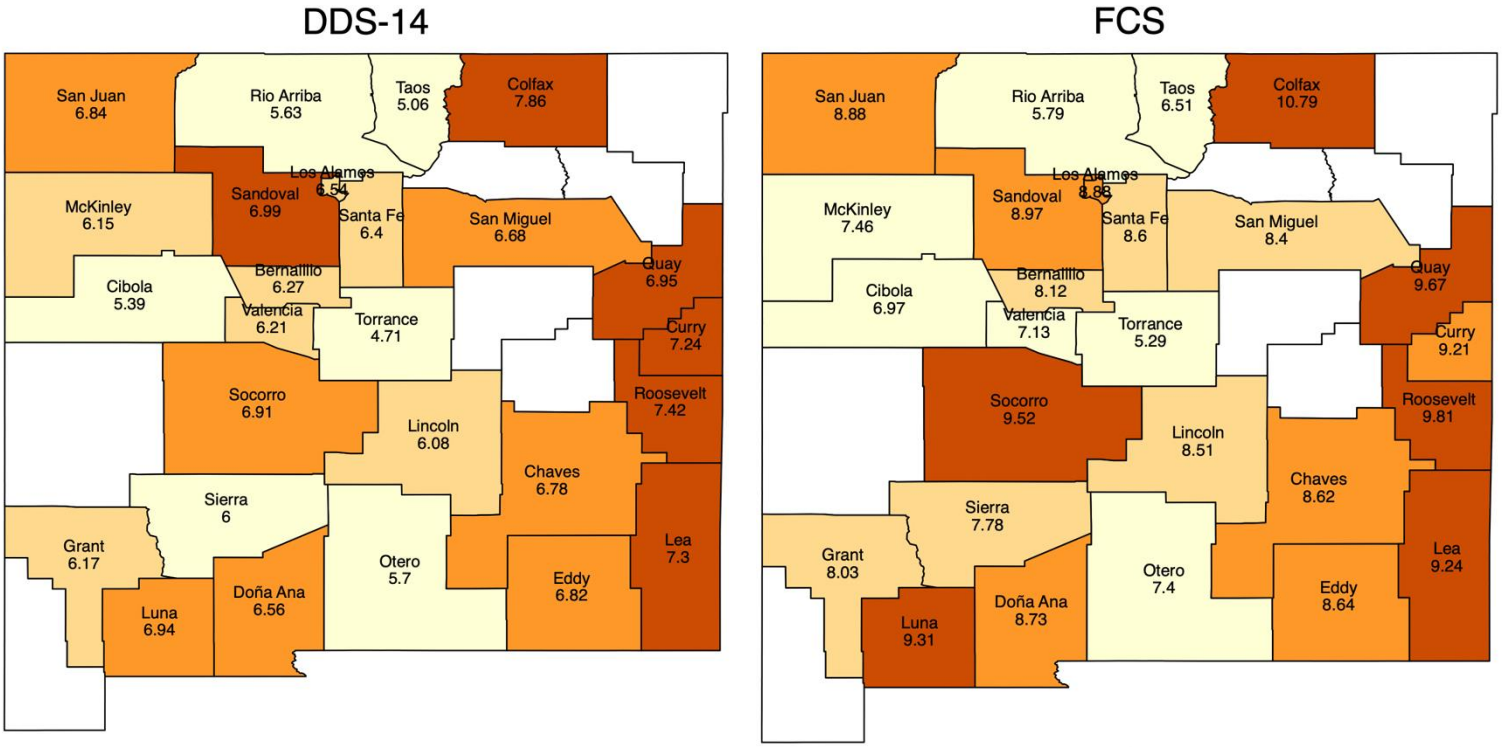


Figure 1: Trends in the Dietary Quality of Food Purchases and Food Insecurity – US & NM

Note: Panel A graphs trends in FCS and DDS scores using the 12-category measure and expanded 14-category measure; Panel B graphs fruit and vegetable purchases, Panel C measures food insecurity using the CPS-FSS; Panels D show trends in food desert prevalence for the US and NM as measured using Low Access and Low Access and Low Income, respectively; Panel E shows trends urban/rural status for the US and NM.

A consistent pattern emerges across all panels – NM tends to fair worse than the rest of the US with few exceptions, but for the past several years, NM rates have been improving towards the national average. DDS-12, DDS-14, and FCS show differences in levels but trend almost identically over time due to the high degree of correlation in the underlying factors contributing to each index. Pairwise correlation coefficients among these variables are high at 0.86 between FCS and DDS-12, 0.87 between FCS and DDS-14, and 0.97 between the two DDS measures. An increase across all measures occurs around 2012. Fruit and vegetable purchases do not trend that differently in NM from in the rest of the US. Interestingly, while both fruit and vegetable consumption have increased over time, fruit consumption has increased substantially more and now is similar to vegetable consumption. The increase in fruit purchases in 2012 matches the jump in the DDS and FCS measures around the same time, which include fruits as a factor. Food insecurity rates are also constantly higher in NM as compared to the national average with the exception of 2013, when the food insecurity rate fell below the national average, and 2020, when it approximately equaled the national average. For food desert prevalence, NM has a higher share of households living in Low Access and Low Access and Low Income areas than the national average, with a relatively flat trend throughout the period. The share of households in rural areas is significantly higher in NM than in the rest of the US with as high as 36.7 percent of NM households living in rural areas in 2016 while the national average was 14 percent. The food desert measures correlate poorly with the measures for rural and urban. The pairwise correlation coefficient between the two food desert measures (Low Access and Low Access and Low Income) is 0.51; between Low Access and Rural, the correlation is 0.24, and between Low Access and Low Income and Rural, the correlation is -0.03, suggesting that these variables measure different dimensions of food security.

In Figure 2, we explore heterogeneity in the dietary quality of food purchased and food insecurity within NM by presenting maps of NM with county-level measures of DDS-14, FCS, and food insecurity. Colfax County had the highest 2016-2020 average quality of food purchased with a DDS-14 of 7.85 and an FCS of 10.78. We obtain the county-level food insecurity data for NM from Map the Meal Gap study conducted by Feeding America (Gundersen et al., 2022).[7,8] For 2020, McKinley County had the highest level of food insecurity at 22.6% and Los Alamos County had the lowest food insecurity at 6.00%. We find that for most of the counties, where they had higher scores for nutritional measures (FCS & DDSs), they have lower food insecurity. Some counties, however, show the opposite pattern. For example, Luna County and Colfax County have high DDS and FCS but they also have high food insecurity values. The maps highlight that substantial heterogeneity exists within NM that is masked by state-level averages.



