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LOW-INCOME AND LOW-ACCESS HOUSEHOLDS' EXPENDITURES ON HEALTHY FOOD AWAY FROM HOME

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ABSTRACT

Low-income and low-access (LILA) households' expenditures on healthy food away from home are analyzed by retailer type using the USDA's National Household Food Acquisition and Purchase Survey. Based on the results of Vuong model selection tests, the lognormal double-hurdle model is used to estimate households' healthy food away from home (FAFH) participation and expenditures at four retailer types: supermarkets, convenience retailers, quick-service restaurants and full-service restaurants. Results indicate that LILA households are more likely to purchase healthy FAFH from convenience retailers than non-LILA households. Participating LILA households also have greater overall expenditures on healthy FAFH. This relationship is particularly pronounced at quick-service restaurants, where participating LILA households spend 15% more than non-LILA households on healthy FAFH. Other significant findings include that households' healthy FAFH participation and expenditure decisions at each retailer type vary based on nutritional knowledge and time constraints, as well as other basic demographic, economic and geographic factors.

Key words: food away from home, low-income, low-access, food desert, healthy, demand, expenditures, participation, double-hurdle.

INTRODUCTION

Over the course of three generations, US dining habits have undergone a major transformation, with Americans cooking at home less and dining out more (Smith et al. 2013). Americans' expenditures on food away from home (FAFH) as a percentage of total food expenditures increased from 25% in 1954 to 50% in 2013 (USDA-ERS 2013). With its increasing importance in Americans' diets, FAFH is facing growing scrutiny from governmental agencies and health organizations due to its lower nutritional quality and its association with obesity (Kim et al. 2014; Fulkerson et al. 2011; Kant et al. 2014; Todd et al. 2010; Lin & Guthrie 2012). In order to address this criticism, FAFH retailers are placing emphasis on improving the healthiness of their prepared food items by offering low-calorie options, low-sodium options, healthier kids meals and fortified nutrition products (Bleich et al. 2015; Euromonitor International 2014).

Low-income and low-access (LILA) households comprise a subset of the US population that is arguably most reliant on FAFH as a source of healthy, prepared meals. An estimated 65.7 million individuals in the US live in census tracts characterized by both low-income and low-access to supermarkets (Food 2015)¹. LILA households' insecurities are compounded by high incidences of inadequate food storage, cooking knowledge, cooking equipment and access to transportation (Weatherspoon et al. 2012; Shaw 2006; Ver Ploeg 2010; Rose & Richards 2004). Thus, LILA households are often unable to prepare healthy meals at home and must instead purchase FAFH from retailers such as convenience stores and fast food restaurants.

The objective of this study is to analyze the role of healthy FAFH in the diets of LILA households.² While FAFH is defined as all meals and snacks prepared by food service establishments, past studies considering the demand for FAFH disaggregated by retailer type have only considered FAFH from restaurants (Hiemstra & Kim 1995; Jensen & Yen 1996; Redman 1980; Mutlu & Gracia 2006; Bai et al. 2012; Liu et al. 2013; Dumagan & Hackett 1995). This study is the first to consider the complete food environment by modeling household's participation and expenditure decisions for healthy FAFH from all types of retailers, including convenience stores, grocery stores, gas stations and restaurants. Considering the complete food environment is especially pertinent in low-access census tracts where gas stations and convenience stores are often the only food retailers. This study further adds to the FAFH literature by being the first to focus on the demand for FAFH from LILA households.

Specifically, this study will address the following questions: (1) at which types of retailers do LILA households make healthy FAFH purchases, (2) how does LILA location, along with geographic, demographic, economic and health factors, influence a household's

¹ A census tract is classified as low-access if there are at least 500 people with no supermarket within .5 miles (urban) or 10 miles (rural) or at least 33% of the population is more than 0.5 miles (urban) or 10 miles (rural) from the supermarket. A census tract is classified as low-income if it has at least a 20% poverty rate or household median incomes at or below 80% of the area or statewide median, whichever is greater (Food 2015).

² A qualitative classification system based on the MyPlate US Dietary Guidelines is used to identify healthy FAFH purchases in this paper.

decision to consume healthy FAFH, (3) how does LILA location, along with geographic, demographic, economic and health factors, affect a household's expenditure levels on healthy FAFH and (4) do LILA households' participation and expenditure decisions for healthy FAFH vary by retailer type.

Findings from this study will provide policymakers with a more complete understanding of the food insecurities faced by LILA households. This knowledge will help inform whether changes to food assistance programs aimed at increasing access to healthy FAFH at particular types of retailers could be successful in easing these food insecurities. Findings from this study will also help inform retail store management on their potential role in underserved LILA markets.

BACKGROUND

In response to the rapid increase in FAFH expenditures in the US, food retailers are expanding their FAFH product offerings. From 1997 to 2010, Bauer et al. (2012) found that the number of menu items offered at fast food restaurants increased by 53%. While FAFH has been synonymous with restaurants in the past, other retailers such as supermarkets and convenience stores are rapidly expanding their FAFH offerings. Jekanowski (1999) explains that these retailers are attempting to regain food dollars lost to the restaurant industry by offering their own FAFH products. Consumers have been responsive to alternative FAFH retailers, with the percentage of consumers purchasing FAFH from supermarkets, convenience stores and grocery stores more than doubling from 2009 to 2010. In 2013, 58% of households reported purchasing FAFH from quick-service restaurants at least once per week. In comparison, 37% and 32% of households reported purchasing FAFH at least once per week from grocery stores and convenience stores respectively (Data Points 2013).

With over 90% of US consumers stating that eating healthily is important, a significant portion of the new FAFH products offered by retailers are health related (Ahmad & Anders 2012; Binkley 2006; Gregory et al. 2006). Between 2009 and 2010, restaurant menu items labeled as healthy increased by 65% (Healthy 2010). Gregory et al. (2006) found that 44% of all quick-service restaurant commercials focus on healthy menu items. Supermarkets, grocery stores and convenience stores are also expanding their healthy FAFH options. Creel et al. (2008) report that these alternative retailers provide more healthy FAFH options than are available at quick-service restaurants.

With FAFH's prominent role in the American diet, many studies have analyzed the demand for FAFH. However, no study has considered the demand in the growing healthy FAFH market or the demand for FAFH from a subset of the population that is uniquely dependent on FAFH as a source of healthy, prepared meals: LILA households. In addition to low-access to supermarkets, two factors likely increase LILA households' dependence on FAFH relative to the average household: (1) lack of transportation and (2) lack of cooking facilities and/or cooking skills.

