The Healthfulness of Food-at-Home Expenditures, the Local Food Environment, and Childhood Obesity

Danhong Chen, PhD[1], Edward C. Jaenicke, PhD[2], and Richard J. Volpe, PhD[3]

Abstract

Purpose: Despite the growth of food-away-from-home expenditures, food-at-home (FAH) expenditures still constitute the majority of American families' food dollars. The FAH expenditures may have important impacts on children's diets and, consequently, their weight statuses. This study examined the association between the composition of FAH expenditures and childhood overweight or obesity.

Design: We compiled a longitudinal data set from the 2010 to 2012 IRI Consumer Panel and its associated MedProfiler surveys.

Setting: This study took place in the United States.

Participants: One thousand seven hundred thirty-one households across the United States, with 2645 children aged 2 to 17, were surveyed over 3 years (2010-2012).

Measures: The binary outcome variable indicated whether a child was overweight or obese. The key predictor variable—composition of FAH expenditures—was an index reflecting households' adherence to expenditure shares for 24 food categories recommended by the United States Department of Agriculture (USDA) Thrifty Food Plans. The key control variables were FAH expenditure shares from different food stores.

Analysis: Data were analyzed by multilevel logistic regressions that controlled for a number of individual-level and household-level characteristics.

Results: Higher compliance with the USDA Thrifty Food Plans was associated with lower risk of childhood overweight or obesity. Channel expenditure shares were not significantly associated with the weight outcomes.

Conclusion: To prevent childhood obesity, the USDA Thrifty Food Plans can provide potential guidelines for households to decide the composition of their FAH expenditures.

Keywords

childhood obesity, food-at-home expenditures, food shopping channels, USDA Thrifty food plans, Dietary Guidelines for Americans

Purpose

Despite the fact that food-away-from-home (FAFH) expenditures have increased steadily since the late 1990s, food-at-home (FAH) expenditures still constitute the slim majority of US households' total food expenditures. According to the Consumer Expenditure Survey by the Bureau of Labor Statistics, American families on average spent 56.2% of their total food dollars on FAH in 2016.[1] For parents of children in kindergarten, first grade, and third grade, this translates to about 10 meals with family in a typical week.[2]

Although a number of studies have been conducted in the public health literature concerning the relationship between home food availability and obesity, there was limited evidence regarding the association between FAH expenditures and obesity. Research has linked overall diet quality with FAFH expenditures, demonstrating that overall adherence to the Dietary Guidelines for Americans (DGA) falls as the share of expenditures on FAFH increases.[3,4] Diet quality, in turn, is associated with a myriad of health outcomes, including obesity

[1] Department of Agricultural Sciences, Sam Houston State University, Huntsville, TX, USA
[2] Department of Agricultural Economics, Sociology, and Education, Pennsylvania State University, University Park, PA, USA
[3] Agribusiness Department, California Polytechnic State University, San Luis Obispo, CA, USA

Corresponding Author:
Danhong Chen, Department of Agricultural Sciences, Sam Houston State University, PO Box 2088, Huntsville, TX 77341, USA.
Email: dchen@shsu.edu

and overweight. One study found that FAH expenditures were negatively related to adult obesity rates, whereas FAFH expenditures were positively associated with adult obesity rates.[5] Children's food consumptions are especially influenced by what is available to them at home. Evidence suggests that the number of meals children eat at home is negatively associated with the risk of overweight.[2] Less availability of healthful, low-energy-dense foods such as fruits and vegetables are often associated with less consumption, whereas more availability of obesogenic foods is associated with higher consumption, with each pathway increasing the likelihood of obesity.[6]

We are motivated to control for the retail food environment, as a number of studies have examined the association between availability of food stores, especially supermarkets, and outcomes related to food consumption and body weight. Kyureghian et al[7] did not find a significant association between densities of food stores, especially supermarkets, and purchases of fruits and vegetables. Caillavet et al[8] found that the number of food stores was negatively associated with the probability of consuming the recommended servings of fruits and vegetables, whereas the total area of the stores devoted to food sales was positively associated with consuming the recommended number of servings of fruits and vegetables.