[7] Due to the confidentiality requirements of CPS-FSS data, we only could measure food security for four counties using that data. Among those, food security for Bernalillo County was the highest with 85% food secure.

[8] To estimate the county-level food insecurity rate, Map the Meal Gap study first estimated a model for food insecurity rates at the state level using variables such as unemployment rate, poverty rate, median income, percentage of Hispanic and Black family, percentage of homeowners, percentage of individuals who reported disability, and year and state fixed effects. They use the state level data from 2009-2020 CPS-FSS. Then, they used the coefficient-estimates from state-level model and information on the same variables at county level from 2016-2020 American Community Survey (ACS) and 2020 Bureau of Labor Statistics (BLS) to estimate the food insecurity rate at the county level. https://map.feedingamerica.org/county/2022/overall/new-mexico. Accessed 07/02/2024.

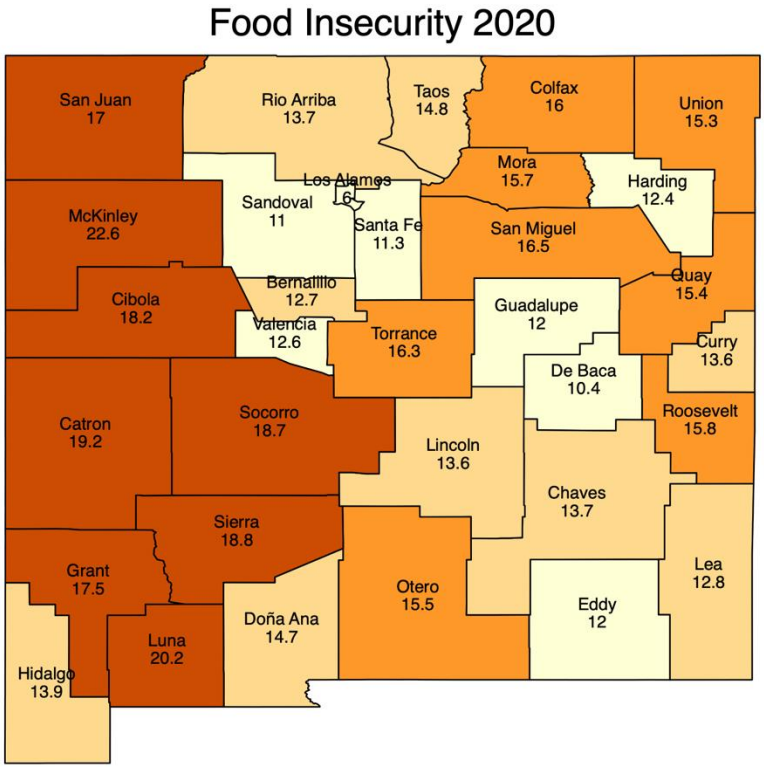
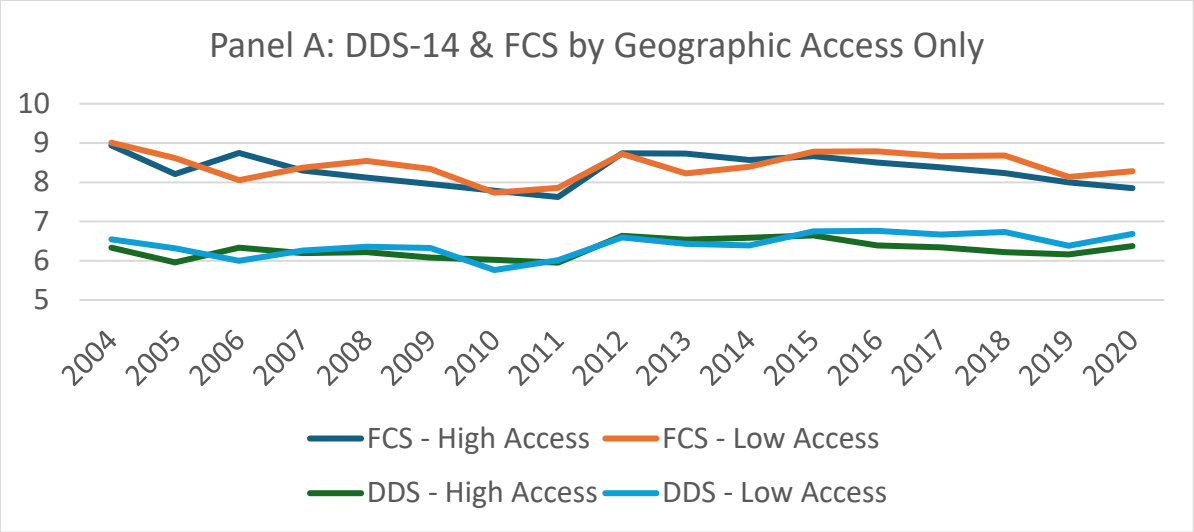
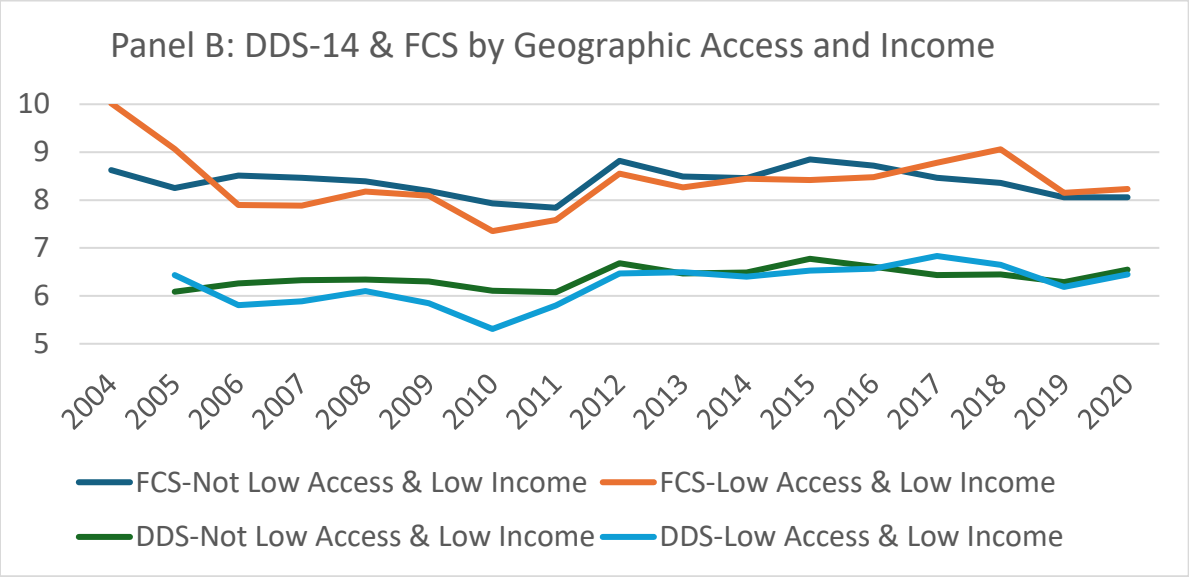


