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RESEARCH ARTICLE

Trips to Food Services, Food Retailers, and their Relationship with the Healthfulness of Food Purchases

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Abstract

This study investigates the relationship between household utilization of food services and retailers and the healthfulness of purchases using data from the 2013 Food Acquisition and Purchase Survey. Overall, our findings suggest that the associations between food service or retailer utilization and the healthfulness of purchases are limited. Thus, interventions may need to be targeted to specific households based on patterns of utilization. We also find evidence for an interdependent relationship between food at home and away from home food shopping behaviors with implications for the healthfulness of purchases.

Keywords: food store utilization; healthy food purchases; shopping trip pattern

JEL classifications: D12; Q18; I12

1. Introduction

The food environment describes the type and quantity of food retailers (including supermarkets, superstores, and convenience stores) and food services (including full-service and fast-food restaurants) within close proximity to a household. Research has found that households, particularly low-income households, living in areas with limited access to supermarkets or easier access to convenience stores and fast-food restaurants, tend to have poorer dietary and health outcomes (Fleischhacker et al., 2011; White, 2007). Such findings were used to justify policy interventions such as the Healthy Food Financing Initiative (HFFI), which subsidizes the cost of building new food retailers, such as supermarkets, in low-access communities (Bitler and Haider, 2011). However, studies evaluating the impact of opening a new supermarket in a low-income low-access community have found it has limited or no effect on household food purchasing behavior, possibly due to the limited number of households utilizing the new supermarket (Abeykon, Engler-Stringer, and Muhajarine, 2017; Cummins, Flint, and Matthews 2014; Sadler, Gilliland, and Arku 2013; Wang et al., 2007).

More specifically, Sadler, Gilliland, and Arku (2013) found only 10% of households switched to a new grocery store that opened in Flint, Michigan, while Cummins, Flint, and Matthews (2014) found only 26.7% of residents adopted a new supermarket in Philadelphia, Pennsylvania, as their primary store and only 51% ever used it during their observation period. Similarly, Allcott et al. (2019) found using Nielsen Homescan data that consumers who shifted expenditures towards a new supermarket were primarily doing so by decreasing expenditures at other supermarkets rather than at convenience stores or drug stores. Furthermore, Cantor et al. (2020) found that

the changes in nutrient outcomes associated with the opening of a new supermarket in Pittsburgh, Pennsylvania, were found only in households that utilized the new store. Yet despite these findings, policy makers continue to express interest in policies that would incentivize opening supermarkets in low-income low-access communities under the assumption that household's utilization of the new supermarkets will improve diet and health outcomes (Atkinson, 2021; Fite, 2020; Jeffrey-Wilensky, 2022; Munoz, 2022). Thus, investigating the relationship between household utilization of food services and retailers and the healthfulness of purchases may provide important insight into the limitations of current food environment interventions, which can be used to develop alternative policies.

There are currently several studies that have investigated either the relationship between food retailer utilization and the healthfulness of foods purchased for at home consumption (Pechey and Monsivais, 2015; Minaker et al., 2016; Rudi and Cakir, 2017; Volpe, Okrent, and Leibtag, 2013; Volpe, Jaenicke, and Chenarides, 2018) or food service utilization and dietary quality (Anderson and Matsa, 2011; Carpio et al., 2020; Mancino, Todd, and Lin 2009; Nguyen and Powell, 2014; Poti, Duffey, and Popkin, 2014). While these studies have found the healthfulness of purchases or dietary quality has a positive association with supermarket utilization, and a negative association with convenience store or fast-food restaurant utilization, not all address potential omitted variable bias in the utilization variables resulting from unobserved household characteristics that influence both the choice of where to shop and what to purchase. Two studies most similar to ours that addressed this potential bias using instrumental variables are Rudi and Cakir (2017) and Volpe, Jaenicke, and Chenarides (2018); however, both used Nielsen Homescan data and are thus limited to food retailer utilization and healthfulness of food at home (FAH) purchases.

Therefore, the purpose of this study is to provide further insight into the relationship between food service and retailer utilization and the healthfulness of purchases. Our data came from the 2013 Food Acquisition and Purchase Survey (FoodAPS), which includes information on all trips for food during a one-week time period. Given that the investigation was motivated by limitations in the food environment literature and HFFI style interventions that emphasize where people can shop for food, we measured utilization with the number of trips to specific food services or retailers. To measure the healthfulness of food purchases, we used the Healthy Eating Index 2010 (HEI-2010) score and assessed the healthfulness of all food purchased, as well as for FAH and food away from home (FAFH) separately. Our strategy for addressing potential omitted variable bias in the utilization variables combined k-means cluster analysis with a multinomial endogenous switching regression (MESR). K-means cluster analysis generated mutually exclusive groups of households based on similarities in their shopping trip patterns. Since households within shopping trip patterns are more similar than households across shopping trip patterns, we examined the relationship between the utilization of specific food services and retailers and the healthfulness of purchases conditional on shopping trip patterns to allow for comparisons among households that are more similar to each other. Estimating the relationship using a MESR further addressed omitted variable bias resulting from the influence of unobserved household characteristics on the choice of shopping trip patterns and the healthfulness of food purchases (Bourguignon, Fournier, and Gurgand 2007; Lee, 1983).

While we believe this strategy at least partially addresses the endogeneity of food service and retailer choice, we do not claim to have identified a causal effect of utilizing a specific food service or retailer. Instead, we focus on investigating two important and policy-relevant sources of heterogeneity resulting from differences in how households combine food services and retailers, captured in household shopping trip patterns, and household income. The former is important given the insight from new supermarket evaluations that the benefit or lack of benefit may be related to how households utilized food retailers before the intervention (Cummins, Flint, and Matthews 2014; Sadler, Gilliland, and Arku 2013; Allcott et al., 2019). Thus, comparing results across shopping trip patterns provides insights into how the potential benefit of additional food service or retailer utilization varies conditional on current patterns of use. Investigating heterogeneity by

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income level is also important given the assumption in the food environment literature that limited access disproportionately affects lower-income households (Ver Ploeg, Dutko, and Breneman 2014). To investigate this source of heterogeneity, we include interaction terms between the food service or retailer trip variables and an indicator for household incomes of less than 130% of the federal poverty line (FPL). The 130% FPL threshold is relevant to policy makers because it captures households eligible for many food assistance programs including the Supplemental Nutrition Assistance Program (SNAP).

Our study provides two contributions to the current literature on the relationship between food service and retailer utilization and the healthfulness of purchases. First, unlike previous studies, we include measures of both food service and retailer utilization and investigate the association between utilization and the healthfulness of all purchases as well as purchases for FAH and FAFH. This is important given the increasing contribution of food services to household food expenditures and caloric intake since the 1980s (Dong and Zeballos, 2021; Saksena et al., 2018) and previous research that found that FAH healthfulness was generally lower among individuals who consumed fast-food (Mancino, Todd, and Lin 2009; and Poti, Duffey, and Popkin 2014). Thus, not only is food service an increasingly important source of food for households but there may also be a relationship between food service and food retailer utilization with implications for health and diet outcomes.

Second, given that households tend to shop at multiple places the influence of a single food service or retailer may depend not only on the nutritional quality of the food it sells but also on how frequently households utilize it and other food services or retailers (Authors, 2020; Carlson and Kinsey, 2002; Stern et al., 2015). Our analysis demonstrates one method of addressing this potentially complicated aspect of household food shopping behavior by using k-means cluster analysis to identify shopping trip patterns and then comparing the association between specific food retailers and food services utilization and healthfulness of purchases across clusters to investigate potential heterogeneity in the relationship based on where households typically shop. K-means cluster analysis was previously used by Carlson and Kinsey (2002) and Stern et al. (2015), to investigate household shopping trip patterns, and by Lusk (2017) as a method for investigating heterogeneity in demand for FAH and away from home.

1.1. Background

While food services can include restaurants and other businesses that prepare meals or snacks for consumption away from home, and food retailers can include supermarkets, ethnic markets, and a variety of other stores where households purchase food primarily used to prepare meals, food environment studies tend to focus on a limited number of specific food services or retailers (USDA-ERS, 2022a, 2022b). This is in part due to the assumption that healthy foods are primarily available at certain food retailers, like supermarkets, which makes their location a proxy for access to healthy foods (Ver Ploeg, Dutko, and Breneman 2014; Allcott et al., 2019). On the other hand, convenience stores and fast-food restaurants often serve as proxies for access to unhealthy foods (Anderson and Matsa, 2011; Dunn, 2010).

Several studies have documented a nutritional gradient across food services and retailers by comparing the healthfulness of food purchases at the store level (Stern, Ng, and Popkin, 2016; Volpe, Kuhns, and Jaenicke, 2017; Kirkpatrick et al., 2013). Most of these studies used data from food retailers and found that purchases from superstores, convenience stores, and dollar stores tend to be lower in nutritional quality than purchases from supermarkets and grocery stores (Stern, Ng, and Popkin, 2016; Volpe, Kuhns, and Jaenicke, 2017). However, several studies also found that the healthfulness of purchases from supercenters increased during the early 2000s (Stern, Ng, and Popkin, 2016; Volpe, Kuhns, and Jaenicke, 2017). Kirkpatrick et al. (2013) found some variation in the healthfulness of food available at different fast-food chains based on a comparison of the nutritional quality of food available on their menus, but the overall score for the

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fast-food chains was below that for the national food supply. While these studies suggest that the healthfulness of food available varies across specific food services and retailers, the influence on household-level outcomes likely also depends on how households utilize specific food services and retailers.