Although the positive association between availability of convenience stores and obesity has been largely consistent, the evidence regarding access to supermarkets and obesity to date is mixed. Several studies found that residential proximity to convenience stores was associated with increased risk of childhood obesity.[9-11] Powell and Bao[12] found that higher densities of supermarkets are significantly associated with lower child body mass index (BMIs). However, studies investigating the ex-post effects of placing supermarkets in geographic food deserts[13,14] have shown little to no effect on diet quality, food choices, or health outcomes.

Supercenters in particular have been studied for their role in both FAH expenditures and obesity. One study found that increased market share of supercenters was negatively associated with the healthfulness of FAH purchases.[15] Another study attributed 10% of the rise in US obesity rates to the proliferation of Walmart supercenters.[16] However, to our knowledge, no study has held food purchase composition constant to test whether the point of purchase has any real impact. That is, if households have the same composition of FAH expenditures, does it matter if they get them from different places?

Our study aggregated FAH expenditures into a single variable that reflects healthfulness of the food shopping basket and investigated this variable's relationship to obesity or overweight status for children younger than 18 years. To control for the food environment and available food outlets, or store formats, we examined households' FAH purchase shares from these formats and their association with childhood overweight or obesity. Understanding the composition of FAH expenditures and the channel sources of household's FAH purchases will help us better prevent childhood obesity by shopping in adherence to the DGA.

Our research objective is to use granular household-level purchase records to study the association between the healthfulness of grocery expenditures and obesity risks among children. We control for the local food environment, understanding that the shopping formats available to households may affect both where they shop and the foods they purchase. We are also able to measure and control for a wide range of household- and individual-level demographics.

Methods

Design

This study uses secondary data collected by IRI, a market research company that continuously tracks the retail purchases of a large number of households over time.[17] Households in the 2010 to 2012 IRI Consumer Panel recorded all of their FAH expenditures using a home-scanning device. A subset of these households participated in the associated MedProfiler surveys in corresponding years. The MedProfiler surveys contain information on each household member's demographics, health behaviors, and outcomes. This study focuses on the sample of children who were present in these households that were surveyed repeatedly from 2010 through 2012.

Sample

From the 2010 to 2012 IRI MedProfiler surveys, we identified 2645 children who could be followed over 3 years and they were nested in 1731 households. So we had a total number of 7935 (= 2645 × 3) observations. Due to missing information on some of the variables, the sample size in the data analyses was lower. The demographic and health-related information of children was reported by the adult household head. The households resided in 737 counties across the United States. The data on children were merged with the matching households' sociodemographics and FAH expenditures in the 2010 to 2012 IRI Consumer Panel.

Measures

Weight measures. Based on self-reported weight and height, we first calculated BMIs ([weight in pounds/(height in inches)^2 × 703]). Following Centers for Disease Control and Prevention,[18] children with BMI values lower than the 5th percentile for their age and gender were classified as underweight, those with BMIs greater than or equal to the 5th percentile but lower than the 85th percentile were categorized as normal weight, those with BMIs greater than or equal to the 85th percentile but lower than the 95th percentile were categorized as overweight, and those with BMIs greater than or equal to the 95th percentile were classified as obese.

Index for evaluating the composition of FAH expenditures. The composition of FAH expenditures was evaluated by an index (hereafter USDAScore) which reflects a household's adherence to United States Department of Agriculture (USDA)

recommended expenditure shares for 24 food categories, derived based on the USDA Thrifty Food Plans.[19] These recommended shares vary across households depending on household demographics that include the age of male household head, age of female household head, and the presence and age of children. USDAScore was calculated by a squared error loss function:

$$\text{USDAScore}_{jfm} = 1/\sum_{f=1}^{24} (\text{ExpShare}_{jfm} - \text{USDAExpShare}_{jf})^2,$$

where ExpShare_{jfm} is household j's actual expenditure share in food category f in month m; USDAExpShare_{jf} is the recommended expenditure share for household j in food category f. A higher USDAScore indicated higher compliance with the USDA Thrifty Food Plans. Detailed explanations of this score can be found in the study by Volpe and Okrent.[19]