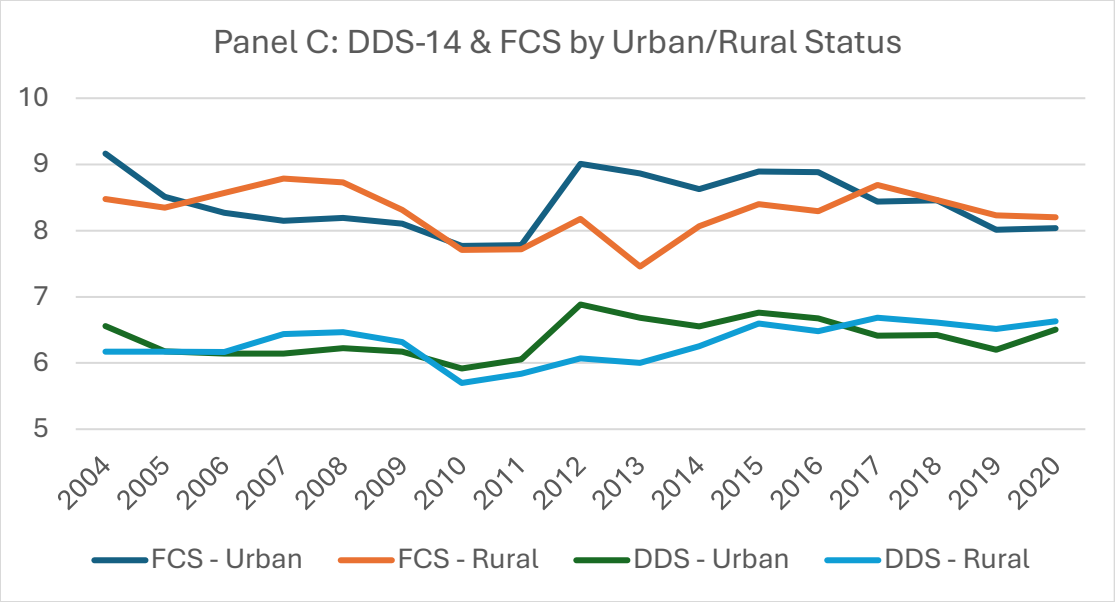
Figure: 2: DDS-14, FCS, and Food insecurity in NM counties

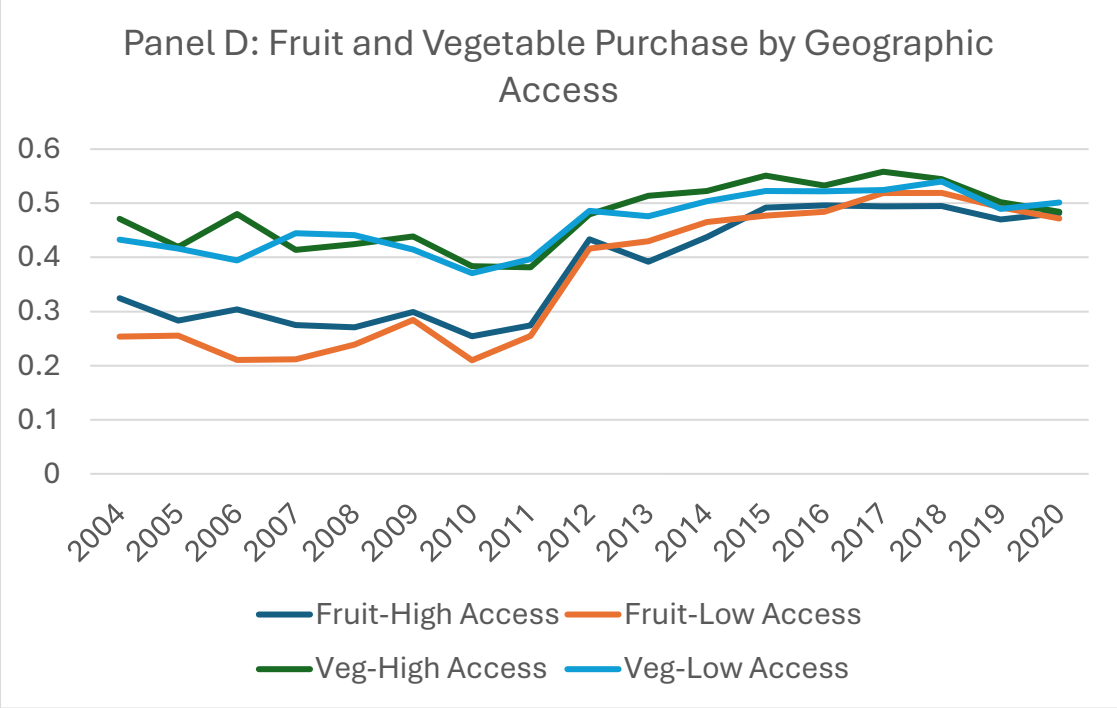
Notes: Maps show variation across counties in DDS-14, FCS, and food insecurity. Darker colors are associated with larger numbers, i.e., higher DDS and FCS scores and higher rates of food insecurity. Food insecurity measures come from Map the Meal Gap study conducted by Feeding America.

Figure 3 graphs DDS-14, our more complete version of the DDS, FCS, and fruit and vegetable purchase in NM by the food insecurity measures from the USDA Food Access Research Atlas (geographic access), and using the rural/urban designation from the USDA and NM Department of Health, the two food insecurity measures for which we have zip-code level information, enabling us to use them in our regression analyses.