There are a limited number of studies that consider the relationship between the utilization of specific food services or food retailers and the healthfulness of purchases. Studies investigating the influence of utilizing specific food services focus on the relationship between restaurant use, and in particular fast-food restaurants, and dietary quality (Anderson and Matsa, 2011; Carpio et al., 2020; Mancino, Todd, and Lin, 2009; Nguyen and Powell, 2014; Poti, Duffey, and Popkin, 2014). Since most of these studies used data from 24-hour dietary recalls, the measure of dietary quality includes consumption at restaurants and food prepared at home (Anderson and Matsa, 2011; Mancino, Todd, and Lin, 2009; Nguyen and Powell, 2014; Poti, Duffey, and Popkin, 2014). However, this also restricts their measurement of restaurant utilization to indicators for any use or number of meals in the past 48 hours (Anderson and Matsa, 2011; Mancino, Todd, and Lin, 2009; Nguyen and Powell, 2014). Most studies found that increased fast-food use or more meals away from home was associated with poorer dietary quality (Anderson and Matsa, 2011; Carpio et al., 2020; Mancino, Todd, and Lin, 2009; Nguyen and Powell, 2014; Poti, Duffey, and Popkin, 2014). To the best of our knowledge, two studies, Carpio et al. (2020) and Nguyen and Powell (2014), included measures of fast-food and full-service restaurant use and both found evidence to suggest the influence of fast-food use was more detrimental to dietary quality than full-service restaurant use.

Several studies have also considered the relationship between the utilization of specific food retailers and the healthfulness of purchases (Pechey and Monsivais, 2015; Minaker et al., 2016; Volpe, Okrent, and Leibtag, 2013; Volpe, Jaenicke, and Chenarides, 2018). The majority of these studies used Nielsen Homescan or Kantar WorldPanel data, both of which collect information on foods brought into the home, also referred to as FAH (Pechey and Monsivais, 2015; Volpe, Okrent, and Leibtag, 2013; Volpe, Jaenicke, and Chenarides, 2018). Therefore, measures of the healthfulness of purchases in these studies primarily include food purchased from food retailers. Utilization was measured using either the number of trips to (Minaker et al., 2016; Pechey and Monsivais, 2015) or expenditure shares at (Volpe, Okrent, and Leibtag, 2013; Volpe, Jaenicke, and Chenarides, 2018) specific food retailers. Three studies found that increased utilization of supermarkets or superstores had a positive influence on the healthfulness of food purchases, while increased utilization of convenience stores had a negative influence on the healthfulness of food purchases (Pechey and Monsivais, 2015; Minaker et al., 2016; Volpe, Jaenicke, and Chenarides, 2018).

Investigating the relationship between household-level food service and retailer utilization and the healthfulness of purchases requires special consideration due to the potential for unobserved household characteristics to influence both the choice of food service and food retailer utilization and the healthfulness of purchases. Such unobserved household characteristics could bias the estimated relationship between utilization and healthfulness of purchases in a simple linear regression. Two studies that address this endogeneity and are most similar to our own due to their focus on the healthfulness of purchases rather than dietary quality are Rudi and Cakir (2017) and Volpe, Jaenicke, and Chenarides (2018). Both studies used Nielsen Homescan data to study the relationship between food retailer utilization and the healthfulness of FAH purchases. Additionally, both used instrumental variables, which included the availability of different food retailers in the respondent's food environment, to address the endogeneity of food retailer choice (Rudi and Cakir, 2017; Volpe, Jaenicke, and Chenarides, 2018).

Volpe, Jaenicke, and Chenarides (2018) measured food retailer utilization with the percentage of FAH expenditures by specific food retailer type, which included supermarkets, supercenters, mass merchandizers, club stores, convenience stores, and a category for other food retailer types. They found that supermarket and superstore use had a positive effect on the healthfulness of food

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purchases, while convenience store use had a negative effect. When considering heterogeneity by income, they found that among lower-income households the positive effect of supermarket and superstore use persisted, but convenience store utilization no longer had a statistically significant effect. Among higher-income households, supermarket utilization instead had a negative effect, and the negative effect of convenience store utilization persisted. Rudi and Cakir (2017) found that increasing the total number of trips to food retailers in a month decreased the share of FAH expenditures for fruit and vegetables and increased the share for prepared food and sugary beverages. However, because they used an aggregate measure of food retailer use it is difficult to determine which food retailers specifically contributed to this relationship.

While both Rudi and Cakir (2017) and Volpe, Jaenicke, and Chenarides (2018) provide important insight into the relationship between food retailer utilization and the healthfulness of FAH purchases, their results are also limited by the inability to include information regarding food service utilization. This is a meaningful limitation given prior research demonstrating the negative association between consumption of food from restaurants or fast-food restaurants and overall dietary quality (Mancino, Todd, and Lin, 2009; Nguyen and Powell, 2014; Poti, Duffey, and Popkin 2014). Furthermore, both Anderson and Matsa (2011) and Poti, Duffey, and Popkin (2014) found a relationship between food service use and FAH dietary quality. Poti, Duffey, and Popkin (2014) found that frequency of fast-food consumption was associated with a lower quality of diet for FAH among children, while Anderson and Matsa (2011) found that on days individuals consumed meals away from home, they also tended to decrease their calories consumed at home. Since household use of food services may have implications for both overall and FAH dietary quality, it is important to include both food retailers and food services when examining the healthfulness of purchases.

2. Methodology

2.1. Data

FoodAPS was administered by the United States Department of Agriculture's Economic Research Service (USDA-ERS) between April 2012 and January 2013 to a nationally representative sample of 4,826 households (ERS, 2013; FoodAPS, 2016a). The sampling procedure for FoodAPS included four target groups: households participating in SNAP, non-SNAP households with incomes between 100% of the FPL and less than 185% of the FPL, and non-SNAP households with incomes of at least 185% of the FPL (FoodAPS, 2016a). Surveys collected information on all members of the household and also identified a primary respondent who was defined as the main food shopper or meal planner. For each shopping trip made by a member of the household during the observation week, the survey recorded where the purchase occurred, what was purchased, and how much was spent (i.e. expenditures) (FoodAPS, 2016a). Expenditure levels must be interpreted with caution because they can include non-food purchases (FoodAPS, 2016b).

Each trip was categorized as being for FAH or FAFH. The survey defines FAH as "food and drinks that are brought home and used to prepare meals for consumption at home or elsewhere," whereas FAFH is defined as "foods and drinks that are obtained and consumed away from home, and prepared foods that are brought home or delivered" (FoodAPS, 2016a). For this analysis, only shopping trips that resulted in positive expenditures were included. Thus, shopping trips in which zero expenditures were recorded or that a household marked as free were excluded. Additionally, any trips that were identified as occurring at unknown or multiple food retailer types were excluded from the analysis. These two exclusions reduced the sample size to 4,665 households.

2.1.1. Food Service and Food Retailer Categories

Every food service or food retailer utilized by a household in the FoodAPS data set was assigned to one of 72 place types (FoodAPS, 2016b). While many of these place types directly corresponded to

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a commonly recognized food service or retailer type, due to the comprehensive nature of the FoodAPS data set there were also place types that corresponded to less commonly used places such as casinos, schools, and gas stations. Therefore, to utilize the place types to construct food service and retailer trip variables we first constructed three food store categories (other food store, other eating place, and other places) to capture some of the less commonly used place types. The other food store category includes farmers' market, fruit and vegetable specialty stores, meat or poultry specialty stores, pharmacies, gas stations, and other less commonly used food retailers. The other eating place includes bakeries, coffee shops, vending machines, food trucks, and other less commonly used food services. Finally, the other places category includes places like gyms, bowling alleys, concerts, and amusement parks. For additional details related to the methods used to classify place types into food retailer or food service categories, please refer Yenerall et al. (2020). In addition to the three previously defined categories (other food store, other eating place, and other places), we also included four commonly used food retailers (superstore, supermarket, convenience store, and grocery store) and two commonly used food services (restaurant and burger store). Although FoodAPS does not distinguish between fast-food and full-service restaurants in its place type categories, we isolated burger stores from restaurants as a proxy for fast-food restaurants.

2.1.2. Healthy Eating Index 2010 (HEI-2010)

The HEI measures the healthfulness of food purchases by assessing how closely household expenditures align with U.S. Dietary Guidelines and is widely used in studies evaluating the healthfulness of household consumption or food purchases (NIH, 2020a, 2020b). The HEI-2010 uses the 2010 Dietary Guidelines, which is relevant to our study because they were the active dietary guidelines available to households during the data collection period. There are two primary advantages to using the HEI-2010 as a measure of healthfulness. First, it is independent of product weight and instead uses densities to compare household purchases to dietary recommendations. This allows researchers to compare how healthfulness varies across different settings. Second, it is a single measure of healthfulness that includes both relatively healthier items, such as fruit and vegetables, as well as less healthy items such as sodium and refined grains. More specifically, the HEI-2010 includes measurements of adherence to 13 different components of dietary quality. Adequacy components measure adherence to recommendations for the consumption of foods that households are encouraged to consume, including fruits, vegetables, whole grains, and proteins, while moderation components measure adherence to recommendations for the consumption of foods that households are encouraged to limit their consumption of, including refined grains and nutrients such as sodium and empty calories. Summing over all components scores creates the final HEI-2010 score that can range from 0 to 100, where higher values indicated closer alliance with U.S. Dietary Guidelines.