Households' monthly FAH expenditure shares from different food stores. All of the food stores where households purchased their food for at-home consumption were classified into 8 formats including supermarket, drug store, mass merchandizer, supercenter, convenience store, dollar store, club store, and other stores. We then calculated households' average monthly FAH expenditure shares for each of the 8 types of stores in each year. Supermarkets referred to grocery stores with over $2 million annual sales. Drug stores included both chain and independent drug stores. Mass merchandizers included Target, Shopko, and Kmart, excluding Walmart. Convenience stores were chain and independent convenience stores with scanning capability. Family Dollar and Fred's were the dollar stores included in the data. Club stores referred to membership stores such as Sam's Club. Walmart supercenters and traditional and neighborhood markets were all included in the data. Detailed descriptions of each store can be found in the study by Muth et al.[17]

Individual-level characteristics. We included age, gender, whether children ate at a fast-food restaurant on most days of a week ("fast food"), whether they exercised for at least 20 minutes per day on most days of a week ("exercise"), and a diet feature variable indicating whether children consumed high-fiber, high-protein, low-calorie, low-carbohydrate, low-fat, low-salt, and low-sugar diets. These diets are not mutually exclusive. These 7 diet variables had a Cronbach α coefficient of .77 and removing any of the 7 variables would decrease the reliability. A factor analysis of the 7 diet feature variables identified one factor with eigenvalue greater than 1. Diet feature was a standardized factor score (with a mean of 0 and a standard deviation of 1) predicted from the factor analysis.

Household-level characteristics. In addition to households' USDAScores and their monthly FAH expenditure shares from different food stores, we used a number of household sociodemographic variables including race/ethnicity (ie, non-Hispanic white, Hispanic, non-Hispanic black, Asian, and other race), education level (ie, high school or lower, some college, college graduate, and post-college graduate), and marital status (ie, married or not) of the household head, household size, and household income.

Analysis

Descriptive statistics of all the variables were reported by the weight status of children. In particular, households' monthly FAH purchases were aggregated to 24 food categories. The total monthly FAH expenditures, purchasing shares of the 24 categories, and expenditure shares from different shopping channels were compared across different weight statuses of children. Two-sample t tests were used to compare USDA-Scores and expenditure shares of normal-weight children with those of children in other weight statuses. To account for the multilevel data structure, we employed a random-intercept logistic model to analyze the individual- and household-level factors associated with being overweight or obese among children, compared to being underweight or normal weight:

$$\text{logit}\{Y_{tij} = 1 | X_{tij}^l, H_{tij}^m, \nu_{00j}, \mu_{0ij}\}$$
$$= \gamma_{000} + \sum_{l=1}^{L} \beta_{1l} X_{tij}^l + \sum_{m=1}^{M} \beta_{2m} H_{tij}^m + \nu_{00j} + \mu_{0ij} + \varepsilon_{tij},$$

where Y_{tij} was a dichotomous variable indicating whether child i in household j in year t was overweight or obese. X_{tij}^l represented a series of individual-level characteristics, and H_{tij}^m denoted measures at the household level including the healthy index for FAH expenditures (USDAScore). γ_{000} represented the fixed intercept. The random intercepts at the household level and individual level were represented by ν_{00j} and μ_{0ij}, respectively. ϵ_{tij} was the residual term. The model was estimated by maximum likelihood estimation. Analyses of the data and model were all done using STATA 14.

Results

The obesity rate was around 17% in each of the 3 years from 2010 to 2012. The means of all the variables are presented in Table 1. About 2.4% obese children and less than 2% of children with other types of weight statuses had meals in a fast-food restaurant for most days of a week. Approximately 51% of obese children exercised for at least 20 minutes for most days of a week, compared to over 60% for children in other weight statuses. Two-sample t tests indicated that families of overweight or obese children had significantly lower USDAScores than those for families of normal-weight children. Overall, households made FAH purchases from 3 major outlets including supermarkets, supercenters, and club stores. Compared to households with normal-weight children, households with obese children had significantly higher FAH expenditure shares from supercenters, dollar stores, and club stores.