Panel A: DDS-14 & FCS by Geographic Access Only
10
9
8
7
6
5
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
FCS - High Access
FCS - Low Access
DDS - High Access
DDS - Low Access


Panel B: DDS-14 & FCS by Geographic Access and Income
10
9
8
7
6
5
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
FCS-Not Low Access & Low Income
FCS-Low Access & Low Income
DDS-Not Low Access & Low Income
DDS-Low Access & Low Income


Panel C: DDS-14 & FCS by Urban/Rural Status
10
9
8
7
6
5
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
FCS - Urban
FCS - Rural
DDS - Urban
DDS - Rural


Panel D: Fruit and Vegetable Purchase by Geographic Access
0.6
0.5
0.4
0.3
0.2
0.1
0
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Fruit-High Access
Fruit-Low Access
Veg-High Access
Veg-Low Access

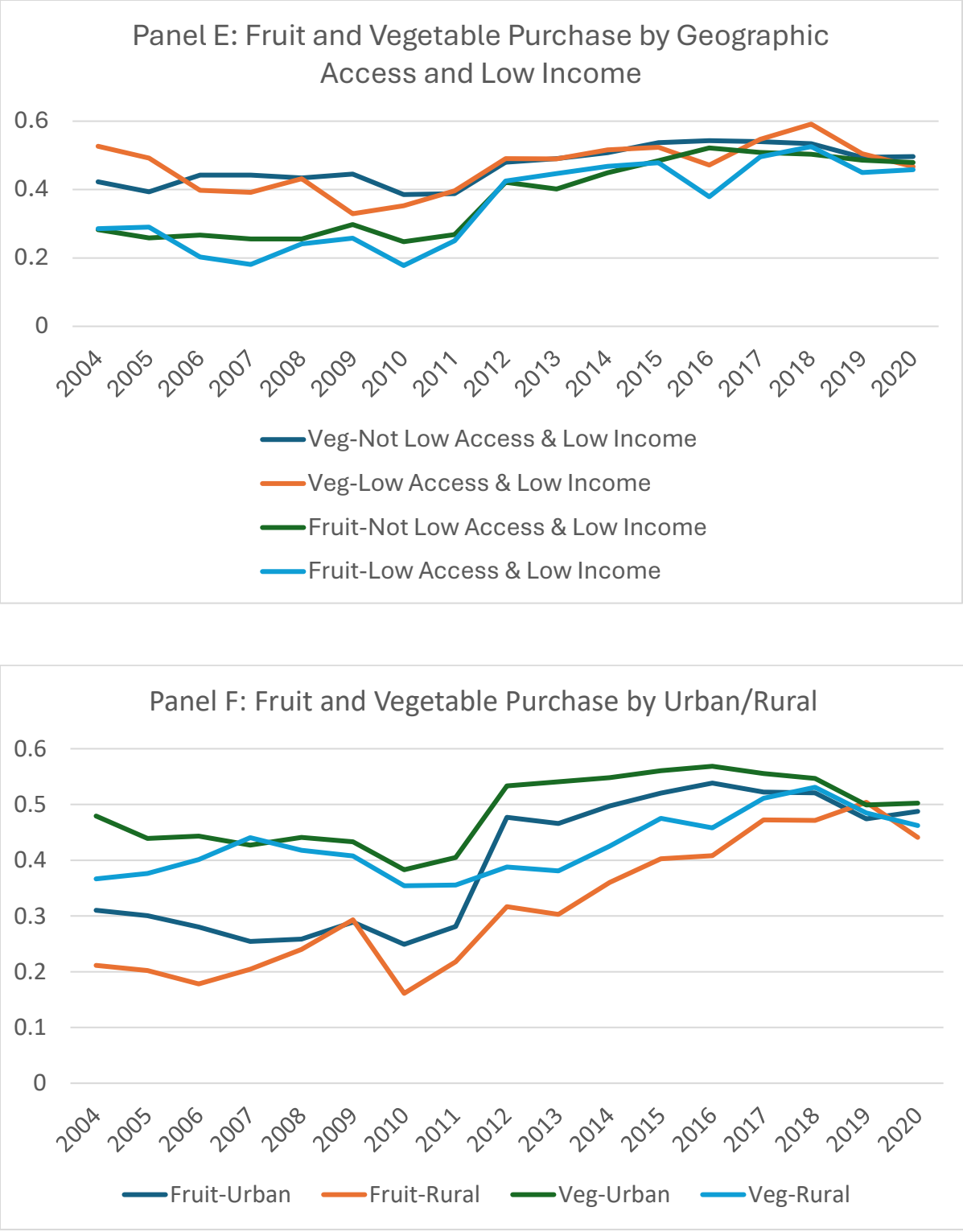


Figure 3: Dietary Quality Measures by Food Insecurity Status

Notes: Panels A and B compare DDS & FCS over time by food desert designations, and Panel C, by urban and rural status. Panels D-F show the same trends for fruit and vegetable purchase by food desert measures and by urban/rural.

The panels in Figure 3 show a mixed story. For DDS and FCS, reduced geographic access and rural status do not correlate necessarily with worse dietary quality scores. Higher income, however, does correlate with better dietary quality scores. However, this relationship does not exist consistently over time and results by urban and rural area suggest geographic access alone does not determine dietary quality. For fruit and vegetable purchases, both measures appear to be converging over time regardless of subgroup, with a marked increase in fruit purchase in 2012. NM households were more likely to purchase vegetables than fruits in an average week until 2018. However, after 2018, the pattern changed, and the likelihood of purchasing both fruits and vegetables is approximately equal. Purchase patterns for fruits and vegetables are similar across two food access criteria: low access and low income and low access. However, living in urban areas is correlated with a higher likelihood of purchasing of both fruits and vegetables as compared to rural areas households, especially after 2010. In the later 2000s, purchase of fruits and vegetables converges, and by 2019, differences by subgroups disappear.

Given the mixed story in the descriptive trends and the significant heterogeneity in the maps, we further explore the socioeconomic and geographic determinants of nutritional deficiencies in foods purchased by New Mexicans using least squares regression analyses, focusing on the association between food security and the dietary quality of foods purchased, both with and without accounting for household characteristics. The specification omitting household characteristics allows us to focus on common outcomes across households within a type of geographic area. Specifications including household characteristics capture exogeneous characteristics common to all households as well as peer effects from living in a certain type of geographic area, but control for differences in the dietary quality of food purchased driven by an individual household's characteristics, such as being a lower income or larger household. We use the following specification:

$$y_{it} = \beta_0 + \beta_1 geo_{it} + \beta_2 household_{it} + \omega_m + \mu_y + \varepsilon_{it}$$

where y_{it} denotes the nutritional quality measure (DDS-12, DDS-14, FCS, and fruit and vegetable purchase) for household *i* observed in week *t*. Whether a household is located in a food desert or a rural area is denoted by geo_{it}. We run regressions with and without controlling for household demographic and socioeconomic characteristics are denoted by $household_{it}$, including educational attainment of the household head, household income, household size, whether there are children present, respondent race, respondent Hispanic ethnicity, and whether the household only has a single male or single female household head. In all regressions, we control for year fixed effects μ_t and month fixed effects ω_m.