HEI-2010 scores were calculated from item-level information available in the FoodAPS data set. The methods used to determine the item-level nutrient levels are described in more detail in the FoodAPS Nutrient Coding Overview handbook, which can be found at the following website: https://www.ers.usda.gov/data-products/foodaps-national-household-food-acquisition-and-purchase-survey.aspx/. While 98% of items contained sufficient information to determine nutrient content, only 86% of items contained sufficient information to determine the weight, which was necessary to convert nutrient information to densities (Mancino, Todd, and Scharadin, 2018). Given a large number of missing values for quantity, the ERS developed an imputation method based on all other information available in the nutrient's data set and provides the imputed values in a supplemental data set (Mancino, Todd, and Scharadin, 2018). The imputed weight values were used in this analysis. We calculated three HEI-2010 scores for our analysis: an overall healthfulness of food purchases score that used data from all trips, a FAH healthfulness score that only used trips for FAH, and finally a FAFH healthfulness score that only used trips

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for FAFH. Households without FAH or FAFH trips will not have HEI-2010 scores for FAH or FAFH, respectively. Households missing all nutrient information and therefore did not have an overall HEI-2010 score were excluded from the analysis which results in a sample size of 4,647 households.

2.2. Empirical Strategy

The primary empirical challenge we addressed in our analysis was the potential endogeneity of food service and retailer utilization resulting from the inability to control for unobserved household variables, such as healthy food preferences, which likely influenced both food service and retailer choice and the healthfulness of purchase. Failure to address this endogeneity may bias the estimated relationship between utilization and healthfulness of purchases. While prior studies used instrumental variables and two or three-stage least squares regression, we used an alternative approach that combined the results from a k-means cluster analysis with a MESR (Rudi and Cakir, 2017; Volpe, Jaenicke, and Chenarides 2018). Additionally, the FoodAPS data contain household-level probability weights to adjust for non-random sampling, unit non-response, and to make the sample nationally representative (FoodAPS, 2016a). These survey weights were used in both the descriptive statistics and regression analysis. Weighted summary statistics and t-tests were used to compare household characteristics, food shopping behavior, and healthfulness of food purchases, across the three shopping trip patterns.

K-means cluster analysis generates mutually exclusive groups or clusters, which we also refer to as shopping trip patterns, with high intra-cluster homogeneity and large inter-cluster heterogeneity (Everitt et al., 2011). Thus, both the observed and unobserved characteristics of households should be more similar within shopping trip patterns, than across shopping trip patterns. Examining the relationship between food service and food retailer utilization, measured using the number of trips, and the healthfulness of purchases within each shopping trip addresses some endogeneity concerns by comparing utilization among households that are more similar to each other. Estimating this relationship with a MESR also addresses potential selection bias resulting from the influence of unobserved household characteristics on the choice of shopping trip patterns and healthfulness of food purchases (Bourguignon, Fournier, and Gurgand 2007; Lee, 1983). Although we believe that these methods at least partially address the endogeneity associated with the choice of food services and food retailers, we do not claim to have identified a causal effect of utilization since unobserved household characteristics may still influence the choice of food services and retailers within each shopping trip pattern. Furthermore, as discussed in the introduction the primary goal of our analysis is to provide additional insight into the relationship between food service and retailer utilization with an emphasis on investigating heterogeneity associated with shopping trip patterns and income as we believe this will be valuable to future researchers seeking to develop the theories and methods necessary to identify a causal effect of food service and retailer utilization.

2.2.1. Household Shopping Trip Patterns

To identify shopping trip patterns in the FoodAPS data set, we conducted a k-means cluster analysis based on the household's percentage of shopping trips to the different food service and retailer categories discussed in Section 2.1.1. The optimal number of clusters was determined from the highest pseudo-F-statistics, as higher values indicated larger intra-cluster homogeneity, and greater inter-cluster heterogeneity (Everitt et al., 2011). Our analysis identified three clusters, or shopping trip patterns, that were named after the predominantly used food service or retailer: superstore (SS), supermarket (SM), and mix (M). For households in the SS shopping trip pattern, superstore trips on average accounted for 63.39% of weekly trips, and for households in the SM shopping trip pattern supermarkets on average accounted for 59.06% of weekly trips. Since

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households in the mix shopping trip pattern did not have a single dominant food service or retailer, the mix name reflects the use of a variety of places. For mix households, restaurants were most frequently utilized but on average accounted for only 19.20% of weekly trips. The mix shopping trip pattern was the largest and included approximately 64% of households, while the SS and SM shopping trip patterns contained approximately 16.64% and 19.36% of households, respectively. Additional discussion of the k-means cluster analysis and results are available in Yenerall et al. (2020).

2.2.2. Multinomial Endogenous Switching Regression (MESR)

The MESR is a form of a generalized econometric model with selectivity (Lee, 1983). In this two-part model, the first equation describes the choice of shopping trip pattern, which was estimated using a multinomial logistic regression given that there were three shopping trip patterns. The remaining three equations describe the relationship between food service and retailer trips and the healthfulness of food purchases within each shopping trip pattern and were estimated by an ordinary least squares regression that included a correction term for the selection bias. More formally, we assume that households choose the shopping trip pattern that provides maximum utility. Since the level of utility received is not observable, a latent variable (S_{ij}*) is used to capture the shopping trip decision-making process for individual i:

$$S_{ij}^{*} = \gamma_j FE_{ij} + \alpha_j X_{ij} + \eta_{ij} \quad j = 1, 2, 3 \tag{1}$$

where FE_{ij} is a vector of food environment variables that measure the availability of superstores, supermarkets, fast-food restaurants, and full-service restaurants within 1 mile of an individual's home for urban households and 10 miles for rural households (Ver Ploeg, Dutko, and Breneman, 2014). Food environment variables were included in the selection, but not the outcome equations, to serve as identification instruments. Additionally, X_{ij} is a vector of household and primary respondent characteristics that influence shopping trip patterns. Primary respondent characteristics included binary indicators for age, sex, race, the highest level of education, and perceptions of healthy food. Healthy food perceptions included indicators for the belief that it costs too much to eat healthily, that there was not enough time to prepare healthy food, and that they did not believe healthy food tastes good. Household characteristics also included a binary indicator for the presence of a child (defined as a household member who was 18 years of age or younger) and the percentage of adults in the household who work (defined as the percentage of all adults in the household who reported being employed in the previous week). A binary indicator was used to indicate if the household's income was at or below 130% FPL. Finally, U.S. Census Region fixed effects (e.g. northeast, midwest, west, and south) were included to capture regional heterogeneity in the availability of food based on seasonality, cultural norms, and/or regional preferences.

Although the level of utility, S_{ij}*, is not observable, we can observe the household's shopping trip pattern, S, which we assumed was chosen because it provides the maximum level of utility relative to all other shopping trips such that:

$$S = \begin{cases} 1 \; if \;\; S_{ij}^{*} > \max_{m \neq 1}\left(S_{im}^{*}\right) \\ 2 \; if \;\; S_{ij}^{*} > \max_{m \neq 2}\left(S_{im}^{*}\right) \\ 3 \; if \;\; S_{ij}^{*} > \max_{m \neq 3}\left(S_{im}^{*}\right) \end{cases} \text{for all } m \neq j \tag{2}$$

Assuming that the error terms, η_{ij}, are independently and identically Gumbel distributed, then the selection equation can be estimated using a multinomial logistic regression (Lee, 1983).

Three outcome equations describe the relationship between the number of trips to food services and retailers and the healthfulness of food purchases (H) within each shopping trip pattern.

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$$\begin{cases} H_{i1} = \beta_1 FS_{i1} + \theta_1 X_{i1} + \mu_{i1} & if\ S = 1 \\ H_{i2} = \beta_2 FS_{i2} + \theta_2 X_{i2} + \mu_{i2} & if\ S = 2 \\ H_{i3} = \beta_3 FS_{i3} + \theta_3 X_{i3} + \mu_{i3} & if\ S = 3 \end{cases} \quad (3)$$

where FS_{ij} is a vector that includes the number of trips to both food retailers and food services described in Section 2.1.1, X_{ij} contains the same vector of household and primary respondent characteristics used in equation (1) but also includes the proportion of expenditures for FAH. The proportion of expenditures for FAH was included to better isolate the influence of how people shop, captured in food shopping trip patterns, from what they buy, captured in expenditures. This is similar to Rudi and Cakir (2017) who include total trips to all food retailers, the primary variable of interest, and the proportion of expenditures at each food retailer type. Failure to address potential selection bias resulting from the relationship between choice of shopping trip patterns, and healthfulness of food purchases for each shopping trip pattern would result in a biased estimation of the β_j and θ_j parameters in equation (3). Therefore, the MESR addresses selection bias by estimating the following equations:

$$\begin{cases} H_{i1} = \beta_1 FS_{i1} + \theta_1 X_{i1} + \sigma_1 \lambda_{i1} + \varepsilon_{i1} & if\ S = 1 \\ H_{i2} = \beta_2 FS_{i2} + \theta_2 X_{i2} + \sigma_2 \lambda_{i2} + \varepsilon_{i2} & if\ S = 2 \\ H_{i3} = \beta_3 FS_{i3} + \theta_3 X_{i3} + \sigma_3 \lambda_{i3} + \varepsilon_{i3} & if\ S = 3 \end{cases} \quad (4)$$

where σ_j is the standard deviation of the error term, μ_{ij}, in the healthfulness of food purchases outcome equation conditional on FE_{ij}, FS_{ij}, and X_{ij} [equation (3)] [i.e. $V(u_{ij}|\mathrm{FE}_{ij}, \mathrm{FS}_{ij}, X_{ij} = \sigma_j^2)$]. Finally, λ_{ij} is the bias correction term derived from the assumed relationship between the two error terms η_{ij} and μ_{ij}. This paper used the Bourguignon, Fournier, and Gurgand (2007) variation of the Dubin and Mcfadden (1984) correction term that assumes the error terms are linearly related and distributed bivariate normal, which results in the following bias correction term:

$$\lambda_{ij} = r_j \int J\left(v - \log P_j\right) g(v) dv + \sum\nolimits_{m \neq j} r_m \int J\left(v - \log P_m\right) g(v) dv \frac{P_m}{(P_m - 1)} \quad (5)$$

where r_j the correlation between the two error terms, and P_j is the probability that shopping trip pattern j is preferred, and $J()$ refers to distribution for the standard normal form for η_{ij} (i.e. $J\left(n_{ij}\right) = n_{ij}^* = \Phi\left(G\left(n_{ij}\right)\right)\ \ j = 1, 2, 3$).