Among LILA households, Ver Ploeg (2010) found that 3.5 million did not have access to a vehicle (Ver Ploeg 2010). According to Doweler (2008), over 20% of individuals without a car reported having difficulty getting to a supermarket. Fitzpatrick & Ver Ploeg

(2013) also found that individuals that do not own a vehicle spend more of their total food budget on FAFH. LILA households' dependence on FAFH is further compounded by a lack of cooking facilities and cooking skills. Shaw (2006), White et al. (2004) and Weatherspoon et al (2012) found that households that lack cooking facilities and cooking skills are more likely to purchase FAFH.

THEORETICAL FRAMEWORK

A commonality amongst all past studies on the demand for FAFH by retailer type is the use of Becker's Household Production Theory (HPT) to model the FAFH market and this study is no exception (Hiemestra & Kim 1995; Jensen & Yen 1996; Redman 1980; Mutlu & Gracia 2006; Bai et al. 2012; Liu et al. 2013). HPT assumes that households are both consumers and producers (Becker 1965). Put in terms of healthy FAFH, households have the choice of whether to purchase prepared, healthy meals (FAFH) or to prepare healthy meals themselves (food at home (FAH)).

Following McCracken and Brandt (1987), this study alters the HPT framework to account for demand from multiple types of FAFH retailers. Mathematically, households maximize the following utility function subject to the household production function (2), a time constraint (3) and an income constraint (4):

$$U = (z_i, D) \quad (1)$$

$$st \ z_i = f_i(x_i, t_{i1}, \dots, t_{im}) \quad i = 1, 2, \dots, n \quad (2)$$

$$T_k = h_k + \sum_{i=1}^n t_{ik} \quad k = 1, 2, \dots, m \quad (3)$$

$$\sum_{k=1}^m w_k h_k + v = \sum_{i=1}^n p_i x_i \quad (4)$$

where z_i represents commodity i produced in the household, x_i is the market good i used to produce z_i , D is a vector of demographic and household characteristic variables, t_{ik} is the time spent by household member k to produce z_i , T_k is the total time available to household member k , h_k is the time input by household member k in the labor market, w_k is the wage rate of household member k , v is unearned income and p_i is the price of the market good x_i .

In this study, maximization of the utility function described in equations 1-4 will result in the following demand function for healthy FAFH from the j th retailer type:

$$x_j = f_j(p_j, w_1, \dots, w_m, v, D). \quad (5)$$

The household expenditure function for healthy FAFH at retailer type j can then be obtained by multiplying equation 5 by price as follows:

$$Exp_j = p_j x_j = f_j(w_1, \dots, w_m, v, D). \quad (6)$$

DATA

Household food acquisition, demographic, economic and health data were obtained from the National Household Food Acquisition and Purchase Survey (FoodAPS). FoodAPS is the first nationally representative survey to collect comprehensive data on households' FAH and FAFH acquisitions in the US. Developed jointly by the Economic Research Service

(ERS) and the Food and Nutrition Service (FNS), FoodAPS was administered by Mathematica Policy Research to 4,826 households between April 2012 and January 2013 (FoodAPS 2015). Households were deliberately sampled from four population subgroups based on income and SNAP participation, making the data set ideal for studying LILA households. Each household participating in the FoodAPS survey completed entry and exit surveys, along with a one-week food acquisition diary, in which they listed all FAH and FAFH purchases.

Because this study focuses specifically on the demand for healthy FAFH, the healthfulness of each of the 91,983 FAFH items in the FoodAPS dataset was evaluated. Currently, quantitative nutritional information, such as calories, is not available for each FAFH item in the FoodAPS data set. Thus, this study follows Creel et al.'s (2008) approach and uses a relative classification system based on the MyPlate US Dietary Guidelines to identify healthy food items. This classification system was chosen to facilitate the use of this study's findings by policy makers; federal food assistance programs such as Women, Infants and Children (WIC) and the National School Lunch Program already use the US Dietary Guidelines to classify healthy food items (Women 2014; National 2014). Figure 1 in Appendix A details how the US Dietary Guidelines were used to label FAFH items in each of the MyPlate food groups as healthy. In general, food items that were fried, sautéed, breaded or contained added sugar or fat were classified as unhealthy. However, food items that were raw, grilled, boiled, steamed, baked or were labeled as low-fat, fat-free, zero-calorie, whole-grain or lean were classified as healthy.

After removing both unhealthy and free FAFH items, the data sample consisted of 20,046 healthy FAFH items. Overall expenditures on healthy FAFH items were then aggregated for each household, resulting in 4,826 observations. Each household's total healthy FAFH expenditures were also aggregated for each of the four retailer types considered in this study: supermarkets, convenience retailers, quick-service restaurants and full-service restaurants. Figure 2 in Appendix A provides a complete list of the NAICS classifications included within each of the four retailer categories.

Of the 4,826 households in the data set, 122 had monthly incomes more than two standard deviations from the mean. These ultra-wealthy households were removed from the dataset so as to not distort the relationship between the LILA and non-LILA households, resulting in a final sample size of 4,704 households.

METHODS

The Zero Expenditure Problem

A common issue when analyzing consumer expenditure data is the presence of a large number of zero expenditures (Angulo et al. 2006). This problem is known as the censored dependent variable problem, or more commonly as the zero expenditure problem (Wooldridge 2010). There are three possible reasons zero expenditures on healthy FAFH occur: (1) corner solutions, (2) abstention and (3) infrequency of purchase (Pudney 1989). A corner solution implies that households choose not to purchase healthy FAFH given the economic environment, while abstention implies that households choose not to purchase

Table 1. Vuong Tests for Model Selection: Censored Tobit (CT) vs Lognormal Double Hurdle (LDH)

Retailer Type	Vuong Test Statistic	Critical Value	Model Selection
All Retailers	25.72***	2.58	LDH
Supermarkets	24.25***	2.58	LDH
Convenience	15.17***	2.58	LDH
QS Restaurant	13.50***	2.58	LDH
FS Restaurant	31.27***	2.58	LDH

*** the null hypothesis is rejected at the 1% level

healthy FAFH independent of economic factors. Under infrequency of purchase, a households' purchase cycle for healthy FAFH is longer than the survey period.

Past studies on the demand for FAFH have considered three main types of models when correcting for the zero expenditures problem: (1) censored tobit models, (2) double-hurdle models and (3) infrequency of purchase models. Censored tobit models imply that zero expenditures are the result of a corner solution, or economic factors (Wooldridge 2010). While the censored tobit model accounts for the zero expenditures problem, it is restrictive in that the same mechanism governs both the expenditure and participation decisions. The double-hurdle model overcomes this restriction by modeling a two-step decision process. In the first step, or the participation decision, the household decides whether to purchase healthy FAFH. In the second step, or the expenditure decision, the household decides its expenditure level on healthy FAFH. This approach allows for zero expenditures to be the result of both economic factors and abstention. As is evident from its name, the infrequency of purchase models attributes zero expenditures to infrequency of purchase.