On average, households in the data set recorded $252 in monthly FAH expenditures from 2010 to 2012. The average monthly FAH expenditures and expenditures shares for 24 food categories are presented in Table 2. There were no significant

Table 1. Means for Study Variables by Weight Status of a Sample of Children From 2010 to 2012 IRI MedProfiler Surveys.[a,b]

Variable	Underweight (n = 729)	Normal Weight (n = 4339)	Overweight (n = 1214)	Obese (n = 1351)
Individual level				
Age	8.05	11.19	11.04	9.88
Female[c]	44.86%	50.73%	45.47%	42.04%
Diet feature	−0.05	−0.04	0.07	0.11
Fast food[c]	1.65%	1.68%	1.73%	2.44%
Exercise[c]	65.38%	66.01%	62.93%	51.22%
Household level				
Race/ethnicity				
Non-Hispanic white[c] (reference)	78.60%	79.60%	78.42%	73.95%
Hispanic[c]	3.98%	5.30%	6.34%	7.11%
Non-Hispanic black[c]	7.82%	6.89%	8.40%	13.40%
Asian[c]	7.82%	6.11%	4.61%	3.11%
Other race[c]	1.51%	1.84%	2.06%	2.37%
Household size	4.57	4.21	4.09	4.07
Household income	$78 323.54	$82 670.72	$75 405.13	$68 281.07
Education				
≤High school[c] (reference)	4.80%	8.53%	12.44%	13.99%
Some college[c]	20.71%	19.64%	21.25%	26.05%
College graduate[c]	45.27%	44.90%	44.89%	41.60%
Post-college graduate[c]	28.94%	26.69%	21.25%	18.28%
Married[c]	95.46%	89.14%	86.06%	83.41%
USDAScore	6.67	6.72	6.53[d]	6.47[d]
Supermarket share	57.58%[e]	59.90%	59.61%	58.44%
Drug store share	1.98%	1.86%	1.83%	1.93%
Mass merchandiser share	3.37%[e]	4.15%	3.57%[e]	4.18%
Supercenter share	19.21%[e]	16.87%	18.20%	18.36%[e]
Convenience store share	0.59%	0.50%	0.62%	0.57%
Dollar store share	0.98%[e]	1.43%	1.76%	2.30%[d]
Club store share	10.68%	11.89%	10.12%[f]	10.25%[f]
Other store share	5.62%[d]	3.38%	4.28%[f]	3.98%[e]

[a]N = 7633. Other variables, except binary variables, were continuous. Means of binary variables were presented as percentages to show the proportions of samples answering "yes."
[b]Two-sample t tests were used to compare USDAScores and expenditure shares for different food stores of normal-weight children with those of children in other weight statuses.
[c]Indicates binary variables.
[d]$P \leq .001$.
[e]$P \leq .05$.
[f]$P \leq .01$

differences in households' monthly FAH expenditures among children with different weight statuses. However, the composition of monthly FAH expenditures differed across weight groups. Families of overweight or obese children spent significantly more money on potato products, soft drinks, sodas, fruit drinks, and rice beverages, compared to families of normal-weight children. Their expenditure shares on grain products (including both wholegrain and non-wholegrain products), whole fruits, and nuts were significantly lower than those for families with normal-weight children. In particular, households with obese children allocated significantly higher proportions of their monthly FAH expenditures to bacon, sausages, lunch meats, fats, and condiments, compared to households with normal-weight children.

The results of the random-intercept logistic model are presented in Table 3. Higher USDAScores were associated with reduced risk of childhood overweight or obesity. However, none of the shopping channel shares was significantly associated with children's weight status. The model results were fairly consistent when we compared normal-weight children with those in each of the other weight statuses, respectively.

Most of the individual-level variables were strongly correlated with children's weight status. Age and being female were negatively associated with the risk of childhood overweight or obesity. Consuming special diets were positively associated with being overweight or obese. Heavy fast-food consumption was not significantly associated with being overweight or obese. Exercising at least 20 minutes a day on most days of a week reduced the odds of being overweight or obese by 44% (odds ratio = 0.56).

Childhood overweight and obesity were associated with a number of household sociodemographic characteristics. All else equal, children living in families with a black household head were more than twice as likely to be overweight or obese as those living with a white household head (odds ratio = 2.10).