A weighted MESR was used to account for the sampling weights in the FoodAPS survey and two versions of the weighted MESR were estimated. In the first, food service and retailer trips and the income indicator were included independently. The second version included trip variables, income indicators, and the interaction between trip and income to investigate the potentially heterogeneous effect of trips among lower-income households. All analyses were conducted in Stata version 16. The weighted MESR was estimated using the svyselmlog command in Stata, which uses the two-step method thus standard errors are estimated using bootstrapping with 1,000 replications (Bourguignon, Fournier, and Gurgand 2007)

3. Results

3.1. Food Store Nutritional Gradient

The nutrient gradient across food services and retailers documented in previous literature was replicated in our data set and presented in Table 1, which contains the HEI-2010 score for categories of food services and retailers described in Section 2.1.1. and lists them in order from highest to lowest HEI-2010 score. As was expected, the HEI-2010 score declined from supermarkets and superstores to convenience stores and was lower for burger restaurants and restaurants. Somewhat surprisingly, grocery stores had the second lowest HEI-2010 score. The other food store category had the highest HEI-2010 score likely because it contains places like direct marketing farmers, farmers' markets, and fruits and vegetable specialty stores.

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Table 1. Dietary quality and food at home (FAH) trips by food store type

	HEI-2010 Score	FAH Trip Percentage
Other food store	58.20	82.69
Supermarket	53.53	98.20
Superstore	53.14	98.05
Other	50.47	4.50
Convenience store	47.20	48.10
Burger restaurant	45.07	0
Restaurant	44.51	0.16
Grocery store	42.14	92.94
Other eating place	41.41	2.21

$N = 203{,}152$ trips.
HEI = Healthy Eating Index; FAH = food at home.
Other food store includes farmers' market, fruit and vegetable specialty stores, meat or poultry specialty stores, pharmacies, gas stations, and other less commonly used food retailers.
Other eating place includes bakeries, coffee shops, vending machines, food trucks, and other less commonly used food services.
Other places category includes places like gyms, bowling alleys, concerts, and amusement parks.

Also included in Table 1 is the percentage of total trips for FAH by food service and retailer category. Since the classification of FAH and FAFH in FoodAPS was based on respondents reporting if the food purchased was brought home or consumed away from home rather than the food service or retailer type, it is useful to show how different food service and retailer categories were used in the data set. As might be expected, the majority of trips to supermarkets, superstores, grocery stores, and other food stores were for FAH. Trips to burger restaurants, restaurants, other, and the other eating place category were almost exclusively not for FAH. However, approximately 48% of trips to convenience stores were used for FAH, suggesting households split their use for convenience stores between FAH and FAFH.

3.2. Household Food Shopping Behavior

To provide some context for the discussion of differences in primary respondent and household characteristics across shopping trip patterns, we begin with a brief discussion of weekly food shopping trips by the use for FAH or FAFH (Figure 1) as well as by food service and retailer category (2). For the remainder of this discussion, we will refer to the supermarket shopping trip pattern as SM, the superstore shopping trip pattern as SS, and the mix shopping trip pattern as mix. Households in mix had, on average, the greatest number of overall trips during the week (Figure 1). They averaged 10.01 trips per week as compared to approximately 5.34 or 5.42 in SS or SM, respectively. The difference in overall trips was driven by FAFH in mix (Figure 1). While the average number of trips per week for FAH within each shopping trip pattern was close to the overall average of 3.29, households in mix averaged 6.83 trips for FAFH compared to approximately 1.96 or 1.88 in SS or SM, respectively. Figure 2 includes the average weekly trips by food service and retailer categories across the three shopping trip patterns. As might be expected, households in SM most frequently visited supermarkets, and households in SS most frequently visited superstores. This is true both when considering other store types within either SS or SM and when comparing superstore and supermarket trips across shopping trip patterns. Households in mix made, on average, one trip to either a supermarket or superstore during the week, but had more than one trip to restaurants, other eating places, or burger restaurants.

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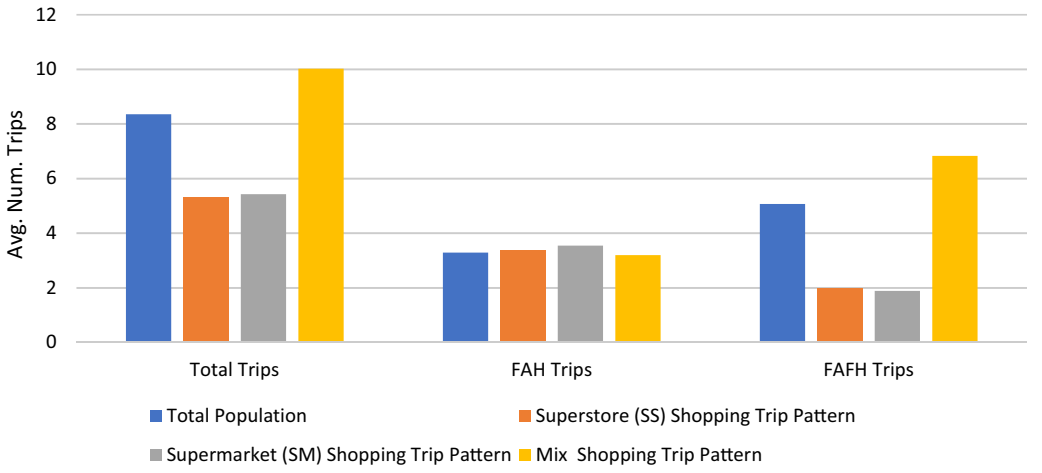

Figure 1. Average weekly trips for food at home and away from home.

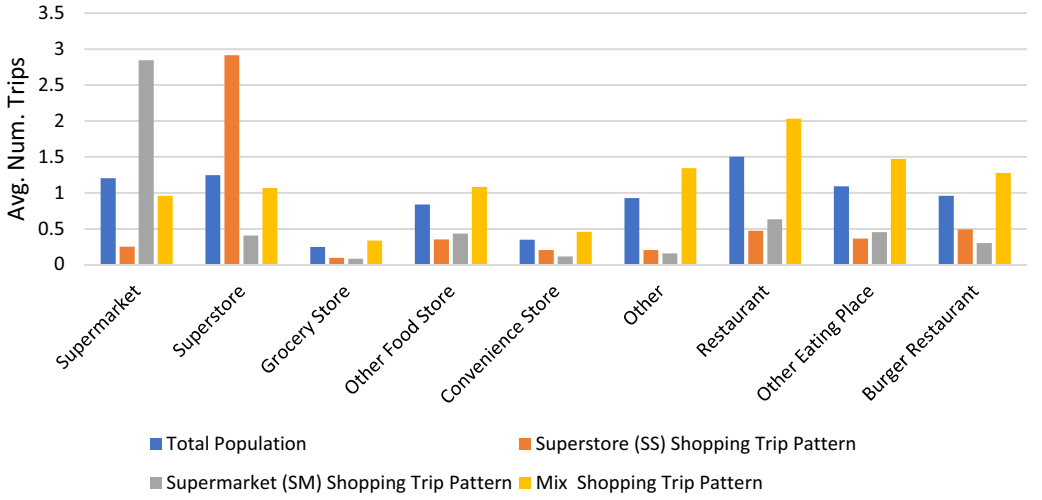

Figure 2. Average weekly trips by food store type.

3.3. Primary Respondent and Household Characteristics

To compare households across the three shopping trip patterns, we used weighted summary statistics and two weighted t-tests to test for significant differences. In the first weighted t-test, we compared the primarily FAH shopping trip patterns (SS vs SM). Then, we combined the primarily FAH shopping trip patterns (SS + SM) to test for differences with mix, the primarily FAFH shopping trip pattern (SS + SM vs mix). Table 2 contains weighted summary statistics describing the demographics of the primary respondent and household characteristics. The table shows that primary respondents from mix were relatively more likely to be married, be younger than 59 years of age, and have at least a college degree as compared to primary respondents in SS or SM. Primary respondents from SS also tended to be younger than those in SM and were less likely to have completed a college degree as compared to SM. There were no significant differences between primary respondents across the different shopping trip patterns by sex or race. Households in

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Table 2. Primary respondent and household characteristics