In this study, the censored-tobit (CT) and lognormal double-hurdle (LDH) models are estimated for overall FAFH purchases and FAFH purchases by retailer type.³ The LDH was chosen over the more commonly used truncated normal double-hurdle model because it has been shown to produce more robust estimates (Hsu & Liu 2008). A Vuong test for non-nested models is used to determine which of the two models best fits the data. The null hypothesis of the Vuong test is:

$$H_0: E[\ell_{i1}(\theta_1^*)] = E[\ell_{i2}(\theta_2^*)] \quad (7)$$

where $\ell_{i1}(\theta_1^*)$ and $\ell_{i2}(\theta_2^*)$ are the log-likelihood functions of the LDH model and CT model respectively (Wooldridge 2010). The Vuong test statistic is given by:

$$VMS = \frac{N^{-.5} \sum_{i=1}^N [\ell_{i1}(\hat{\theta}_1) - \ell_{i2}(\hat{\theta}_2)]}{\{N^{-1} \sum_{i=1}^N [\ell_{i1}(\hat{\theta}_1) - \ell_{i2}(\hat{\theta}_2)]^2\}^{.5}} \xrightarrow{d} Normal(0,1). \quad (8)$$

The results of the Vuong test for each retailer type are shown in Table 1. The null hypothesis that the CT and LDH models fit the data equally well is strongly rejected for each of the five models in favor of the LDH model. Thus, the LDH model is used to model

³ The infrequency of purchase model is not estimated due to the length of the survey period and the fact that no past studies on FAFH demand in the US have found infrequency of purchase to be the explanation for zero expenditures.

households healthy FAFH participation and expenditure decisions in this study.

The Lognormal Double-Hurdle Model

In the LDH model, a household's healthy FAFH participation and expenditure decision are modeled as follows:

$$y = s \cdot w^* = 1[x\gamma + v > 0] \exp(x\beta + \mu) \tag{9}$$

$$u|x \sim Normal(0, \sigma^2)$$

where s is a binary indicator of healthy FAFH participation, w^* is a continuous random variable with a lognormal distribution representing expenditure on healthy FAFH and x is a set of explanatory variables (Wooldridge 2010). The log-likelihood function for the LDH model is:

$$\ell_i(\theta) = 1[y_i = 0] \log[1 - \Phi(x_i\gamma)] + 1[y_i > 0] \log[\Phi(x_i\gamma)] \tag{10}$$

$$+ 1[y_i > 0] \left\{ \log \left(\phi \left[\frac{\log(y_i) - x_i\beta}{\sigma} \right] \right) - \log(\sigma) - \log(y_i) \right\}$$

Estimation of the LDH model is broken into two steps. In the first step, a probit regression of s_i on x_i is estimated to model the participation decision. In the second step, an OLS regression of $\log(y_i)$ on x_i is estimated to model the expenditure decision. While the resulting coefficients from the LDH model give the direction of the effect of the explanatory variables on participation or expenditures, partial effects and semi-elasticities must be calculated to interpret the magnitude of the coefficients. The average partial effect of participation (APE) and the semi-elasticity of conditional expected expenditures (CSE) are calculated as follows:

$$APE = \frac{\partial P(y>0|x)}{\partial x} = \Phi(x\gamma_j) \tag{11}$$

$$CSE = \frac{\partial \log(E(y|x, y>0))}{\partial x} = 100 * \beta_j \tag{12}$$

Description of Explanatory Variables

Table 2 defines the explanatory variables that comprise x_i in this study. The explanatory variables can be grouped into four categories: (1) geographic, (2) health, (3) economic and (4) demographic variables. While the explanatory variables are allowed to vary between the participation and expenditure decisions, it is common practice to include the same variables in both equations.

The geographic variable category includes the main variable of interest in this study, whether a household is located in a LILA census tract. The association between LILA households and healthy FAFH participation is expected to vary by retailer type. Due to the issue of low-access, LILA households are expected to be less likely to purchase healthy

Table 2. Description of Independent Variables

Variable	Variable Description
Geographic	
LILA	Household is below the poverty threshold and is located in a low-access census tract
Population Density	Census tract population per square mile
Rural	Household is located in a rural census tract
Has Car	Household owns or leases a vehicle
Northeast	Household located in the Northeastern region of the US
Midwest	Household located in the Midwestern region of the US
South	Household located in the Southern region of the US
Health	
BMI	Body mass index of the primary survey respondent (self-reported)
Healthy Cost	Primary survey respondent feels it costs too much to eat healthy foods
Healthy Time	Primary survey respondent is too busy to take time to prepare healthy foods
Nutrition Search	Primary survey respondent has searched the internet for nutrition information in the last 2 months
Economic	
Income	Monthly household income in dollars
Employed	Primary survey respondent is employed
SNAP	Household receives SNAP benefits
Total FAFH Expenditure	Household expenditures on all FAFH during the survey period in dollars
Demographic	
Household Size	Number of people living in household, excluding guests
Age	Age of primary survey respondent
Education	Education level of primary survey respondent
Married	Primary survey respondent is married
Kids	Primary survey respondent has children
African-American	Primary survey respondent is African-American
Hispanic	Primary survey respondent is Hispanic
Asian	Primary survey respondent is Asian
Female	Primary survey respondent is female

FAFH from supermarkets. Conversely, LILA households are predicted to be more likely to consume healthy FAFH from convenience retailers; these retailer types are prevalent in LILA communities and offer lower-priced food items (Sharkey et al 2009; Powell et al. 2007). While participation is expected to vary by retailer type, LILA households are expected to have lower expenditures than non-LILA households at all retailer types. By definition, LILA households are below the poverty threshold and thus have less disposable income to spend on healthy FAFH irrespective of retailer type.

Geographic variables are also included to account for urbanization, population density, vehicle access and geographic region. Several studies have shown that rural households are less likely to consume FAFH, likely due to their lack of proximity to food retailers (Redman 1980; Binkley 2006; Parks & Capps 1997). Vehicle ownership is expected to have a positive effect on healthy FAFH participation and expenditures due to the fact that nearly 25% of consumers purchase FAFH because they realize they're hungry while 'on the go' (Driggs 2015). Nearly all studies have also included dummy variables for geographic regions. While findings have been mixed, one consistent conclusion is that households located in the Southern region of the U.S. tend to have higher expenditures on fast food (Binkley 2006; Byrne et al. 1998; Jekanowski et al. 2001).