Table 2. Average Monthly Food-at-Home Expenditure Shares of 24 Food Categories by Weight Status of a Sample of Children From 2010 to 2012 IRI MedProfiler Surveys.[a,b]

Number	Food Category	Underweight (n = 729)	Normal Weight (n = 4339)	Overweight (n = 1214)	Obese (n = 1351)
1	Wholegrain products	3.83%[c]	3.21%	2.72%[c]	2.79%[c]
2	Non-wholegrain products	24.58%	24.10%	23.42%[d]	23.44%[d]
3	Potato products	1.61%[d]	1.80%	1.93%[e]	1.91%[e]
4	Dark green vegetables	0.52%[e]	0.46%	0.45%	0.44%
5	Orange vegetables	0.03%	0.04%	0.04%	0.05%[e]
6	Canned and dry beans, lentils, and peas (legumes)	0.86%	0.86%	0.85%	0.83%
7	Other vegetables	1.94%	1.90%	1.92%	1.82%
8	Whole fruits	1.37%	1.35%	1.24%[e]	1.22%[d]
9	Fruit juices	2.17%	2.14%	1.83%[c]	2.09%
10	Whole milk products	5.48%[e]	5.11%	4.91%	4.81%[d]
11	Low-fat dairy products	6.66%	6.68%	6.50%	5.67%[c]
12	Cheese	4.83%	5.02%	5.25%[e]	5.09%
13	Beef, pork, veal, lamb, and game	0.63%	0.63%	0.65%	0.60%
14	Chicken, turkey, and game birds	2.51%	2.36%	2.52%[e]	2.34%
15	Fish and fish products	1.52%	1.60%	1.51%	1.46%[e]
16	Bacon, sausages, and lunch meats	4.96%[e]	5.27%	5.43%	6.01%[c]
17	Nuts, nut butters, and seeds	2.03%	2.11%	1.96%[e]	1.91%[d]
18	Eggs and egg mixtures	1.15%	1.11%	1.18%	1.21%[d]
19	Fats and condiments	6.86%	6.87%	6.97%	7.07%[e]
20	Coffee and tea	2.19%[e]	2.46%	2.59%	2.47%
21	Soft drinks, sodas, fruit drinks, and rice beverages	5.41%	5.80%	6.77%[c]	7.18%[c]
22	Sugars, sweets, and candies	8.22%	8.33%	8.36%	8.55%
23	Soups	1.94%	1.83%	1.79%	1.84%
24	Frozen or refrigerated entrees	8.70%	8.97%	9.22%	9.19%
	Average monthly food-at-home expenditure	$251	$253	$250	$255

[a]N = 7633.
[b]Two-sample *t* tests were used to compare average monthly food-at-home expenditure and expenditure shares for 24 food categories of normal-weight children with those of children in other weight statuses.
[c]$P \leq .001$.
[d]$P \leq .01$.
[e]$P \leq .05$.

The larger the household size and household annual income, the less likely the children were overweight or obese. Children living with a household head who had some college education or beyond had significantly lower odds of being overweight or obese than those living with a household head who had an education level of high school or less.

Discussion

The obesity rate found in this study (around 17%) was consistent with data from the National Health and Nutrition Examination Survey.[20] There were no substantial differences in terms of total monthly FAH expenditures among families with children of different weight statuses, but the composition of their FAH expenditures differed significantly. Previous studies have consistently found that a healthier food-based diet is more expensive than a less healthy diet.[21] Based on the current study, families of normal-weight and underweight children did not necessarily spend more on food for at-home consumption. Compared to households of normal-weight and underweight children, families of overweight or obese children were less likely to comply with the expenditure shares recommended

by the USDA Thrifty Food Plans and spent more on soft drinks, sodas, fruit drinks, and rice beverages that are recommended for limited consumption by DGA. It is well established that consumption of sugar-sweetened beverages is associated with childhood obesity.[22]