Table 4: Associations between Food Insecurity and Food Purchase Diversity

	(1) DDS-12	(2) DDS-14	(3) FCS	(4) Vegetables	(5) Fruit
Panel A: Low Access and Dietary Quality					
Low Access	0.117***	0.127***	0.113***	-0.014***	-0.016***
	(0.020)	(0.023)	(0.035)	(0.004)	(0.003)
R-squared	0.007	0.006	0.006	0.012	0.053
Panel B: Low Access and Low Income and Dietary Quality					
Low Access and Low Income	-0.035	-0.085***	0.059	-0.002	-0.022***
	(0.025)	(0.030)	(0.045)	(0.005)	(0.004)
R-squared	0.006	0.006	0.005	0.012	0.053
Panel C: Rural and Dietary Quality					
Rural	-0.038*	-0.082***	-0.187***	-0.065***	-0.081***
	(0.023)	(0.026)	(0.039)	(0.004)	(0.004)
R-squared	0.006	0.006	0.006	0.015	0.058
Outcome Mean	5.57	6.43	8.51	0.51	0.43
Observations	179,151	180,054	196,044	194,023	193,958

Notes: Each column and panel combination represent a separate regression with the coefficient on the food insecurity variable, standard error, and R-squared reported. Each column designates a different dietary quality measure as an outcome and each panel analyzes a different food insecurity measure as a treatment. The outcome mean is reported below the panels. All models include month and year fixed effects. Robust standard errors in parentheses, ***p<0.01, **p<0.05, *p<0.1.

The results in Table 4 show that low geographic access to food is associated with better dietary diversity-related measures but reduced likelihood of purchasing vegetables and fruit. Living in Low Access and Low Income areas does not explain much of the variation in DDS-12, FCS, or vegetable consumption, but is associated with worse dietary diversity in foods purchased as measured by FCS and reduced consumption of fruit. Living in a rural area is the only food

insecurity measure that consistently is associated with worse food purchase quality across all five measures. The R-squared values suggest our model does best at explaining variation in fruit consumption, followed by vegetable consumption, across all measures of food insecurity, likely in part due to the seasonable component of vegetable and fruit consumption, captured by the month fixed effects and the dramatic change over time exhibited in fruit consumption, captured by the year fixed effects.

Table 5 reports results controlling for household characteristics, with results including the coefficients for the household characteristics reported in Appendix Tables 2-4.

Table 5: Associations between Food Insecurity and Food Purchase Diversity – Controlling for Household Characteristics

Controls	(1) DDS-12	(2) DDS-14	(3) FCS	(4) Vegetables	(5) Fruit
			Panel A		
Low Access	0.036*	0.031	0.010	-0.025***	-0.026***
	(0.020)	(0.023)	(0.035)	(0.004)	(0.003)
R-squared	0.060	0.060	0.052	0.035	0.077
			Panel B		
Low Access and Low Income	0.004	-0.037	0.096**	0.008	-0.005
	(0.025)	(0.029)	(0.044)	(0.005)	(0.004)
R-squared	0.060	0.060	0.052	0.035	0.076
			Panel C		
Rural	-0.047**	-0.089***	-0.186***	-0.064***	-0.073***
	(0.022)	(0.026)	(0.039)	(0.004)	(0.004)
R-squared	0.060	0.060	0.053	0.038	0.081
			Panel D		
Variable Mean	5.57	6.43	8.51	0.51	0.43
Observations	179,151	180,054	196,044	194,023	193,958

Notes: Each column and panel combination represent a separate regression with the coefficient on the food insecurity measure, standard error, and R-squared reported. Each column designates a different dietary quality measure (outcome) and each panel analyzes a different food insecurity measure. The outcome mean is reported below the panels. All models include month and year fixed effects. Robust standard errors in parentheses, ***p<0.01, **p<0.05, *p<0.1.

After controlling for demographics, both Low Access and Low Access and Low Income perform relatively poorly across measures of the diversity of foods purchased. Low Access remains negatively associated with fruit and vegetable consumption but no longer explains a

statistically significant amount of variation in DDS-14 or FCS and only has a marginally significant positive effect on DDS-12, which does not include snack foods and premade foods. Low Income and Low Access no longer is statistically significantly associated with reduced DDS-14 or reduced likelihood of fruit purchase. Living in a rural rather than an urban area remains statistically significantly associated with a reduction in the dietary quality of food purchased across all measures. In other words, rural appears to be a better measure of food insecurity with respect to the dietary quality of foods purchased than the measures used by the USDA's food desert measures, which appear to be capturing primarily individual household-level characteristics associated with reduced dietary diversity rather than geographic area-level limitations on access to high quality food. Appendix Tables 2-4 show the full regression results and that many household characteristics are associated with differences in the dietary quality of food purchased.

Education matters, both those without a high school education and those with some college have better dietary quality in food purchasing than those with just a high school education. College graduates have worse DDS and FCS scores but higher rates of vegetable and fruit consumption. The health-wealth-education gradient is well-established in the economics literature, so these results are somewhat counterintuitive. A possible explanation is that dietary diversity scores are not highly correlated with differences in the dietary quality of food purchased, the dietary quality of food consumed, and associated differences in health. Fruit and vegetable consumption tracks more closely with education, although those with no high school education consume more vegetables and fruit than those with a high school education. Individuals without a high school education constitute only one percent of the sample, and so the results may not be representative for this group. Participating in the NielsenIQ Homescan data collection process involves some technological sophistication to track food purchases, which may limit participation among the least educated.

As detailed in Appendix Tables 2-4, being low income or having only a single household head is associated with poor outcomes for all dietary diversity measures, while living in a larger household is consistently associated with better outcomes. Households with children show better dietary diversity scores and higher fruit purchase rates but reduced purchase of vegetables relative to households without children. Blacks have higher dietary diversity scores but lower fruit purchases than Whites; FCS and vegetable purchase is similar for Blacks and Whites. Being Asian relative to White has no statistically significant association with the DDS and fruit and vegetable

purchase measures. Other races than Black, Asian, and White consistently have worse outcomes across all measures. Hispanics exhibit similar dietary diversity in their food purchases to Non-Hispanics, but are less likely to purchase vegetables and possibly more likely to purchase fruit than Non-Hispanics.