A handful of studies have also considered the association between health variables and FAFH participation and expenditures. Richards & Mancino (2013) and Binkley (2006) found that body mass index (BMI) is positively related to expenditures at all restaurant types. This study also includes the variable 'nutrition search' to account for whether the household

head uses the internet to search for nutrition information. While past studies have found that dietary knowledge is inversely related to overall FAFH expenditures, the nutrition search variable is expected to be positively related to healthy FAFH expenditures (Stewart et al. 2005; Binkley 2006). Two variables are also included to account for why households do not prepare healthy meals at home. The first variable, healthy cost, is a dummy variable indicating that the household feels eating healthy foods is too expensive. The relationship between this variable and FAFH expenditures is expected to vary by restaurant type. Binkley (2006) found that the importance a household places on price is positively related to expenditures at fast food restaurants. However, sit-down restaurant expenditures are likely lower amongst households concerned about the cost of healthy meals. The second variable, healthy time, is a dummy variable indicating that households do not prepare healthy meals due to time constraints. Binkley (2006) and McCracken & Brandt (1987) found that the importance a household places on the convenience of a meal is positively associated with FAFH expenditures.

There is a well-established relationship between the main economic variable, income, and FAFH participation and expenditures. Nearly all studies found that household income is positively related and income squared is inversely related to FAFH participation and expenditures (Liu et al. 2013; Bai et al. 2010; Lee & Tan 2006; Byrne et al. 1996; Jensen & Yen 1996; Jekanowski et al. 2001; Stewart et al. 2004; Binkley et al. 2006). This implies that as a household's disposable income increases, it increases its expenditures on FAFH at a decreasing rate. As predicted by HPT, there is also a strong relationship between employment and FAFH consumption due to the time constraints associated with working (Mutlu & Gracia 2006; Bai et al. 2012; Stewart et al. 2004). Further, past studies have considered the relationship between receiving SNAP benefits and FAFH demand, finding that SNAP benefits are inversely related to participation and expenditures on FAFH (Binkley 2006; Liu et al. 2013). However, these studies did not consider FAFH purchases from retailers that accept SNAP benefits for certain FAFH items such as supermarkets and convenience stores. This study hypothesizes that receiving SNAP benefits is positively associated with expenditures at retailer types that accept SNAP.

The literature also suggests that demographic variables significantly impact a household's demand for FAFH. Household size and education are typically positively related to both the participation and expenditure decisions for FAFH (Liu et al. 2013; Mutlu & Gracia 2006; Bai et al. 2012; Stewart et al. 2004; Richards & Mancino 2013). However, Stewart et al. (2004) found that larger household's tend to have lower expenditures at sit-down restaurants due their higher prices relative to other restaurant types. Unlike household size and education, the majority of past studies have found age to be inversely related to FAFH participation and expenditures due to generational differences in dining habits (Binkley 2006; Stewart et al. 2004; Liu et al. 2013; Richards & Mancino 2013). Demographic variables such as marital status, number of children, gender and race have been included in nearly all past studies, but no consistent findings have been documented.

RESULTS

Descriptive Statistics

Of the 4,704 households included in the study, 23% are located in LILA census tracts

Table 3. Household FAFH Participation by Access Level and Food Type (N=4,704)

	LILA (N=1,282)		Non-LILA (N=3,422)	
	Frequency	%	Frequency	%
Healthy FAFH	623	49%	2,256	66%
All FAFH	1,124	88%	3,123	91%

and 73% are located in non-LILA census tracts. Of particular interest, are the differences in participation and expenditures on healthy FAFH. Household FAFH participation by access level is presented in Table 3. During the survey period, 49% of LILA households and 66% of non-LILA households purchased healthy FAFH, a 17% difference. However, there is only a 3% difference in the percentage of households purchasing all FAFH, with 88% and 91% of LILA and non-LILA households participating respectively. This implies that while the two populations are almost equally likely to consume FAFH, LILA households are less likely to consume healthy FAFH.

Also noteworthy are the differences in household participation by retailer type. As shown in Table 4, LILA households make fewer visits than non-LILA households to purchase healthy FAFH from all types of retailers. When LILA households do purchase healthy FAFH, 44% of their acquisitions come from quick-service restaurants, followed by 35% from full-service restaurants, 13% from convenience retailers and 8% from supermarkets. Compared to non-LILA households, a greater percentage of LILA households FAFH acquisitions occur at supermarkets and convenience stores. However LILA households have fewer acquisitions at full-service restaurants than do non-LILA households.

Table 4 also presents descriptive statistics on households' healthy FAFH expenditures by retailer type. In terms of overall expenditures, LILA households spent on average \$31.27 less on healthy FAFH than non-LILA households during the survey period. Expenditures on healthy FAFH are also lower at each of the four retailer types considered in this study, particularly at restaurants. On average, LILA households spent \$9.77 and \$19.77 at quick-service and full-service restaurants, while non-LILA households spent \$16.01 and \$41.33 respectively.

Descriptive statistics of each of the independent variables are presented in Table 5. Mean comparison tests strongly support that LILA and non-LILA households are two distinct subgroups of the population; the means of nearly all variables significantly differ between the two groups. The descriptive statistics also highlight key differences in the two populations demographics. LILA household heads are 18% less likely to be married than non-LILA households, yet they are 11% more likely to have children. Minorities also comprise a higher percentage of the population in LILA census tracts; 22% and 23% of LILA residents identify as African-American and Hispanic respectively. The mean comparison tests also suggest that LILA residents' lifestyles are less healthy than those of non-LILA households. Not only do LILA residents tend to have higher BMIs than non-LILA residents, they are also 8% less likely to search for nutritional information online.

The mean comparison tests further emphasize the stark differences in the economic status of LILA and non-LILA households. Household heads in LILA census tracts are 26%

Table 4. Visits & Expenditures on Healthy FAFH by Access Level & Retailer Type (N=4,704)

	LILA (N=1,282)			Non-LILA (N=3,422)		
	Mean	SD	%	Mean	SD	%
Number of Visits						
All Retailers***	2.02	3.48	100%	3.43	4.81	100%
Supermarket*	0.16	0.81	8%	0.22	1.39	6%
Convenience***	0.27	0.97	13%	0.36	1.26	10%
QS Restaurant***	0.89	1.84	44%	1.46	2.43	43%
FS Restaurant***	0.70	2.10	35%	1.39	2.83	41%
Expenditures						
All Retailers***	37.12	150.05	100%	68.39	110.76	100%
Supermarket	3.24	36.24	9%	3.77	50.76	6%
Convenience**	1.77	10.19	5%	3.21	26.65	5%
QS Restaurant***	9.77	27.75	26%	16.01	42.04	23%
FS Restaurant***	19.74	91.48	53%	41.33	119.02	60%

*Means differ at the 0.10 level, ** 0.05 level and *** 0.01 level

less likely to be employed relative to non-LILA households. This lack of employment, along with lower levels of education, helps explain LILA households' significantly lower household incomes. On average, LILA households earn a monthly income of \$781.89 while non-LILA households earn a monthly income of \$3,811.38. This corresponds with the higher incidence of households receiving SNAP benefits in LILA census tracts, 62%, versus non-LILA households, 23%. Lower household income also likely explains the disparities in vehicle ownership between the two groups; 88% of non-LILA households own or lease a vehicle versus only 72% of LILA households.