The composition of households' FAH shopping cart plays an important role in what children eat and their subsequent weight statuses. Higher compliance with the USDA Thrifty Food Plans (ie, a higher USDAScore) was associated with reduced risk of being overweight or obese for children, suggesting the importance of the composition of FAH expenditures in shaping children's diets and their subsequent weight outcomes. Comparing households' food expenditure shares for 24 food categories with the recommended values suggested by USDA offers clear suggestions of improvement regarding the expenditure shares of specific food categories for households with children. Specifically, American families purchased far more non-wholegrain products, bacon, sausages, and luncheon meats, fats and condiments, soft drinks, sugars, sweets, and candies, and frozen or refrigerated entrees, but much fewer fruits and vegetables than the recommended values.[23] One of the implications of

Table 3. Individual- and Household-Level Factors Associated With Overweight or Obese Status of a Sample of Children From 2010 to 2012 IRI MedProfiler Surveys.[a]

Independent Variables	Odds Ratio (95% CI)
Individual level	
Age	0.92 (0.89-0.95)[b]
Male (reference)	
Female	0.63 (0.49-0.81)[b]
Diet feature	1.14 (1.04-1.26)[c]
Fast food	1.20 (0.60-2.40)
Exercise	0.56 (0.46-0.68)[b]
Household level	
Race/ethnicity	
Non-Hispanic white (reference)	
Hispanic	1.60 (0.85-3.02)
Non-Hispanic black	2.10 (1.24-3.56)[c]
Asian	0.59 (0.30-1.18)
Other race	1.58 (0.56-4.48)
Household size	0.87 (0.76-1.00)[d]
Ln (income)	0.69 (0.54-0.89)[c]
Education	
≤High school (reference)	
Some college	0.56 (0.32-0.97)[d]
College graduate	0.42 (0.25-0.71)[b]
Post-college graduate	0.33 (0.18-0.59)[b]
Married	0.79 (0.48-1.31)
USDAScore	0.92 (0.85-0.99)[d]
Supermarket share	0.75 (0.26-2.16)
Drug store share	0.79 (0.05-11.67)
Mass merchandiser share	0.35 (0.07-1.73)
Supercenter share	0.76 (0.25-2.34)
Convenience store share	1.86 (0.02-148.11)
Dollar store share	0.76 (0.08-6.94)
Club store share	0.54 (0.15-1.89)
Intraclass correlation coefficient at the individual level	3.37
Intraclass correlation coefficient at the household level	4.01

Abbreviation: CI, confidence interval.
[a]N = 7615.
[b]$P \leq .001$.
[c]$P \leq .01$.
[d]$P \leq .05$.

this study is that families do not necessarily need to have higher FAH expenditures but need to tweak the expenditure shares for different food categories in order to maintain a healthy weight for their children.

Moreover, the recommended composition of FAH expenditures can provide potential guidelines for participants in food assistance programs, especially the Supplemental Nutrition Assistance Program (SNAP). Unlike the Special Supplemental Nutrition Program for Women, Infants, and Children program, SNAP—the largest food assistance program in the United States—does not restrict the food categories that participants can buy. There was evidence that SNAP participants consume more sugar-sweetened beverages, high-fat dairy, processed meats than comparable nonparticipants.[24] Imposing purchasing share limitations on SNAP benefits redemption can potentially help improve participants' dietary composition and reduce their risk of obesity.

None of the respective channel expenditure shares were associated with being overweight or obese for children in this study. Although a large number of studies have examined access to or availability of food stores and childhood obesity, rarely did any study investigate the association between expenditure shares from different stores and childhood obesity. Findings on the relationship between retail food environment and obesity were mixed depending on a number of factors including the measurement of the food environment, sample characteristics, method of analysis, and so on.[25,26] Significant associations were often found in early studies with cross-sectional design and ecological model,[25,27] whereas recent interventions did not show any significant effect.[13,14] We were able to track the food purchases of 1731 families over 3 years and calculate their purchasing shares from different food outlets. Controlling for the composition of household FAH purchases, the specifics of where households shop did not have important implications for childhood obesity.

The results with respect to food outlets, or store formats, were broadly consistent with the extant literature on the topic. Few studies have found substantial food environment impacts on food choices, dietary quality, and health outcomes. However, given that we controlled for the overall composition of FAH purchases according to food categories, our results spoke to healthfulness comparisons across store formats. Our findings suggested that there were no important differences in healthfulness across store types for products such as fresh produce, meats, and seafood.