Mean (SD)	Total Population ($N = 4,647$)	Superstore (SS) Shopping Trip Pattern ($N = 836$)	Supermarket (SM) Shopping Trip Pattern ($N = 885$)	Mix Shopping Trip Pattern ($N = 2,926$)	SS vs SM	SS + SM vs Mix
Primary respondent demographics						
Female (%)	68.69 (1.10)	66.57 (2.36)	68.21 (3.80)	69.38 (1.48)		
Married (%)	46.27 (1.61)	41.77 (2.66)	40.00 (2.94)	49.32 (1.87)		**
Primary respondent age						
Less than 35 (%)	23.02 (1.22)	21.59 (1.40)	14.93 (2.41)	25.80 (1.77)	*	**
36–59 (%)	45.93 (1.55)	39.26 (2.73)	38.90 (3.35)	49.77 (1.70)		***
Over 60 (%)	31.05 (1.42)	39.15 (3.11)	46.16 (4.01)	24.43 (1.73)		***
Race						
African American (%)	11.18 (1.48)	9.99 (2.62)	10.03 (1.96)	11.83 (1.59)		
Caucasian (%)	77.65 (1.89)	79.98 (3.77)	79.17 (2.64)	76.58 (2.05)		
Other (%)	11.18 (1.17)	10.03 (1.99)	10.80 (1.59)	11.59 (1.28)		
Education						
High school degree or less (%)	33.37 (1.67)	43.37 (2.75)	36.03 (2.39)	29.98 (2.08)		***
Some college or associates degree (%)	33.29 (1.80)	33.07 (3.52)	30.72 (3.38)	34.13 (2.00)		
College and more (%)	33.34 (2.10)	23.56 (2.88)	33.25 (3.53)	35.90 (2.63)	*	*
Household characteristics						
Household size	2.45 (0.05)	2.30 (0.10)	2.11 (0.07)	2.60 (0.06)		***
Household with kids (%)	33.23 (1.37)	28.15 (2.44)	21.57 (1.84)	38.07 (1.94)	*	***
Number of children	1.91 (0.04)	1.98 (0.10)	1.86 (0.05)	1.90 (0.05)		
Household monthly income	5198.98 (206.50)	4238.14 (287.10)	4538.11 (252.08)	5647.34 (260.26)		***
Income $\leq$ 130% FPL (%)	17.59 (1.23)	24.97 (2.40)	25.49 (2.34)	13.29 (1.27)		***
Percentage of adults working	58.73 (1.03)	52.10 (3.34)	46.74 (2.26)	64.06 (1.25)		***
SNAP participant (%)	13.14 (0.88)	19.37 (1.63)	15.86 (1.89)	10.70 (1.00)		***
Healthy Food Attitudes						
Too busy to prepare healthy food (%)	20.24 (0.75)	15.96 (2.03)	12.89 (1.92)	23.55 (1.12)		***
Cost too much to eat healthy (%)	32.37 (1.44)	34.20 (3.38)	30.91 (2.86)	32.33 (1.96)		
People in the household do not think healthy food is tasty (%)	21.64 (1.02)	19.44 (2.29)	13.29 (1.35)	24.73 (1.39)	*	***
Environmental Variables						
Rural (%)	34.35 (3.66)	39.04 (4.51)	28.40 (4.80)	34.92 (4.15)		
Regions						
Northeast (%)	15.64 (2.47)	8.97 (2.88)	16.27 (3.48)	17.19 (2.63)		*

(*Continued*)

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Table 2. (*Continued*)

Mean (SD)	Total Population ($N = 4,647$)	Superstore (SS) Shopping Trip Pattern ($N = 836$)	Supermarket (SM) Shopping Trip Pattern ($N = 885$)	Mix Shopping Trip Pattern ($N = 2,926$)	SS vs SM	SS + SM vs Mix
Midwest (%)	31.16 (3.53)	46.38 (8.06)	15.57 (5.09)	31.91 (3.59)	*	
South (%)	35.20 (3.98)	31.70 (6.49)	43.32 (6.49)	33.66 (4.09)		
West (%)	18.00 (2.71)	12.95 (3.29)	24.85 (5.10)	17.24 (2.55)	*	
Food Environment: Availability						
Superstore	2.04 (0.29)	1.99 (0.23)	1.77 (0.36)	2.14 (0.36)		
Supermarket	2.60 (0.50)	1.69 (0.28)	2.84 (0.43)	2.77 (0.63)	**	
Fast-food restaurant	12.53 (1.57)	9.89 (1.40)	12.50 (2.31)	13.23 (1.77)		
Non-fast-food restaurant	55.38 (7.76)	41.34 (6.97)	56.59 (10.28)	58.65 (8.72)		

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
Availability measures number of food stores within 1 mile of an individual's home for urban households and 10 miles for rural households.
FPL = federal poverty line; SNAP = supplemental nutrition assistance program.

mix were larger, more likely to have children, had the highest average monthly income, and have a higher percentage of adults working in the home. Households in SS were the next most likely to have children, the most likely to participate in SNAP, and had the lowest average monthly income.

When considering the primary respondent's perceptions of healthy foods, those in mix were most likely to indicate that they were too busy to prepare healthy food, or that people in their household did not like healthy food. Primary respondents in SS were also more likely to indicate people in their household do not like healthy food as compared to primary respondents in SM. Primary respondents were similarly likely across all three shopping patterns to indicate it costs too much to eat healthy food. Table 2 also shows that there were very few differences in the regional location and local food environments of households across shopping trip patterns. There were no significant differences by rurality and most regional indicators. Households in SS were more likely to be located in the Midwest than households in SM, while households in SM were more likely than those in SS to live in the West. When considering the local food environment, the only significant difference occurs when comparing supermarket availability across households in SS and SM, where supermarket availability was on average higher for households in the SM shopping trip pattern.

Finally, Table 3 compares the HEI-2010 scores and food expenditures per household member across the three shopping trip patterns. Weekly food expenditures per household member mirror the patterns found in shopping trips captured in Figure 1. Households in the mix shopping trip pattern had, on average, the highest total food expenditures at $86.13 per household member, while households in either the SS or SM spent on average $70.04 or $77.29 per household member respectively. Again, this difference was driven by differences in FAFH spending. Households in mix spent on average $33.94 per household member on FAFH, which was twice as much as households in SM, on average $15.01 per household member, and three times more than households in SS who spent on average $9.97 per household member. By comparison, differences in FAH spending were much smaller. Average per household member spending in mix was $52.18, in SM $62.13, and in SS $60.26.

Households in SM had the highest average overall HEI-2010 score, 55.76, and it was statistically different from households in SS which had the lowest average overall score at 51.92. Households in SM also had the highest average HEI-2010 score for FAH at 55.18, followed by households in SS at 52.10, and finally households in mix at 51.62. However, households in mix had the highest average

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Table 3. Household food expenditures and Healthy Eating Index 2010 (HEI-2010) scores

Mean (SD)	Total Population ($N = 4,647$)	Superstore (SS) Shopping Trip Pattern ($N = 836$)	Supermarket (SM) Shopping Trip Pattern ($N = 885$)	Mix Shopping Trip Pattern ($N = 2,926$)	SS vs SM	SS + SM vs Mix
Food expenditures per household member						
Total	81.77 (2.10)	70.04 (2.68)	77.29 (3.84)	86.13 (2.95)		**
Food at home (FAH)	55.44 (1.48)	60.26 (2.56)	62.13 (3.20)	52.18 (1.87)		**
Food away from home (FAFH)	26.32 (0.96)	9.97 (0.78)	15.01 (2.12)	33.94 (1.45)	*	***
HEI-2010 Scores						
Total food purchases	53.06 (0.46)	51.92 (0.89)	55.76 (0.82)	52.54 (0.62)	**	
FAH purchases	52.39 (0.52)	52.10 (0.99)	55.18 (0.98)	51.62 (0.68)		*
FAFH purchases	42.63 (0.30)	40.40 (0.73)	40.97 (0.94)	43.36 (0.42)		**
No FAFH events (%)	14.02 (0.92)	35.05 (2.42)	31.97 (2.62)	3.15 (0.53)		***

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
HEI = Healthy Eating Index; FAH = food at home; FAFH = food away from home.

HEI-2010 score for FAFH at 43.36 while the HEI-2010 score was approximately 40 for households in either SS or SM. Across all shopping trip patterns, the average HEI-2010 score was lower for FAFH as compared with FAH. Since the FAH and FAFH HEI-2010 scores could only be calculated for households that had FAH and FAFH expenditures respectively, we also reported the percentage of households without FAFH events in Table 3. Approximately one-third of households in either SS or SM have no FAFH events, as compared to only 3% of households in mix. Missing FAH events were so rare in all three shopping trip patterns that the weighted prevalence was 0, and therefore not reported.

3.4. The Relationship between Food Service and Retailer Utilization and the Healthfulness of Food Purchases

The coefficients for the number of trips to different food service and retailer categories from the outcome equations for the weighted MESR are found in Tables 4–6. Although results for all food service and retailer categories were included in the tables, our discussion will focus on supermarkets, superstores, convenience stores, and burger restaurants (a proxy for fast-food restaurants) given their importance in past research. The results for all households came from the MESR without income interactions, while the results for specific income groups came from the MESR with income interactions. For the purposes of this discussion, we will refer to households with an income below 130% FPL as lower-income households and those with an income exceeding 130% FPL as higher-income households. The influence of food service and retailer trips for higher-income households came directly from the trip variable in the MESR with income interactions. The influence for lower-income households was calculated by summing across the coefficients from food service or retailer trips and the interaction between the trip variable and income variable (e.g. an indicator for household income less than 130% FPL). Full results for the outcome equations are found in Appendix Tables 1 to 6, and the results from the shopping trip selection equation are included in Appendix Table 7 but not discussed because they were not of primary interest to this study.