Lognormal Double-Hurdle Model Estimates

The log-likelihood function of the lognormal double-hurdle model (LDH) shown in Equation 10 was maximized for each type of FAFH retailer in order to model households' expenditures on healthy FAFH. The LDH model estimates of households' healthy FAFH participation and expenditure decisions for each retailer type are presented in Table 6. Pseudo r-squared values ranged from 0.17 to 0.25, which are respectable for cross-sectional data. In order to facilitate interpretation of the LDH model estimates, the average partial effects of participation (APE) and the semi-elasticities of conditional expected expenditures (CSE) are also presented in Table 7.

Considering first the main population sub-group of interest, LILA households, the LDH estimates show that overall healthy FAFH participation does not vary based on LILA census tract location. However, the LILA dummy variable is positively and significantly related to participation at convenience retailers, which in this study include retailers such as convenience stores, gas stations and pharmacies. With an APE of 0.03, LILA households are 3% more likely to purchase healthy FAFH from convenience retailers than non-LILA households. This relationship corresponds with past studies findings that convenience retailers are readily accessible to LILA households due to their high concentration in LILA census tracts (Sharkey et al 2009; Powell et al. 2007).

A priori, this study hypothesized that LILA households would be less likely to purchase healthy FAFH from supermarkets because, by definition, they lack access to

Table 5. Descriptive Statistics by Access Level (N=4,704)

Variables	LILA Household (N=1,282)		Non-LILA Household (N=3,422)	
	Mean	SD	Mean	SD
Dependent				
Total Healthy FAFH Exp.***	37.12	150.05	68.39	110.76
Spmkt. Healthy FAFH Exp.	3.24	36.26	3.77	50.76
Conv. Healthy FAFH Exp.**	1.77	10.19	3.21	26.65
QSR Healthy FAFH Exp.***	9.77	27.75	16.01	42.04
FSR Healthy FAFH Exp.***	19.74	91.48	41.33	119.02
Healthy FAFH Participation***	0.49	0.5	0.66	0.47
Geographic				
Population Density***	3,380.44	4,839.68	6,043.67	11,954.80
Rural	0.27	0.44	0.27	0.45
Has Car***	0.72	0.45	0.88	0.33
Northeast***	0.12	0.32	0.18	0.39
Midwest	0.23	0.42	0.25	0.43
South ***	0.46	0.50	0.34	0.47
Demographic				
Household Size***	3.07	1.88	2.88	1.67
Age***	43.81	15.94	46.84	16.53
Education***	19.32	2.88	20.33	2.69
Married***	0.28	0.45	0.46	0.49
Kids***	0.51	0.5	0.4	0.49
African-American***	0.22	0.41	0.13	0.34
Hispanic**	0.23	0.42	0.19	0.39
Asian***	0.02	0.15	0.05	0.21
Female	0.75	0.43	0.73	0.44
Economic				
Income***	781.89	671.73	3,811.38	2,601.86
Employed***	0.26	0.44	0.52	0.5
SNAP***	0.62	0.49	0.23	0.42
Total FAFH Exp.***	92.23	104.12	104.08	97.93
Health				
BMI***	29.35	7.59	28.54	6.78
Healthy Cost	0.45	0.50	0.42	0.49
Healthy Time***	0.16	0.36	0.22	0.42
Nutrition Search***	0.20	0.40	0.28	0.45

*Means differ at the 0.10 level, ** 0.05 level and *** 0.01 level

supermarkets. While the LILA coefficient is negative, it is not significantly related to healthy FAFH participation at supermarkets. A possible explanation for this result is Ver Ploeg’s (2010) finding that despite having low-access and lower rates of vehicle ownership, 93% of LILA households are able to travel to supermarkets using a vehicle. Thus, despite having no supermarkets in the vicinity of their home, LILA households are equally as likely as non-LILA households to purchase healthy FAFH at supermarkets. There is also no significant relationship between the LILA dummy variable and participation at quick-service and full-service restaurants. Thus, LILA and non-LILA households are equally likely to purchase healthy FAFH from restaurants.

While LILA and non-LILA households are equally likely to purchase healthy FAFH, LILA households have greater expenditures on overall healthy FAFH. On average, the CSE implies that participating LILA households spend 16% more on healthy FAFH than non-LILA households. Disaggregating expenditures by retailer type, the LDH estimates show a significant positive relationship between the LILA dummy variable and expenditures on healthy FAFH at quick-service restaurants. Comparatively, participating LILA households spend 15% more on healthy FAFH from quick-service restaurants than non-LILA

Table 6. Lognormal Double-Hurdle Model Estimates of Household Healthy FAFH Participation and Expenditures

Participation Decision	All Retailers	Supermarkets	Convenience	QS Restaurant	FS Restaurant
Geographic					
LILA	-0.01	-0.05	0.13*	0.02	-0.01
Population Density	5.79E-06**	6.40E-08	1.17E-06	7.15E-06***	7.72E-06***
Rural	-0.44***	-0.24***	-0.05	-0.40***	-0.23***
Has Car	0.11**	-0.03	0.07	0.18***	0.10
Northeast	-0.04	-0.18*	0.30***	-0.20***	-0.04
Midwest	-0.08	-0.20**	0.01	-0.14**	-0.07
South	0.02	-0.04	0.02	-0.02	0.05
Demographic					
Household Size	1.24E-03	0.06***	0.07***	0.02	-2.67E-03
Age	-0.01***	2.46E-03	-0.01**	-0.01***	9.65E-05
Education	0.04***	0.01	0.02*	0.04***	0.04***
Married	0.04	0.04	0.01	0.08*	0.08*
Kids	0.07	-0.05	0.02	0.06	-0.15***
African-American	-0.14**	0.06	-0.29***	-0.10*	-0.20***
Hispanic	0.15**	0.12	0.06	-0.01	0.09
Asian	-0.03	-0.12	-0.42***	-0.14	0.01
Female	0.12***	-0.06	0.04	0.10**	0.14***
Economic					
Income	1.23E-04***	1.20E-05	1.11E-04***	1.32E-04***	1.13E-04***
Income Squared	-4.88E-09**	-6.10E-10	-6.11E-09**	-7.10E-09***	-4.01E-09*
Employed	0.11**	0.06	0.17***	0.04	0.07
SNAP	-0.20***	0.04	0.13**	-0.13**	-0.26***
Total FAFH Expenditure	9.06E-04***	6.19E-04**	-1.17E-05	4.15**	5.51E-04***
Health					
BMI	0.01**	5.87E-04	0.01*	0.01*	0.01***
Healthy Cost	-0.06	0.04	-0.01	-0.03	-0.13***
Healthy Time	0.19***	0.25***	0.02	0.28***	0.15***
Nutrition Search	0.17***	0.10	0.16***	0.13***	0.15***
Expenditure Decision	All Retailers	Supermarkets	Convenience	QS Restaurant	FS Restaurant
Geographic					
LILA	0.16*	0.23	0.16	0.15*	0.15
Population Density	8.31E-06***	8.10E-06	4.76E-06	-1.49E-07	3.26E-06
Rural	-0.02	0.06	0.10	-0.05	-0.08
Has Car	0.24***	-0.19	0.29*	0.16**	0.19*
Northeast	-0.12	0.29	0.10	-0.20**	-0.14
Midwest	-0.14*	0.49*	-0.15	-0.14*	-0.08
South	-0.18	0.12	-0.09	-0.03	-0.02
Demographic					
Household Size	0.06***	-0.04	0.04	0.07***	0.02
Age	0.01***	0.01	0.01	1.20E-04	0.01***
Education	0.03***	1.33E-03	-0.04	0.01	0.02
Married	0.16***	-0.22	-0.20*	0.09*	0.18**
Kids	-0.11	0.06	-0.08	0.10	-0.06
African-American	-0.30***	-0.09	-0.36**	-0.16**	-0.24**
Hispanic	0.01	-0.10	-0.10	0.11	-3.44E-03
Asian	-0.03	0.40	0.64*	-0.31***	0.03
Female	0.10*	-0.17	0.01	0.02	-0.02
Economic					
Income	5.54E-04	7.48E-05	2.76E-05	5.98E-05*	-3.07E-06
Income Squared	1.95E-09	-3.77E-09	1.39E-09	-2.42E-09	4.34E-09
Employed	0.09	-0.28	-0.02	0.03	0.06
SNAP	-0.34***	-0.24	-0.07	-0.20***	-0.35***
Total FAFH Expenditure	5.53E-04**	7.72E-04	3.86E-04	1.03E-04	4.52E-04
Health					
BMI	0.01**	-0.01	-1.26E-03	0.01	-0.01
Healthy Cost	-0.10*	0.12	-0.03	-0.02	-0.08
Healthy Time	0.16***	0.11	0.07	0.06	0.03
Nutrition Search	0.10*	-0.38**	-0.04	0.07	0.03
Log Likelihood	-15,251.74	-1893.12	-2,353.82	-8,359.94	-7,869.94
Pseudo R-Squared	0.25	0.18	0.17	0.22	0.21