Findings concerning 2 control variables might seem unexpected. First, consuming special diets was positively correlated with childhood overweight or obesity. Since this model could not establish causality, it was likely that overweight or obese children were sometimes treated with special diets. Second, heavy fast-food consumption was not significantly associated with childhood overweight or obesity. This result could be related to the fact that only a small portion of children had meals in a fast-food restaurant for most days of a week in this sample.

This study had several limitations. First, not all the food items were recorded by the households in this study. American families on average spent about \$3624 to \$3921 per year on food for at-home consumption or approximately \$302 to \$327 per month from 2010 to 2012.[28] However, households included in this study only recorded an average of \$252 in monthly FAH expenditures from 2010 to 2012. This discrepancy might indicate an underreporting issue in the data set. Foods without Universal Product Codes (UPCs) might not always be recorded as they created great burden of reporting, compared to foods with UPCs.[17] Second, we examined what foods households bought from food stores and not what they actually consumed at home. The food allocation among family members, food waste at home, and food consumption at school might have blurred the findings of this study.

Differing from previous studies on the impact of selected foods and food access on obesity, this study not only examined the association between the composition of FAH expenditures and childhood overweight and obesity risk but also investigated

SO WHAT?

What is already known on this topic?

The home and neighborhood food environments may have important impacts on children's diets and, consequently, their weight outcomes.

What does this article add?

We used household-level food purchase records to investigate the association between the healthfulness of food-at-home expenditures and overweight or obesity among children, while controlling for the retail food environment. The composition of food-at-home expenditures differed significantly across households with children of different weight statuses. Shopping in higher compliance with the USDA Thrifty Food Plans was associated with reduced risk of childhood overweight or obese.

What are the implications for health promotion practice or research?

Households can use the USDA Thrifty Food Plans as a guide for them to decide what food to purchase and how much to spend on each type of food. Further studies regarding the composition of food-at-home expenditures and obesity are warranted.

the relationship between FAH expenditure shares from multiple shopping channels and the risk of childhood overweight and obesity. Higher compliance with the USDA Thrifty Food Plans (higher USDAScore) was associated with reduced risk of being overweight or obese for children. Given the same USDAScore, the sourcing channels for the foods were not significantly associated with overweight and obesity risk. In other words, where households shop for their foods is not crucial, as long as they get the correct combination of foods that are in line with the DGA. The USDA Thrifty Food Plans can serve as the guide for households in terms of what food and how much to put in their shopping cart.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

1. Bureau of Labor Statistics. Consumer Expenditures 2016. 2017. https://www.bls.gov/news.release/pdf/cesan.pdf. Accessed June 28, 2018.
2. Gable S, Chang Y, Krull JL. Television watching and frequency of family meals are predictive of overweight onset and persistence in a national sample of school-aged children. *J Am Diet Assoc*. 2007;107(1):53-61.
3. Guthrie JF, Lin BH, Frazao E. Role of food prepared away from home in the American diet, 1977-78 versus 1994-96: changes and consequences. *J Nutr Educ Behav*. 2002;34(3):140-150.
4. Todd JE, Mancino L, Lin BH. The impact of food away from home on adult diet quality, ERR-90. Washington, DC: U.S. Department of Agriculture, Economic Research Service, February 2010. https://www.ers.usda.gov/webdocs/publications/46352/8170_err90_1_.pdf. Accessed June 28, 2018.
5. Cai Y, Alviola PA, Nayga RM, Wu X. The effect of food-away-from-home and food-at-home expenditures on obesity rates: a state-level analysis. *J Agric Appl Econom*. 2015;40(2):507-521.
6. Rosenkranz RR, Dzewaltowski DA. Model of the home food environment pertaining to childhood obesity. *Nutr Rev*. 2008;66(3):123-140.
7. Kyureghian G, Nayga RM, Bhattacharya S. The effect of food store access and income on household purchases of fruits and vegetables: a mixed effects analysis. *Appl Econ Perspect Policy*. 2013;35(1):69-88.
8. Caillavet F, Kyureghian G, Nayga RM, Ferrant C, Chauvin P. Does healthy food access matter in a French urban setting? *Am J Agric Econom*. 2015;97(5):1400-1416.
9. Galvez MP, Hong L, Choi E, Liao L, Godbold J, Brenner B. childhood obesity and neighborhood food-store availability in an inner-city community. *Acad Pediatr*. 2009;9(5):339-343.
10. Laska MN, Hearst MO, Forsyth A, Pasch KE, Lytle L. Neighbourhood food environments: are they associated with adolescent dietary intake, food purchases and weight status? *Public Health Nutr*. 2010;13(11):1757-1763.
11. Leung CW, Laraia BA, Kelly M, et al. The influence of neighborhood food stores on change in young girls' body mass index. *Am J Prev Med*. 2011;41(1):43-51.
12. Powell LM, Bao Y. Food prices, access to food outlets and child weight. *Econ Hum Biol*. 2009;7(1):64-72.
13. Escaron AL, Meinen AM, Nitzke SA, Martinez-Donate AP. Supermarket and grocery store–based interventions to promote healthful food choices and eating practices: a systematic review. *Prev Chronic Dis*. 2013;10:E50.
14. Kristal AR, Goldenhar L, Muldoon J, Morton RF. Evaluation of a supermarket intervention to increase consumption of fruits and vegetables. *Am J Health Promot*. 1997;11(6):422-425.
15. Volpe R, Okrent A, Leibtag E. The effect of supercenter-format stores on the healthfulness of consumers' grocery purchases. *Am J Agric Econ*. 2013;95(3):568-589.
16. Courtemanche C, Carden A. Supersizing supercenters? The impact of Walmart Supercenters on body mass index and obesity. *J Urban Econ*. 2011;69(2):165-181.