Discussion

This study documents significant food insecurity and low dietary quality of foods purchased by households in NM relative to the US and substantial variation in food insecurity and the dietary quality of foods purchased by households within NM alone. Common food security measures based solely on access, such as food deserts defined by access to grocery retailers and urban versus rural designations perform well in comparing outcomes across geographic areas, but those that measure food deserts by income *and* access perform less well in explaining differences in the dietary quality of food purchased. Once individual household education, income level, size, children present, race, ethnicity, and number and sex of household heads, only urban versus rural consistently explains a statistically significant difference in the dietary quality of food purchased across all measures.

The US federal and state governments spend significant amounts on policies targeting access to quality food. In fiscal year 2023, NM spent $29.9M on food assistance programs. Whether these policies will reap benefits remains unknown. The results herein suggest that policies targeting rural populations might be particularly effective, such as the Rural Pantries/Food Boxes for Seniors, as rural versus urban consistently explains poor food purchase quality among New Mexicans. Native Americans are the primary race included in the Other Race category in our analyses. The negative coefficient on Other Race for all dietary quality measures suggests that Native Americans, who often live in more rural areas in New Mexico, may be disproportionately facing dietary diversity issues.

One of the reasons why differences in the food desert-based insecurity measures do little to explain changes in the dietary quality of food purchased after controlling for household demographics may relate to the challenges in changing dietary habits, particularly when most commercial marketing efforts seem designed to gear customers towards less healthy, high-margin processed foods. For example, rolled oats are typically sold in containers with subdued advertising, while sugary cereals are covered with bright, happy cartoon characters. While access

to healthy foods clearly is a first step in improving diets, incentivizing people to even just purchase healthy foods requires more than simply making them available. Affecting actual consumption may be even more difficult. Prices need to be affordable, and the relative prices of higher quality foods cannot be significantly higher than the prices of lower quality foods. Furthermore, studies abound that dietary changes are notoriously difficult. US obesity rates exceed 40 percent (National Institute on Diabetes and Digestive and Kidney Diseases, 2023a) and diabetes rates are over 11 percent (National Institute on Diabetes and Digestive and Kidney Diseases, 2023b) suggesting that even when faced with major health issues, individuals find it challenging to change their dietary habits.

In addition to increasing access to healthy foods, policymakers should simultaneously focus on ways to reduce access to and the relative attractiveness of unhealthy foods in order to adequately incentivize households to switch to healthier foods. Food companies spend significant amounts on marketing unhealthy foods every year – these dollars would not be spent if they did not generate profits. Tobacco companies are banned from advertising using cartoons and their products bear warning labels – perhaps the food industry is similarly primed for such a regulatory intervention. Much remains to be done to improve the dietary quality of food purchased in New Mexico and beyond, including addressing increasing access to and the attractiveness of healthy food as well as decreasing access to and incentives to consume unhealthy food.

The $29.9M NM budget to address food insecurity in 2023 focused primarily on food insecurity, i.e., supply-side subsidies, with funds provided to food banks for food purchases, food distribution, storage, and infrastructure; to schools to provide healthier meal options to students; to various organizations to promote local agriculture and farmers' markets; and to grocery stores and other food stores in the form of low interest loans. Some programs directly increased access to low cost or free prepared food in the form of meals delivered to seniors and to the homeless through nonprofit organizations. The effectiveness of such programs on increasing dietary quality may not be guaranteed if access to food alone does not incentivize its purchase and consumption. Demand-side subsidies included vouchers and price incentives for families to increase fruit and vegetable purchases. No programs appear to or track whether the targeted population improved the quality of food purchased and consumed or experienced any health benefits from the expansion in food assistance funding. The dietary quality of food purchase

measures generated in this study can be used in future studies on the effectiveness of NM's 2023 food security initiatives.

Like many studies on this topic, this study faces significant limitations. The NielsenIQ data, while useful in tracking purchases and avoiding recall bias, only captures purchasing behavior, not consumption, and miss crucial information on quantities purchased. Einav, Leibtag & Nevo (2008) examined the accuracy of NielsenIQ Homescan data and found that more than 20 percent of the items purchased were not recorded by the households. Nonetheless, food purchased by a household likely is highly correlated with its consumption of high-quality food. It may, however, be an overestimate of average dietary quality if food consumed outside the house is less healthy than meals prepared at home. Furthermore, the DDS and FCS do not clearly distinguish between some types of unhealthy and healthy foods – both hot dogs and lean chicken would be classified as Meat. Another limitation is that measures of food deserts are imprecise and obviously occur on a continuum rather than that abrupt transitions exist between food deserts and non-food deserts, as assumed by variables that only take on the values of one and zero. Nutritional, dietary quality measures are imprecise as well, often due to data availability, as well as due to simplifying assumptions that classify all types of food similarly, as in the DDS; require significant, detailed nutrient information not available on nutrition labels as with the HEI; or under-emphasize fresh produce as with DDS and FCS. The literature on nutrition itself is underdeveloped, research is often funded by product manufacturers' organizations, e.g., the National Confectioners' Association, and government authorities are slow to change their recommendations, often due to costly bureaucratic barriers to change. The relationships measured also are correlational, not causal; we are able to determine that food desert-based measures are not highly correlated with the dietary diversity of foods purchased but we cannot say that living in a rural area causes reduced fruit and vegetable consumption. It may be that those who live in rural areas do not like to consume fruits and vegetables, grow their own fruits and vegetables, or face barriers to healthy food purchases that are correlated with living in a rural area, such as the inability to store products between more infrequent trips to the grocery store or the lack of a reliable vehicle. Unfortunately, the sample count of individuals moving between urban and rural or in and out of the food desert measures is too small for us to measure the within-household effects of living in food deserts or rural settings.

Conclusion

The results of this study highlight the limitations of policies and research focusing on food insecurity without considering the nutritional content of food purchased, with food availability at home likely an important determinant the quality of food consumed. The USDA food desert measures performed particularly poorly in explaining the dietary quality of foods purchased, while urban and rural appear more appropriate distinctions for targeting policies aimed at improving the dietary quality of foods purchased rather than just access to quality food. As far as improving dietary quality directly, this study documents that almost half of households purchase no fruits or vegetables in an average week, whether fresh, frozen, or canned, a deficiency ripe for policy targeting.

The measures constructed herein will be used for future research further exploring the relationship between access-based food insecurity measures and the nutritional quality of food purchased, especially the role of rural public transportation and dollar stores on food consumption, which are not captured by current USDA measures of food deserts.