households. At the other three types of FAFH retailers, the LILA dummy variable is also positively related to healthy FAFH expenditures, however the relationships are not statistically significant. These findings are noteworthy in that they suggest LILA households rely more heavily on FAFH retailers, particularly quick-service restaurants, as a source of healthy FAFH than do non-LILA households.

Turning to the other geographic variables included in the model, the LDH estimates indicate that rural households are less likely to participate at all retailer types except convenience retailers. This finding is supported by the fact that convenience stores are the most common food retailers in rural communities (Liese et al. 2007; Powell et al. 2007). However, when rural households do decide to participate, their expenditure levels on healthy FAFH are not significantly different from those of non-rural households. The LDH estimates also indicate that vehicle ownership increases the likelihood that households will purchase healthy FAFH overall and from quick-service restaurants. Specifically, households that own or lease a vehicle are 7% more likely to purchase healthy FAFH from quick-service restaurants. This relationship is likely the result of the fact that automobile usage and fast food restaurants are inextricably linked, with fast food restaurants emerging during the 1940s and 1950s to cater to the growing number of automobiles (Freund & Martin 2008). Vehicle ownership is also associated with higher average household expenditures on healthy FAFH at all retailers except supermarkets. Several of the regional dummy variables are also significant, suggesting that there are regional differences in where households purchase healthy FAFH and their expenditure levels. The final geographic variable, population density has a significant effect on both healthy FAFH participation and expenditures, but its effects are marginal.

There are several relationships of note between the health variables and healthy FAFH participation and expenditures. Healthy cost, i.e. the primary survey respondent feels healthy foods are too expensive, is inversely related to participation at full-service restaurants. This relationship is logical in that meal prices tend to be higher at full-service restaurants. Households that feel healthy foods are too expensive also spend 10% less overall on healthy FAFH. Estimation results further indicate that the variable healthy time has a significant positive relationship with healthy FAFH participation at all retailer types except supermarkets. Specifically, households that feel they are too busy to prepare healthy FAFH are 7% more likely to purchase healthy FAFH from all retailers and 3%, 11% and 5% more likely to purchase healthy FAFH from supermarkets, quick-service restaurants and full-service restaurants respectively. This relationship is derived from household production theory, under which time constrained consumers choose to purchase healthy FAFH instead of expending the time preparing healthy FAFH themselves. Notice that the APE is particularly pronounced at quick-service restaurants, 11%, a retailer type that is synonymous with time savings (Jekanowski et al. 2001). The healthy time variable also influences the expenditure decision, with time constrained households spending on average 16% more on healthy FAFH.

In addition to the monetary and opportunity costs associated with healthy food, knowledge of nutrition also significantly affects healthy FAFH consumption. Households that use the internet to search for nutritional information are 7% more likely to consume

Table 7. Average Partial Effects and Semi-Elasticities of Household Healthy FAFH Participation and Expenditures