17. Muth MK, Sweitzer M, Brown D, et al. *Understanding IRI Household-Based and Store-Based Scanner Data*, TB-1942. Washington, DC: U.S. Department of Agriculture, Economic Research Service, April 2016. https://www.ers.usda.gov/webdocs/publications/47633/57105_tb-1942.pdf?v=42473. Accessed June 28, 2018.

18. Centers for Disease Control and Prevention. 2016. Defining childhood obesity. https://www.cdc.gov/obesity/childhood/defining.html. Accessed June 28, 2018.

19. Volpe R, Okrent AM. *Assessing the Healthfulness of Consumers' Grocery Purchases*, EIB-102, U.S. Department of Agriculture, Economic Research Service, November 2012. https://www.ers.usda.gov/webdocs/publications/43680/33405_eib102.pdf?v=41263. Accessed June 28, 2018.

20. Ogden CL, Carroll MD, Fryar CD, Flegal KM. *Prevalence of Obesity Among Adults and Youth: United States, 2011-2014*. NCHS data brief, no 219. Hyattsville, MD: National Center for Health Statistics. 2015. https://www.cdc.gov/nchs/data/databriefs/db219.pdf. Accessed June 28, 2018.

21. Rao M, Afshin A, Singh G, Mozaffarian D. Do healthier foods and diet patterns cost more than less healthy options? A systematic review and meta-analysis. *BMJ Open*. 2013;3(12):e004277.

22. Ludwig DS, Peterson KE, Gortmaker SL. Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet*. 2001;357(9255):505-508.

23. Chen D, Jaenicke EC, Volpe RJ. Food environments and obesity: household diet expenditure versus food deserts. *Am J Public Health*. 2016;106(5):881-888.

24. Leung CW, Blumenthal SJ, Hoffnagle EE, et al. Associations of food stamp participation with dietary quality and obesity in children. *Pediatrics*. 2013;131(3):463-472

25. Holsten JE. Obesity and the community food environment: a systematic review. *Public Health Nutr*. 2009;12(3):397-405.

26. Odoms-Young AM, Zenk SN, Karpyn A, Ayala GX, Gittelsohn J. Obesity and the food environment among minority groups. *Curr Obes Rep*. 2012;1(3):141-151.

27. Sallis JF, Glanz K. Physical activity and food environments: solutions to the obesity epidemic. *Milbank Q*. 2009;87(1):123-154.

28. Bureau of Labor Statistics. Consumer Expenditures in 2012. 2014. https://www.bls.gov/cex/csxann12.pdf. Accessed June 28, 2018.