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Table 4. Influence of food store trips on Healthy Eating Index (HEI) 2010 score for total food purchases

Coef	Superstore (SS) Shopping Trip Pattern ($N = 836$)	Supermarket (SM) Shopping Trip Pattern ($N = 885$)	Mix Shopping Trip Pattern ($N = 2{,}926$)
Supermarket trips			
All households[1]	2.09	−0.30	0.80*
Income > 130% FPL[2]	2.93	−0.23	0.57
Income ≤ 130% FPL[2]	−0.58	−0.58	2.46***
Superstore trips			
All households[1]	−0.15	2.40*	1.03**
Income > 130% FPL[2]	−0.29	2.13	1.08**
Income ≤ 130% FPL[2]	0.40	3.17	0.31
Convenience store trips			
All households[1]	0.12	−2.69*	−0.11
Income > 130% FPL[2]	0.49	−3.15*	−0.18
Income ≤ 130% FPL[2]	−1.59	0.36	0.31
Restaurant trips			
All households[1]	0.71	0.91	0.29
Income > 130% FPL[2]	1.06	1.16	0.30
Income ≤ 130% FPL[2]	−0.97	−2.26	0.61
Burger restaurant trips			
All households[1]	−0.12	−4.49E-03	−0.52*
Income > 130% FPL[2]	−0.23	0.34	−0.70**
Income ≤ 130% FPL[2]	0.04	−0.47	0.22
Grocery store trips			
All households[1]	1.34	2.81	0.33
Income > 130% FPL[2]	2.33	1.32	0.32
Income ≤ 130% FPL[2]	−0.56	4.81	0.37
Other food store trips			
All households[1]	0.60	1.64	−0.82**
Income > 130% FPL[2]	0.58	1.84	−0.85**
Income ≤ 130% FPL[2]	0.90	0.80	−0.59
Other eating place trips			
All households[1]	1.08	0.37	0.44*
Income > 130% FPL[2]	1.40	−0.37	0.41
Income ≤ 130% FPL[2]	−0.43	5.76*	1.08
Other trips			
All households[1]	−0.75	1.36	0.10
Income > 130% FPL[2]	−0.78	1.75	0.12

(*Continued*)

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Table 4. (*Continued*)

Coef	Superstore (SS) Shopping Trip Pattern ($N = 836$)	Supermarket (SM) Shopping Trip Pattern ($N = 885$)	Mix Shopping Trip Pattern ($N = 2{,}926$)
Income $\leq$ 130% FPL[2]	−0.12	0.30	0.23
Proportion FAH expenditures			
All households[1]	3.03	3.23	5.30**

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
Results are from a weighted linear regression for the outcome equation of a weighted multinomial endogenous switching regression (MESR). Variables included in all regressions but not reported: primary respondent age, gender, race, income of at most 130% FPL, percent of adults working, presence of a child, married, healthy eating attitude variables, census region fixed effects, selection bias correction.
FAH = food at home; FPL = federal poverty line.
[1]From MESR outcome equations without income interaction see Appendix Tables 2–4 for full results.
[2]From MESR outcome equations with income interactions see Appendix Tables 5–7 for full results.

In general, the results show a limited association between food service and retailer trips and the healthfulness of food purchases that varies by households' shopping trip patterns and income. Beginning with supermarkets, Table 4 demonstrates that increasing supermarket trips were associated with a higher HEI-2010 score for total food purchases but only for households in mix (coeff = 0.80). However, the income interactions show that the association was only statistically significant among lower-income households (coeff = 2.46). Most of this relationship appears to come from the association with the healthfulness of FAH purchases (Table 5). There was a positive association between supermarket trips and FAH purchase healthfulness for all households in mix (coeff = 0.80) as well as among higher (coeff = 0.85) and lower (coeff = 2.11) income households. Among lower-income households, there was also a positive association between supermarket trips (coeff = 1.49) and FAFH healthfulness (Table 6). Additionally, there was a positive association between supermarket trips and the healthfulness of FAH purchases (Table 5) in SS (coeff = 2.44).

Superstore trips were also associated with increased healthfulness of purchases in certain shopping trip patterns. For the healthfulness of all food purchases (Table 4), increasing trips to a superstore was associated with higher HEI-2010 scores among households in either SM (coeff = 2.40) or mix (coeff = 1.03). Within mix, the association with the healthfulness of all food purchases was only statistically significant for higher-income households (coeff = 1.08). Additionally, within mix only increasing superstore trips was associated with increasing healthfulness of FAH purchases (Table 5) (coeff = 1.03), although the association was only statistically significant among higher-income households (coeff = 1.22).

Finally, convenience store and burger restaurant trips were generally associated with decreased healthfulness of purchases. Increasing convenience store trips was associated with a decrease in the healthfulness of total food purchases (Table 4) but only within SM (coeff = −2.69). Furthermore, the negative association was only found among higher-income households (coeff = −3.15). While increasing trips to burger restaurants was associated with lower HEI-2010 scores for total food purchases (Table 4) in mix (coeff = −0.52), the negative association was only statistically significant for higher-income households (coeff = −0.70). Additionally, within mix, the negative association with burger restaurant trips was also found for the healthfulness of FAH purchases (coeff = −0.52, Table 5). Finally, within lower-income households in SS only increasing trips to burger restaurants was associated with higher FAFH healthfulness (coeff = 2.69, Table 6).

Although the proportion of expenditures for FAH is not a measure of specific food retailer utilization, it does capture another potentially important aspect of food shopping behavior related to how households allocate spending across the food to be used in cooking at home (which

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Table 5. Influence of food store trips on Healthy Eating Index (HEI) 2010 score for food at home (FAH) purchases

Coef	Superstore (SS) Shopping Trip Pattern ($N = 827$)	Supermarket (SM) Shopping Trip Pattern ($N = 881$)	Mix Shopping Trip Pattern ($N = 2{,}603$)
Supermarket trips			
All households[1]	2.44*	−0.72	0.80*
Income > 130% FPL[2]	3.07*	−0.81	0.85*
Income ≤ 130% FPL[2]	0.42	−0.50	2.11**
Superstore trips			
All households[1]	0.10	2.10	1.03**
Income > 130% FPL[2]	0.03	1.87	1.22**
Income ≤ 130% FPL[2]	0.46	2.77	0.67
Convenience store trips			
All households[1]	0.01	−2.21	−0.11
Income > 130% FPL[2]	0.35	−2.45	0.09
Income ≤ 130% FPL[2]	−1.61	0.18	0.57
Restaurant trips			
All households[1]	1.13	1.98	0.29
Income > 130% FPL[2]	1.75	2.38	0.48
Income ≤ 130% FPL[2]	−1.57	−1.70	0.85
Burger restaurant trips			
All households[1]	−0.54	0.82	−0.52*
Income > 130% FPL[2]	−0.87	1.20	−0.32
Income ≤ 130% FPL[2]	0.34	0.20	0.41
Grocery store trips			
All households[1]	1.77	2.84	0.33
Income > 130% FPL[2]	2.58	1.28	0.73
Income ≤ 130% FPL[2]	0.08	4.67	1.15
Other food store trips			
All households[1]	0.40	1.73	−0.82**
Income > 130% FPL[2]	0.43	2.05	−0.73*
Income ≤ 130% FPL[2]	0.40	0.62	−0.42
Other eating place trips			
All households[1]	0.72	1.04	0.44*
Income > 130% FPL[2]	0.94	0.42	0.69**
Income ≤ 130% FPL[2]	−0.52	5.84*	1.66*
Other trips			
All households[1]	−0.64	1.95	0.10
Income > 130% FPL[2]	−0.85	2.40	−0.09

(*Continued*)

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Table 5. (*Continued*)

Coef	Superstore (SS) Shopping Trip Pattern ($N = 827$)	Supermarket (SM) Shopping Trip Pattern ($N = 881$)	Mix Shopping Trip Pattern ($N = 2{,}603$)
Income $\leq$ 130% FPL[2]	0.42	0.74	0.24
Proportion FAH expenditures			
All households[1]	4.89	12.96*	5.30**

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
Results are from a weighted linear regression for the outcome equation of a weighted multinomial endogenous switching regression (MESR). Variables included in all regressions but not reported: primary respondent age, gender, race, income of at most 130% FPL, percent of adults working, presence of a child, married, healthy eating attitude variables, census region fixed effects, selection bias correction.
FAH = food at home; FPL = federal poverty line.
[1]From MESR outcome equations without income interaction, see Appendix Tables 2–4 for full results.
[2]From MESR outcome equations with income interactions, see Appendix Tables 5–7 for full results.

primarily comes from food retailers) and food consumed away from home (which primarily comes from food services). The results in Tables 4–6 show that for households in SM and mix increasing FAH expenditure shares was associated with the healthfulness of both FAH and FAFH purchases, although it was only positively associated with the healthfulness of all food purchases for households in mix (coef = 5.30; Table 4). For households in either SM or mix, increasing the share of FAH expenditures was associated with increasing healthfulness of FAH purchases (SM coeff = 12.96; mix coeff = 5.30; Table 5) but decreasing healthfulness of FAFH purchases (SM coeff = −18.56; mix coeff = −5.69; Table 6).

Since the share of expenditures for FAH may be endogenous due to omitted variables, such as preferences for cooking, we estimated the MESR models without income interactions and excluded the share of FAH expenditures variables (Appendix Table 8 through 10) for a sensitivity analysis. The sign and magnitude of the trip variables are fairly robust, although we do observe changes in the statistical significance for several trip variables in the models for FAH (Appendix Table 9) and FAFH (Appendix Table 10). While the results of the sensitivity analysis do not change our overall conclusion that food retailer or food service use has a limited effect on the healthfulness of purchases, it does further caution against a causal interpretation of the findings.