Variables	All Retailers		Supermarkets		Convenience		QS Restaurants		FS Restaurants	
	APE	CSE	APE	CSE	APE	CSE	APE	CSE	APE	CSE
Geographic										
LILA	-0.01	16.00***	-0.01	23.00	0.03*	16.00	0.01	15.00*	-2.63E-03	15.00
Population Density	2.20E-06**	8.31E-04***	8.38E-09	8.10E-04	0.000000247	4.76E-04	2.77E-06***	-1.49E-05	2.66E-06***	3.26E-04
Rural	-0.17***	-2.00	-0.03***	6.00	-0.01	10.00	-0.16***	-5.00	-0.08***	-8.00
Has Car	0.04*	24.00***	-0.00349	-19.00	0.02	29.00*	0.07***	16.00**	0.03	19.00*
Northeast	-0.02	-12.00	-0.02*	29.00	0.06***	10.00	-0.08***	-20.00**	-0.01	-14.00
Midwest	-0.03	-14.00*	-0.03**	49.00*	1.91E-03	-15.00	-0.06**	-14.00*	-0.03	-8.00
South	0.01	-18.00	-0.01	12.00	0.01	-9.00	-0.01	-3.00	0.02	-2.00
Demographic										
Household Size	4.69E-04	6.00***	0.01***	-4.00	0.01***	4.00	0.01	7.00***	-9.18E-04	2.00
Age	-1.59E-03***	1.00***	3.22E-04	1.00	-8.28E-04**	1.00	-1.82E-03***	0.01	3.32E-05	1.00***
Education	0.01***	3.00***	1.22E-03	0.13	0.01*	-4.00	0.02***	1.00	0.02***	2.00
Married	0.01	16.00***	0.01	-22.00	2.34E-03	-20.00*	0.03*	9.00*	0.03*	18.00**
Kids	0.03	-11.00	-0.01	6.00	3.24E-03	-8.00	0.03	10.00	-0.05***	-6.00
African-American	-0.05**	-30.00***	0.01	-9.00	-0.06***	-36.00**	-0.04*	-16.00**	-0.07***	-24.00**
Hispanic	0.06**	1.00	0.02	-10.00	0.01	-10.00	-3.41E-03	11.00	0.03	-0.34
Asian	-0.01	-3.00	-0.02	40.00	-0.09***	64.00*	-0.06	-31.00***	2.06E-03	3.00
Female	0.04**	10.00*	-0.01	-17.00	0.01	1.00	0.04**	2.00	0.05***	-2.00
Economic										
Income	4.86E-05***	0.06	1.57E-06	0.01	2.35E-05***	2.76E-03	5.14E-05***	5.98E-03*	3.87E-05***	-3.07E-04
Income Squared	-1.85E-09*	1.95E-07	-7.98E-11	-3.77E-07	-1.29E-09**	1.39E-07	-2.76E-09***	-2.42E-07	-1.38E-09	4.34E-07
Employed	0.04**	9.00	0.01	-28.00	0.04***	-2.00	0.02	3.00	0.03	6.00
SNAP	-0.08***	-34.00***	0.01	-24.00	0.03**	-7.00	-0.05***	-20.00***	-0.09***	-35.00***
Total FAFH Expenditure	3.44E-04***	0.06**	8.09E-05**	0.08	-2.47E-06	0.04	1.61E-04**	0.01	-0.08***	0.05
Health										
BMI	2.29E-03**	1.00**	7.67E-05	-1.00	1.29E-03*	-0.13	1.83E-03*	1.00	3.26E-03***	-1.00
Healthy Cost	-0.02	-10.00*	0.01	12.00	-1.31E-03	-3.00	-0.01	-2.00	-0.04***	-8.00
Healthy Time	0.07***	16.00***	0.03***	11.00	0.01	7.00	0.11***	6.00	0.05***	3.00
Nutrition Search	0.07***	10.00*	0.01	-38.00**	0.03***	-4.00	0.05***	7.00	0.05***	3.00

Note: standard errors were calculated using the delta method

and have 10% higher expenditures on healthy FAFH. Nutrition searches also have a significant positive relationship with participation at all retailer types except supermarkets, at which these households spend 38% less on healthy FAFH. Individuals that actively use nutrition information to inform healthy FAFH purchases may have been less likely to purchase from supermarkets during the survey period due to labeling changes brought about by the 2010 Patient Protection and Affordable Care Act. Under the Act, FAFH retailers with 20 or more locations are required to display calories for all menu items by 2016 (FDA 2014; Questions 2014). While most chain restaurants have already implemented calorie count displays, supermarkets have been slow to follow suit. Thus, households actively searching for healthy FAFH may avoid supermarkets where the nutritional composition of FAFH is less transparent. The final health variable, BMI, is associated with a 1% increase in overall healthy FAFH expenditures. However, its effect on healthy FAFH participation is marginal at all retailer types.

Of particular interest amongst the economic variables, are the coefficients for SNAP participation. The APEs indicate that households receiving SNAP benefits are 8% less likely to consume healthy FAFH overall and are 5% and 9% less likely to consume healthy FAFH at quick-service and full-service restaurants respectively. However, households receiving SNAP benefits are 3% more likely to purchase healthy FAFH from convenience retailers. While the relationship between receiving SNAP benefits and supermarket participation is positive, the coefficient is not significant. This finding may be due to the relatively small number of positive expenditures at supermarkets. The relationship between participation and receiving SNAP benefits is most likely the result of the retailer types that accept SNAP benefits; supermarkets and convenience stores accept SNAP benefits for certain FAFH products, while restaurants do not. Receiving SNAP benefits is also associated with spending 34% less on healthy FAFH from all retailers, as well as lower expenditures at both types of restaurants.

The remaining economic variables support the findings from past studies, including that employment has a significant effect on healthy FAFH participation; households with employed adults are 4% more likely to purchase healthy FAFH from all retailer and convenience retailers (Mutlu & Gracia 2006; Bai et al. 2012; Stewart et al. 2004). The coefficient estimates for income's effect on participation also confirm the findings of past studies: income is positively related to healthy FAFH participation, while income squared is inversely related to healthy FAFH participation for all retailer types except supermarkets (Liu et al. 2013; Bai et al. 2010; Lee & Tan 2006; Byrne et al. 1996; Jensen & Yen 1996; Jekanowski et al. 2001; Binkley et al. 2006). However, unlike past studies, this study finds that expenditures on healthy FAFH are not significantly affected by income. This discrepancy likely resulted due to the fact that this study included two variables not included in the prior studies: SNAP participation and LILA location. Both variables identify the differing consumption habits of two sub-groups of low-income households that would have previously only been accounted for through the income variable. As was expected *a priori*, total FAFH expenditures are positively related to healthy FAFH expenditures; a \$1 increase in total FAFH expenditures leads to a 6% increase in healthy FAFH expenditures. Total FAFH expenditures also have a significant, positive relationship with healthy FAFH participation, but the effect is marginal.

The LDH estimates for the demographic variables largely confirm the findings of prior studies. Similar to the findings of Liu et al. (2013), Mutlu & Gracia (2006), Bai et al. (2012), Stewart et al. (2004) and Richards & Mancino (2013), household size and education are generally positively related to healthy FAFH participation and expenditures. Generational differences in dining preferences are reflected in the inverse relationship between age and purchasing healthy FAFH from convenience retailers, quick-service restaurant and all retailers. Estimation results also indicate that households in which the primary survey respondent is married or female are more likely to purchase healthy FAFH from restaurants. However, households with children are 5% less likely to dine at full-service restaurants. A household's race was also found to have a significant effect on its healthy FAFH participation and expenditures. Relationships of note include that African-American households are 5% less likely to consume and spend 30% less on healthy FAFH; this relationship also holds for all retailer types except supermarkets. Hispanic households, however, are 6% more likely to consume healthy FAFH. The estimated coefficients also indicate that Asian households are 9% less likely to purchase healthy FAFH from convenience retailers, but that they spend on average \$64 more on healthy FAFH when they do choose to participate.

CONCLUSIONS

This paper adds to the literature on FAFH by analyzing LILA households' expenditures on healthy FAFH by retailer type. A nationally representative dataset was used to determine which geographic, health, economic and demographic factors affected households' healthy FAFH expenditures at supermarkets, convenience retailers, quick-service restaurants and full-service restaurants. A lognormal double-hurdle model was used to estimate the households' expenditure and participation decisions due to the presence of zero expenditures in the data set.