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Appendix A: Tables & Figures

Table A1: State food programs supported immediately prior to and at the start of the Food Initiative in FY23

Programs Supported through the Food Initiative (FI)	**FY22 Total K$[6]**	**FY23 FI-Only Amt K$[6]**	**FY23 Total K$[6]**
Food Security Grant	0	10000	10000
Community Food Assistance	1200	6920	8034
College Food Security	0	1000	1050
Healthy Soil	268	1000	1512
Double Up Food Bucks	367	957	1554
NM Grown for Schools	0	800	1200
Nutrition Support (NM Grown for Schools, Breakfast After the Bell, and Reduced-Price Co-Pay)	2400	0	0
Rural Pantries/Food Boxes for Seniors	0	692	692
Summer Food and Supper Enhancement/Expansion	0	513	513
Fruit and Vegetable Prescription	0	500	500
Healthy Food Financing Initiative	0	400	400
NM Grown for Seniors	148	400	598
Administrative & Operating Support	0	398	398
Agricultural Workforce Development	125	250	375
Food Security Coordinator FTE	0	243	243
Approved Supplier	0	200	200
Administrative FTEs	0	167	167
NM Grown for Preschools	0	154	154
Mobile Technology for Nutrition Incentive	58	108	108
Programs that did not receive funding directly through the Food Initiative			
Homeless meals[1]	194	0	220
SNAP Senior Supplement (State)[1]	2000	0	2000
Total	**6760**	**24702**	**29918**

Table A2: Associations between Low Access and Food Purchase Quality Controlling for Demographics

	(1) DDS-12	(2) DDS-14	(3) FCS	(4) Veg	(5) Fruit
Low Access	0.036*	0.031	0.010	-0.025***	-0.026***
	(0.020)	(0.023)	(0.035)	(0.004)	(0.003)
No high school	0.755***	0.879***	1.315***	0.183***	0.161***
	(0.079)	(0.091)	(0.138)	(0.015)	(0.013)
Some college	0.141***	0.114***	0.065	0.047***	0.085***
	(0.028)	(0.032)	(0.049)	(0.005)	(0.005)
College graduate	-0.193***	-0.279***	-0.414***	0.028***	0.056***
	(0.030)	(0.034)	(0.053)	(0.006)	(0.005)
Low income	-0.275***	-0.315***	-0.455***	-0.079***	-0.060***
	(0.028)	(0.032)	(0.049)	(0.005)	(0.005)
Household size	0.256***	0.309***	0.470***	0.032***	0.013***
	(0.013)	(0.015)	(0.022)	(0.002)	(0.002)
With child	0.105***	0.194***	0.124**	-0.025***	0.039***
	(0.034)	(0.039)	(0.059)	(0.006)	(0.006)
Black	0.242***	0.190***	-0.045	0.006	-0.042***
	(0.055)	(0.064)	(0.096)	(0.010)	(0.010)
Asian	-0.049	0.085	0.013	0.013	0.007
	(0.070)	(0.085)	(0.122)	(0.014)	(0.014)
Other race	-0.242***	-0.287***	-0.640***	-0.035***	-0.061***
	(0.029)	(0.034)	(0.052)	(0.005)	(0.005)
Hispanic	-0.001	-0.010	-0.031	-0.020***	0.007*
	(0.024)	(0.028)	(0.043)	(0.004)	(0.004)
Female-only household head	-0.553***	-0.568***	-1.023***	-0.060***	-0.031***
	(0.026)	(0.030)	(0.047)	(0.005)	(0.004)
Male-only household head	-0.566***	-0.589***	-0.976***	-0.097***	-0.091***
	(0.031)	(0.036)	(0.055)	(0.005)	(0.005)
Observations	179,151	180,054	196,044	194,023	193,958
R-squared	0.060	0.060	0.052	0.035	0.077

Notes: Each column designates a regression for different dietary quality measure (outcome). No High School, Some College, and College Graduate are relative to High School; Black, Asian, and Other Race are relative to White. Hispanic is relative to Non-Hispanic. Female-only household head and Male-only household head are relative to houses with two household heads. All models include month and year fixed effects. Robust standard errors in parentheses, ***p<0.01, **p<0.05, *p<0.1.

Table A3: Low Access and Low Income and Food Purchase Quality Controlling for Household Characteristics

	(1) DDS-12	(2) DDS-14	(3) FCS	(4) Veg	(5) Fruit
Low Access and Low Income	0.004	-0.037	0.096**	0.008	-0.005
	(0.025)	(0.029)	(0.044)	(0.005)	(0.004)
No high school	0.750***	0.868***	1.328***	0.189***	0.165***
	(0.079)	(0.092)	(0.138)	(0.015)	(0.013)
Some college	0.143***	0.112***	0.074	0.047***	0.083***
	(0.028)	(0.032)	(0.049)	(0.005)	(0.005)
College graduate	-0.194***	-0.285***	-0.399***	0.031***	0.056***
	(0.030)	(0.035)	(0.053)	(0.006)	(0.005)
Low income	-0.280***	-0.319***	-0.456***	-0.076***	-0.057***
	(0.028)	(0.032)	(0.049)	(0.005)	(0.005)
Household size	0.257***	0.311***	0.466***	0.030***	0.012***
	(0.013)	(0.015)	(0.023)	(0.002)	(0.002)
With child	0.105***	0.187***	0.140**	-0.023***	0.039***
	(0.034)	(0.040)	(0.059)	(0.006)	(0.006)
Black	0.243***	0.196***	-0.055	0.004	-0.043***
	(0.056)	(0.064)	(0.096)	(0.010)	(0.010)
Asian	-0.049	0.080	0.025	0.014	0.007
	(0.070)	(0.085)	(0.122)	(0.014)	(0.014)
Other race	-0.239***	-0.287***	-0.636***	-0.036***	-0.063***
	(0.029)	(0.034)	(0.052)	(0.005)	(0.005)
Hispanic	-0.004	-0.009	-0.038	-0.018***	0.010**
	(0.024)	(0.028)	(0.043)	(0.004)	(0.004)
Female only household head	-0.551***	-0.565***	-1.026***	-0.062***	-0.032***
	(0.026)	(0.030)	(0.047)	(0.005)	(0.004)
Male only household head	-0.565***	-0.585***	-0.984***	-0.098***	-0.092***
	(0.031)	(0.036)	(0.055)	(0.005)	(0.005)
Observations	179,151	180,054	196,044	194,023	193,958
R-squared	0.060	0.060	0.052	0.035	0.076

Notes: Each column designates a regression for different dietary quality measure (outcome). No High School, Some College, and College Graduate are relative to High School; Black, Asian, and Other Race are relative to White. Hispanic is relative to Non-Hispanic. Female-only household head and Male-only household head are relative to houses with two household heads. All models include month and year fixed effects. Robust standard errors in parentheses, ***p<0.01, **p<0.05, *p<0.1.