4. Discussion and Conclusions

Households living in areas with limited access to supermarkets or easy access to fast-food or convenience stores tend to have poorer health outcomes (Fleischhacker et al., 2011; White, 2007). Furthermore, access to certain food services and retailers is generally assumed to imply a certain level of access to healthy foods (i.e. supermarkets are assumed to provide a higher level of healthy food access while fast-food restaurants are not). Current food environment policies, such as the HFFI, assume that modifying the supply of certain food services or food retailers also modifies healthy food availability, which will have an impact on purchasing behavior and consequently dietary and health outcomes. However, studies investigating the causal effect of a new supermarket have found it has no or limited impact on household food purchasing behaviors and no impact on health outcomes (Abeykon, Engler-Stringer, and Muhajarine, 2017). Several studies have suggested this limited effect is in part related to how the new supermarket was utilized (Cummins, Flint, and Matthews 2014; Sadler, Gilliland, and Arku, 2013; Allcott et al., 2019; Cantor et al., 2020). Allcott et al. (2019) found that households who utilized a new supermarket primarily shifted expenditures away from other supermarkets, rather than food retailers with limited availability of healthy foods such as convenience stores. Thus, investigating household food service and retailer utilization may provide further insight into the limited effect of HFFI style interventions

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Table 6. Influence of food store trips on Healthy Eating Index (HEI) 2010 score for food away from home (FAFH) purchases

Coef	Superstore (SS) Shopping Trip Pattern ($N = 534$)	Supermarket (SM) Shopping Trip Pattern ($N = 560$)	Mix Shopping Trip Pattern ($N = 2{,}807$)
Supermarket trips			
All households[1]	1.11	0.51	0.18
Income > 130% FPL[2]	1.80	0.31	0.03
Income ≤ 130% FPL[2]	−0.69	1.12	1.49**
Superstore trips			
All households[1]	0.14	0.30	0.01
Income > 130% FPL[2]	0.05	1.48	0.06
Income ≤ 130% FPL[2]	0.89	−3.84	−0.36
Convenience store trips			
All households[1]	−0.13	−2.54	−0.29
Income > 130% FPL[2]	0.34	−2.72	−0.39
Income ≤ 130% FPL[2]	−3.59	0.51	0.27
Restaurant trips			
All households[1]	−1.16	1.82	0.39
Income > 130% FPL[2]	−1.46	2.14	0.40
Income ≤ 130% FPL[2]	0.39	−0.24	0.30
Burger restaurant trips			
All households[1]	1.38	−0.79	−0.27
Income > 130% FPL[2]	1.26	−0.40	−0.36
Income ≤ 130% FPL[2]	2.69*	−1.44	0.08
Grocery store trips			
All households[1]	−3.12	1.69	0.28
Income > 130% FPL[2]	−4.16	1.74	0.26
Income ≤ 130% FPL[2]	−1.78	1.34	0.37
Other food store trips			
All households[1]	0.41	0.96	−0.54*
Income > 130% FPL[2]	0.24	0.83	−0.41
Income ≤ 130% FPL[2]	0.97	0.45	−1.23***
Other eating place trips			
All households[1]	1.04	−0.53	0.32
Income > 130% FPL[2]	−0.78	−0.68	0.32
Income ≤ 130% FPL[2]	0.44	0.46	−0.09
Other trips			
All households[1]	−0.36	0.50	0.31*
Income > 130% FPL[2]	−0.19	0.65	0.33*

(*Continued*)

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Table 6. (*Continued*)

Coef	Superstore (SS) Shopping Trip Pattern ($N = 534$)	Supermarket (SM) Shopping Trip Pattern ($N = 560$)	Mix Shopping Trip Pattern ($N = 2{,}807$)
Income $\leq$ 130% FPL[2]	−1.56	1.11	0.08
Proportion FAH expenditures			
All households[1]	−6.71	−18.56**	−5.69**

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
Results are from a weighted linear regression for the outcome equation of a weighted multinomial endogenous switching regression (MESR). Variables included in all regressions but not reported: primary respondent age, gender, race, income of at most 130% FPL, percent of adults working, presence of a child, married, healthy eating attitude variables, census region fixed effects, selection bias correction.
FAH = food at home; FPL = federal poverty line.
[1]From MESR outcome equations without income interaction, see Appendix Tables 2–4 for full results.
[2]From MESR outcome equations with income interactions, see Appendix Tables 5–7 for full results.

and suggest opportunities for future policy development. This study used data from the 2013 FoodAPS to investigate the relationship between food service and retailer utilization, measured using the number of trips in a week, on the healthfulness of food purchases. The healthfulness of food purchases was measured using the HEI 2010 and calculated for total food purchases, FAH purchases, and FAFH purchases.

Although we found a gradient in store level HEI-2010 scores in which supermarkets and superstores scored the highest, and convenience stores and restaurants scored lower, the association between trips to supermarkets, superstores, convenience stores, and burger restaurants was modest. This suggests utilization moderates the relationship between the healthfulness of food available at food services and food retailers and household outcomes. Most relevant to the food environment and supermarket intervention literature are our findings related to supermarket utilization. Similar to Minaker et al. (2016) and Volpe, Jaenicke, and Chenarides (2018), we found that increasing use of supermarkets was associated with increasing healthfulness of purchases. Further, like Volpe, Jaenicke, and Chenarides (2018), we also found that the positive association was stronger among lower-income households. However, unlike either study, we found this association was concentrated among households in two of the three shopping trip pattern groups, superstore (SS) and mix. Since both groups do not frequently use supermarkets, this suggests the marginal benefit from supermarket utilization is increasing at a decreasing rate. In other words, the households most likely to benefit from the utilization of supermarkets are also those least likely to currently use them. A similar relationship was observed with superstore trips, which had a positive association with the healthfulness of purchases but only within the supermarket (SM) and mix shopping trip pattern groups.

Convenience stores and burger restaurants generally sell lower-quality food, and it is often assumed they are used by households in low-income low supermarket access neighborhoods. However, we found that the negative relationship between convenience store or burger restaurant trips and the healthfulness of total food purchases was only statistically significant among higher-income households in the SM and mix shopping trip pattern groups. The finding related to convenience store utilization is consistent with Volpe, Jaenicke, and Chenarides (2018). Additionally, we found that increasing burger restaurant trips were associated with lower healthfulness of FAH purchases in the mix shopping trip pattern. Food retailers, including supermarkets, are generally used for FAH, while food services, including burger restaurants, are generally used for FAFH. Thus, finding that burger restaurant trips were associated with FAH quality while supermarket trips were associated with FAFH quality would suggest an interdependency between FAH and

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FAFH behaviors. Such an interdependent relationship was further supported by our finding of a positive association between supermarket trips and FAFH healthfulness among lower-income households in the mix shopping trip pattern and our finding in the SM and mix shopping trip patterns that a higher proportion of expenditures on FAH was associated with lower FAFH purchase healthfulness. The latter is consistent with two studies that found a relationship between the use of fast-food restaurants and FAH dietary quality (Anderson and Matsa, 2011; Poti, Duffey, and Popkin 2014). Furthermore, the magnitude of the FAH expenditure proportion association was larger than many of the food service or retailer utilization variables. This suggests households' decisions related to the allocation of expenditures across FAH and FAFH may matter more for the healthfulness or purchases than the use of a specific food service or retailer. An important area for future research is to study possible trade-offs between FAH and FAFH use and quantify the interaction impact on the overall healthfulness of purchase.

Overall, our results suggest that food environment interventions designed to encourage the utilization of any given food service or retailer may only have a modest influence on the healthfulness of household food purchases. Additionally, for supermarket interventions, this may require targeting households that are currently non-frequent users, like households in the SS and mix shopping trip pattern groups. This may be particularly challenging for households in the mix shopping trip pattern since it would likely involve incentivizing them to shift away from food services and toward food retailers. However, given that the mix shopping trip pattern includes 64% of households in our sample and had the second lowest HEI-2010 for all food purchases it may also be important to understand how to effectively target these households. As these households were more likely to indicate that they were too busy to prepare healthy food and had more working adults and children as compared to the other shopping trip patterns, it suggests time constraints may play a role in their food shopping behavior. Thus, as others have suggested policies that influence demand for healthy food may be more effective at influencing healthy eating than modifying the supply of food retailers (Bitler and Haider, 2011). Although not reported in the manuscript, the full results in the appendix show that several household characteristics, and in particular education, have a strong association with the healthfulness of purchases across all shopping trip patterns.

There were several limitations to our study. First, although we have utilized multiple methods to address the potential endogeneity of food retailer or food service choice, these methods likely cannot completely resolve the endogeneity in the model. Furthermore, the share of expenditures for FAH may be also endogenous. Thus, the results of our study should be used with caution to discuss the causal effect of food retailer or food service use on the healthfulness of purchases. Second, the number of households in the SS and SM shopping trip pattern groups was relatively small and may limit our statistical power. Third, it is unclear if a one-week time period is sufficient to capture the influence of shopping trip patterns. While some of our findings were consistent with studies using a longer observation period (including Volpe, Jaenicke, and Chenarides 2018), future research should consider the influence of the length of the observation window on the sensitivity of findings. Finally, our data only measured the quality of food purchased which does not necessarily equal the quality of food consumed. Ultimately, the health effect of how and where households shop for food depends on how and what they actually consume. For FAH, this depends not only on the method of preparation but also on how much food is discarded instead of being consumed. If households purchase healthier foods at food retailers but ultimately dispose of these foods due to time constraints or other challenges, this could undermine the positive influence of supermarket utilization and FAH expenditures identified in this analysis. Therefore, future research should consider the relationship between shopping trip patterns on both expenditures and consumption.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/aae.2022.27

Data availability statement. The data that support the findings of this study are openly available online at https://www.ers.usda.gov/data-products/foodaps-national-household-food-acquisition-and-purchase-survey/

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References

Abeykon, A.M., R. Engler-Stringer, and N. Muhajarine. "Health-Related Outcomes of New Grocery Store Interventions: A Systematic Review." *Public Health Nutrition* **20**,12(2017):2236–48.

Allcott, H., R. Diamond, J.P. Dube, J. Handsbury, I. Rahkovsky, and M. Schnell. "Food Deserts and the Causes of Nutritional Inequality." *The Quarterly Journal of Economics* **134**,4(2019):1793–844.