After accounting for geographic, economic, demographic and health differences, estimation results indicate that LILA and non- LILA households are equally likely to purchase healthy FAFH. Of the LILA households choosing to consume healthy FAFH, 44% of their acquisitions are from quick-service restaurants, 35% from full-service restaurants, 13% from convenience retailers and 8% from supermarkets. Disaggregating by retailer type, we find that LILA households are equally likely to purchase healthy FAFH from supermarkets and restaurants. However, LILA households are more likely to purchase healthy FAFH from convenience retailers.

Estimation results further indicate that participating LILA households had greater overall expenditures on healthy FAFH than did non-LILA households. Disaggregating by retailer type, this finding also holds for quick-service restaurants; participating LILA households spent on average 15% more than non- LILA households on healthy FAFH at quick-service restaurants. Expenditures at supermarkets, convenience retailers and full-service restaurants were not significantly different amongst LILA and non- LILA households.

Other significant findings include the relationship between SNAP participation and healthy FAFH participation. While SNAP recipients are more likely than non-SNAP

recipients to purchase healthy FAFH from convenience stores, they are less likely to purchase healthy FAFH from retailers that do not accept SNAP benefits, i.e. quick-service and full-service restaurants. Households receiving SNAP benefits also had significantly lower expenditures at quick-service and full-service restaurants. Estimation results further indicated that living in a rural area also had a significant effect on healthy FAFH consumption. Rural households were less likely to purchase healthy FAFH from all retailer types, except convenience stores. However, expenditures on healthy FAFH between participating rural and urban households did not differ.

Several relationships of note were also found between the health variables and healthy FAFH consumption. Households that reported actively searching for nutritional information online had a higher probability of participation at all retailer types except supermarkets and had higher overall expenditures on healthy FAFH. Explanations for why households do not eat healthy foods at home also significantly affected healthy FAFH consumptions. Households that felt they were too busy to prepare healthy foods were more likely to purchase healthy FAFH from nearly all retailers, while households that felt healthy foods were too expensive were less likely to purchase healthy FAFH from full-service restaurants. Significant relationships between healthy FAFH participation and the remaining demographic, economic, health and geographic variables largely confirm the findings of past studies.

This study had two main limitations that should be noted. First, the lognormal double-hurdle model used assumes that the error terms are homoscedastic. When the homoscedasticity assumption is violated, the resulting ML estimates are inconsistent. The second weakness is the use of a relative classification system to identify healthy FAFH items. In future studies, it would be informative to use a data set that includes quantitative nutritional data on each FAFH items purchased.

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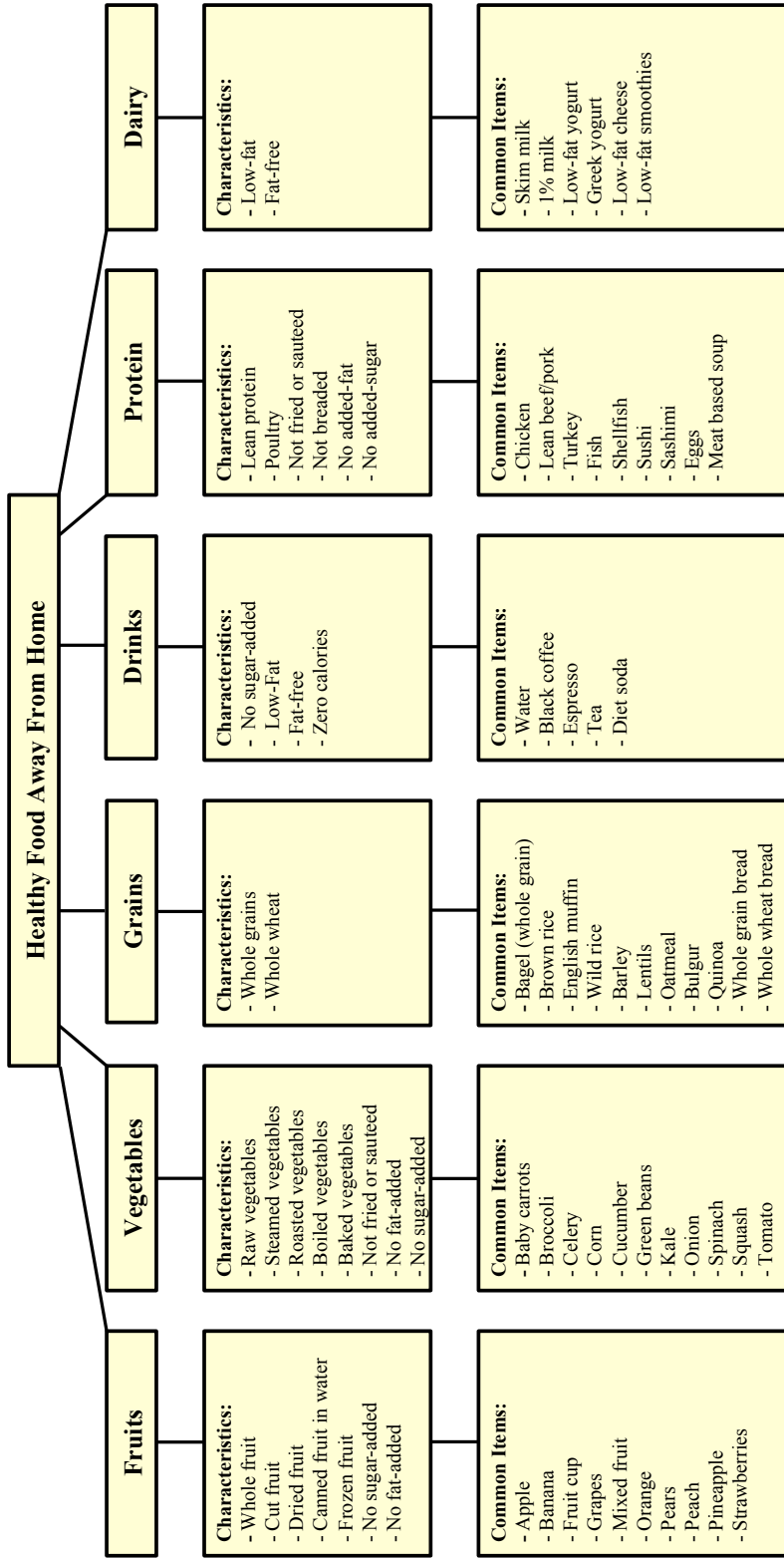
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APPENDIX A

Figure 1. MyPlate US Dietary Guidelines Classification of Healthy Food Away From Home



Sources: (Tips to Help You Eat Fruit 2015; Tips to Help You Eat Vegetables 2015; Tips to Help you Eat Whole Grains 2015; Tips for Making Wise Choices in the Dairy Group 2015; Tips to Help You Make Wise Choices from the Protein Foods Group 2015; Make Better Beverage Choices 2012)

Figure 2. Classification of Food Away From Home Retailers