Table A4: Associations between Rural Status and Food Purchase Quality Controlling for Demographics

	(1) DDS-12	(2) DDS-14	(3) FCS	(4) Vegetables	(5) Fruit
Rural	-0.047**	-0.089***	-0.186***	-0.064***	-0.073***
	(0.022)	(0.026)	(0.039)	(0.004)	(0.004)
No high school	0.755***	0.885***	1.335***	0.194***	0.174***
	(0.079)	(0.092)	(0.139)	(0.015)	(0.013)
Some college	0.138***	0.106***	0.047	0.039***	0.076***
	(0.028)	(0.032)	(0.049)	(0.005)	(0.005)
College graduate	-0.200***	-0.291***	-0.436***	0.021***	0.048***
	(0.030)	(0.035)	(0.053)	(0.006)	(0.005)
Low income	-0.280***	-0.318***	-0.450***	-0.074***	-0.055***
	(0.028)	(0.032)	(0.049)	(0.005)	(0.005)
Household size	0.256***	0.307***	0.463***	0.029***	0.010***
	(0.013)	(0.015)	(0.022)	(0.002)	(0.002)
With child	0.104***	0.194***	0.129**	-0.023***	0.041***
	(0.034)	(0.039)	(0.059)	(0.006)	(0.006)
Black	0.250***	0.203***	-0.026	0.013	-0.033***
	(0.055)	(0.064)	(0.096)	(0.010)	(0.009)
Asian	-0.058	0.067	-0.024	0.001	-0.007
	(0.070)	(0.085)	(0.122)	(0.014)	(0.014)
Other race	-0.237***	-0.282***	-0.630***	-0.034***	-0.059***
	(0.029)	(0.034)	(0.052)	(0.005)	(0.005)
Hispanic	-0.006	-0.017	-0.040	-0.021***	0.005
	(0.024)	(0.028)	(0.043)	(0.004)	(0.004)
Female-only household head	-0.556***	-0.576***	-1.044***	-0.069***	-0.041***
	(0.026)	(0.030)	(0.047)	(0.005)	(0.004)
Male-only household head	-0.568***	-0.594***	-0.990***	-0.102***	-0.097***
	(0.031)	(0.036)	(0.055)	(0.005)	(0.005)
Observations	179,151	180,054	196,044	194,023	193,958
R-squared	0.060	0.060	0.053	0.038	0.081

Notes: Each column designates a regression for different dietary quality measure (outcome). No High School, Some College, and College Graduate are relative to High School; Black, Asian, and Other Race are relative to White. Hispanic is relative to Non-Hispanic. Female-only household head and Male-only household head are relative to houses with two household heads. All models include month and year fixed effects. Robust standard errors in parentheses, ***p<0.01, **p<0.05, *p<0.1.

Appendix B
Survey Questions Used by USDA To Assess Household Food Security

1. "We worried whether our food would run out before we got money to buy more." Was that often, sometimes, or never true for you in the last 12 months?

2. "The food that we bought just didn't last and we didn't have money to get more." Was that often, sometimes, or never true for you in the last 12 months?

3. "We couldn't afford to eat balanced meals." Was that often, sometimes, or never true for you in the last 12 months?

4. In the last 12 months, did you or other adults in the household ever cut the size of your meals or skip meals because there wasn't enough money for food? (Yes/No)

5. (If yes to question 4) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?

6. In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food? (Yes/No)

7. In the last 12 months, were you ever hungry, but didn't eat, because there wasn't enough money for food? (Yes/No)

8. In the last 12 months, did you lose weight because there wasn't enough money for food? (Yes/No)

9. In the last 12 months did you or other adults in your household ever not eat for a whole day because there wasn't enough money for food? (Yes/No)

10. (If yes to question 9) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?

(Questions 11–18 were asked only if the household included children age 0–17)

11. "We relied on only a few kinds of low-cost food to feed our children because we were running out of money to buy food." Was that often, sometimes, or never true for you in the last 12 months?

12. "We couldn't feed our children a balanced meal, because we couldn't afford that." Was that often, sometimes, or never true for you in the last 12 months?

13. "The children were not eating enough because we just couldn't afford enough food." Was that often, sometimes, or never true for you in the last 12 months

14. In the last 12 months, did you ever cut the size of any of the children's meals because there wasn't enough money for food? (Yes/No)

15. In the last 12 months, were the children ever hungry but you just couldn't afford more food? (Yes/No)

16. In the last 12 months, did any of the children ever skip a meal because there wasn't enough money for food? (Yes/No)

17. (If yes to question 16) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?

18. In the last 12 months did any of the children ever not eat for a whole day because there wasn't enough money for food? (Yes/No)

Note: These questioners and responses coding are obtained from the report Household food security in the United States in 2020 by Alisha Coleman-Jensen, Matthew P. Rabbitt, Christian A. Gregory, and Anita Singh, 2020, ERR-298, U.S. Department of Agriculture, Economic Research Service.The report can be accessed at: https://www.ers.usda.gov/webdocs/publications/102076/err-298.pdf?v=7720.7 (retrieved on 27th June, 2024)

Coding of Responses

Questions 1–3 and 11–13 are coded as affirmative (i.e., possibly indicating food insecurity) if the response is "often" or "sometimes." Questions 5, 10, and 17 are coded as affirmative if the response is "almost every month" or "some months but not every month." The remaining questions are coded as affirmative if the response is "yes."

Assessing Food Security Status in Households Without Children

Households without children are classified as food insecure if they report 3 or more indications of food insecurity in response to the first 10 questions; they are classified as having very low food security if they report 6 or more food-insecure conditions out of the first 10 questions.

Assessing Food Security Status in Households with Children Age 0–17

Households with children are classified as food insecure if they report 3 or more indications of food insecurity in response to the entire set of 18 questions; they are classified as having very low food security if they report 8 or more food-insecure conditions in response to the entire set of 18 questions.

The food security status of children in the household is assessed by responses to the child-referenced questions (11–18). Households reporting two or more of these conditions are

classified as having food insecurity among children. Households reporting five or more are classified as having very low food security among children.