Anderson, Micahel, and David Matsa. "Are Restaurants Really Supersizing America?" *American Economic Journal: Applied Economics* **3**,1(2011):152–88.

Atkinson, M. "New Incentives Could Add Grocery Stores in Low Income Neighborhoods in Greenville." *Greenville News*, 2021. Internet site: https://www.greenvilleonline.com/story/news/local/2021/10/28/greenville-sc-business-license-incentives-could-bring-more-grocery-stores/6173096001/

Bitler, M., and S. Haider. "An Economic View of Food Deserts in the United States." *Policy Retrospectives* **30**,1(2011):153–76.

Bourguignon, F., M. Fournier, and M. Gurgand. "Selection Bias Corrections Based on the Multinomial Logit Model: Monte Carlo Comparisons." *Journal of Economic Surveys* **21**,1(2007):174–205.

Cantor, J., R. Beckman, R. Collins, M. Dastidar, A. Richardson, and T. Dubowitz. "SNAP Participants Improved Food Security and Diet After a Full-Service Supermarket Opened in an Urban Food Desert." *Health Affairs* **39**,8(2020):1386–94.

Carlson, A., and J. Kinsey. "Consumers' Retail Source of Food: A Cluster Analysis." *Family Economics and Nutrition Review* **14**,2(2002):11–20.

Carpio, C., C. Kalenskoski, A. Moyeda-Carabaza, and M. Murimi. "The Effect of Time Use and Food Cost on Dietary Qualtiy." *Public Health Nutrition* **23**,18(2020):3284–94.

Cummins, S., E. Flint, and S. Matthews. "New Neighborhood Grocery Store Increased Awareness of Food Access But Did Not Alter Dietary Habits or Obesity." *Health Affairs* **33**,2(2014):283–91.

Dong, X., and E. Zeballos. "COVID-19 Working Paper: The Effects of COVID-19 on Food Sales." Working Paper #AP-088, Economic Research Service, 2021.

Dubin, J.A., and D.L. McFadden. "An Econometric Analysis of Residential Electric Appliance Holdings and Consumption." *Econometrica* **52**,2(1984):345–62.

Dunn, R. "The Effect of Fast-Food Availability on Obesity: An Analysis by Gender, Race, and Residential Location." *American Journal of Agricultural Economics* **92**,4(2010):1149–64.

Economic Research Service (ERS), U.S. Department of Agriculture (USDA). National Household Food Acquisition and Purchase Survey (FoodAPS), 2013. Internet site: https://www.ers.usda.gov/foodaps (Accessed July 1, 2019).

Everitt, B., S. Landau, M. Leese, and D. Stahl. *Cluster Analysis*. 5th ed. London: Wiley, 2011.

Fite, E. "Sen. Gardenhire's Bill to Combat 'Food Deserts' in Tennessee Passes First Legislative Hurdle." *Chattanooga Times Free Press*, 2020. Internet site: https://www.timesfreepress.com/news/politics/state/story/2020/feb/27/sen-gardenhires-bill-combfood-deserts-tenness/516896/

Fleischhacker, S.E., K.R. Evenson, D.A. Rodriguez, and A.S. Ammerman. "A Systematic Review of Fast Food Access Studies." *Obesity* **12**(2011):E460–71.

Jeffrey-Wilensky, J. "Mayor Adams Wants to Fix Food Access. Here Are the Neighborhoods Lacking Supermarkets." *Gothamist*, 2022. Internet site: https://gothamist.com/news/mayor-adams-wants-to-fix-food-access-here-are-the-neighborhoods-lacking-supermarkets

Kirkpatrick, S., J. Reedy, L. Kahle, J. Harris, P. Ohri-Vachaspati, and S. Krebs-Smith. "Fast-Food Menu Offerings Vary in Dietary Quality, but Are Consistently Poor." *Public Health Nutrition* **17**,4(2013):924–31.

Lee, L.F. "Generalized Econometric Models with Selectivity." *Econometrica* **51**,2(1983):507–12.

Lusk, J. "Consumer Research with Big Data: Applications from the Food Demand Survey (FooDS)." *American Journal of Agricultural Economics* **99**,2(2017):303–20.

Mancino, L., J. Todd, and B. Scharadin. *USDA's National Household Food Acquisition and Purchase Survey: Methodology for Imputing Missing Quantities to Calculate Healthy Eating Index-2010 Scores and Sort Foods Into ERS Food Groups*. Washington, DC: U.S. Department of Agriculture, Economic Research Service, Technical Bulletin No. 1947, 2018.

Mancino, L., J. Todd, and B.H. Lin. "Separating What We Eat From Where: Measuring the Effect of Food Away from Home on Diet Quality." *Food Policy* **34**,6(2009):557–62.

Minaker, L., D. Olstad, M. Thompson, K. Raine, P. Fisher, and L. Frank. "Associations Between Frequency of Food Shopping at Different Store Types and Diet and Weight Outcomes: Findings from the NEWPATH Study." *Public Health Nutrition* **19**,12(2016):2268–77.

Munoz, D. "State Lists 50 Communities Eligible for Food Desert Tax Break." *NJBiz*, 2022. Internet site: https://njbiz.com/state-lists-50-communities-eligible-for-food-desert-tax-breaks/

National Household Food Acquisition and Purchase Survey (FoodAPS): User's Guide to Survey Design, Data Collection, and Overview of Datasets. Washington, DC: Department of Agriculture, 2016a.

National Household Food Acquisition and Purchase Survey (FoodAPS): Codebook: Food-at-Home Event Data – Public Use File. Washington, DC: Department of Agriculture, 2016b.

Nguyen, B., and L. Powell. "The Impact of Restaurant Consumption Among US Adults: Effects on Energy and Nutrient Intakes." *Public Health Nutrition* **17**,11(2014):2445–52.

NIH National Cancer Institute. Selected Healthy Eating Index Publications. Internet site: https://epi.grants.cancer.gov/hei/publications.html (Accessed August 1, 2020a).

NIH National Cancer Institute. Overview and Background of the Healthy Eating Index. Internet site: https://epi.grants.cancer.gov/hei/ (Accessed August 1, 2020b).

Pechey, R., and P. Monsivais. "Supermarket Choice, Shopping Behavior, Socioeconomic Status, and Food Purchases." *American Journal Preventative Medicine* **49**,6(2015):868–77.

Poti, J., K. Duffey, and B. Popkin. "The Association of Fast Food Consumption with Poor Dietary Outcomes and Obesity Among Children: Is It the Fast Food or the Remainder of the Diet?" *American Journal of Clinical Nutrition* **99**,1(2014): 162–71.

Rudi, J., and M. Cakir. "Vice or Virtue: How Shopping Frequency Affects Healthfulness of Food Choices." *Food Policy* **69**,2(2017):207–17.

Sadler, R., J. Gilliland, and G. Arku. "A Food Retail-Based Intervention on Food Security and Consumption." *International Journal of Environmental Research and Public Health* **10**,8(2013):3325–346.

Saksena, M., A. Okrent, T. Anekwe, C. Cho, C. Dicken, A. Effland, H. Elitzak et al. *America's Eating Habits: Food Away from Home*. Washington, DC: U.S. Department of Agriculture, Economic Research Service, Technical Bulletin No. 196, 2018.

Stern, D., S.W. Ng, and B. Popkin. "The Nutrient Content of U.S. Household Food Purchases by Store Type." *American Journal of Preventive Medicine* **50**,2(2016):180–90.

Stern, D., W.R. Robinson, S.W. Ng, P. Gordon-Larsen, and B.M. Popkin. "US Household Food Shopping Patterns: Dynamic Shifts Since 2000 and Socioeconomic Predictors." *Health Affairs* **34**,11(2015):1840–8.

United States Department of Agriculture Economic Research Service (USDA-ERS). Internet site: https://www.ers.usda.gov/topics/food-markets-prices/food-service-industry/ (Accessed May 5, 2022a).

United States Department of Agriculture Economic Research Service (USDA-ERS). Internet site: https://www.ers.usda.gov/topics/food-markets-prices/retailing-wholesaling/ (Accessed May 5, 2022b).

Ver Ploeg, M., P. Dutko, and V. Breneman. "Measure Food Access and Food Deserts for Policy Purposes." *Applied Economic Perspectives and Policy Access* **37**,2(2014):205–25.

Volpe, R., A. Okrent, and E. Leibtag. "The Effect of Supercenter-Format Stores on the Healthfulness of Consumers' Grocery Purchases." *American Journal of Agricultural Economics* **95**,3(2013):568–89.

Volpe, R., A. Kuhns, and T. Jaenicke. *Store Formats and Patterns in Household Grocery Purchases*. Washington, DC: U.S. Department of Agriculture, Economic Research Service, Economic Information Bulletin No. 167, 2017.

Volpe, R., E. Jaenicke, and L. Chenarides. "Store Formats, Market Structure, and Consumers' Food Shopping Decisions." *Applied Economic Perspectives and Policy* **40**,4(2018):672–94.

Yenerall, J., W. You, and J. Hill. "Beyond the Supermarket: Analyzing Household Shopping Trip Patterns that Include Food at Home and Away from Home Retailers." *BMC Public Health* **20**(2020):1747.

Wang, M., K. MacLeod, C. Steadman, L. Williams, S. Bowie, D. Herd, M. Luluquisen, and M. Woo. "Is the Opening of a Neighborhood Full-Service Grocery Store Followed by a Change in the Food Behavior of Residents?" *Journal of Hunger and Environmental Nutrition* **21**,1(2007):3–18.

White, M. "Food Access and Obesity." *Obesity Reviews* **8**,1(2007):99–107.

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