IS SHOPPING AT CERTAIN TYPES OF STORES ASSOCIATED WITH THE NUTRIENT PROFILE OF PACKAGED FOODS PURCHASED BY US HOUSEHOLDS?

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ABSTRACT

Dalia Stern: Is shopping at certain types of stores associated with the nutrient profile of packaged foods purchased by US households?
(Under the direction of Barry M. Popkin)

Growing attention is being given to areas with poor access to healthy foods. However, studies looking at the food environment and its association to diet and health do not collect data on where people shop for food, what they actually purchase, or examined the nutrient profile of purchases.

Using packaged food and beverage purchases (PFP) of households participating in the 2000-2012 Homescan longitudinal panel, this work aimed to understand whether types of stores (e.g., grocery, convenience) where US households shop for food are associated with the nutrient profile of PFP and foods/beverages households purchase. In Aim 1, we classified PFP by type of store and described volume trends, nutrient profile of PFP and food/beverage groups households purchased by type of store. The proportion of total volume of household PFP significantly increased from 2000 to 2012 for mass-merchandisers, convenience-stores and warehouse-club. The energy, total sugar, sodium and saturated fat densities of household PFP from mass-merchandisers, warehouse-club and convenience-stores were higher, compared to grocery-stores. Top common sources of calories from household PFP by food/beverage group included: savory snacks, grain-based desserts, fruit drinks/juices and soft-drinks. In Aim 2, we used cluster analysis to derive food shopping patterns from 2000-2012. We used multinomial logistic regression to determine socio-demographic predictors of food shopping patterns in 2012. We

found three shopping patterns: primary-grocery- , primary-mass-merchandise- and combination-cluster. Regardless of income/race-ethnicity, households predominantly shopped at the primary-grocery-cluster. However, among low- and middle-income households, non-whites were less likely to shop at the primary-mass-merchandise-cluster and more likely to shop at the combination-cluster. In Aim 3, we determined the association between food shopping patterns and PFP and whether this association differs by race-ethnicity from 2007-2012. We found that, no matter which food shopping pattern different race-ethnic groups employed, the nutrient profile and foods/beverages purchased were very similar.

In conclusion, the ubiquity of unhealthy packaged foods and beverages regardless of type of store may thwart efforts to improve eating habits. Additionally, there is a need to re-focus efforts on improving the nutritional quality of product offerings and promote their sales over less healthy options across all types of stores.

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NFP	Nutrition facts panels
PFP	Packaged food purchases
RTE	Ready-to-eat
SES	Socioeconomic status
SSB	Sugar-sweetened beverage

CHAPTER 1. INTRODUCTION

Background

Improving access to healthy foods has been a cornerstone of the federal administration's food policy, with hundreds of millions of dollars dedicated to eliminate food deserts, or areas with limited access to healthy foods. Programs and policies at the state and national level have focused on building new supermarkets or grocery stores in food deserts with the goal of improving household food purchases, dietary quality, and reducing health disparities. These strategies are implemented under the underlying assumption that shopping at supermarkets, versus other types of stores (i.e., convenience), is associated with higher nutritional quality of food purchases. However, this assumption has not been supported by empirical evidence. Moreover, the existing literature has been conducted on small samples with limited geographical scope. In addition, these policy strategies were informed by studies that have focused primarily on people shopping at one type of store only, rather than looking at the combination of stores that people use to shop for food. In fact, evidence from epidemiologic studies indicates that food shopping is complicated: people appear to shop for food at several types of stores. There is an emerging literature focused on socioeconomic status (SES) and race-ethnic differences in food purchasing. However, studies have been small, limiting generalizability and their ability to conduct subgroup analyses. In order to implement cost effective and impactful food policy, it is critical that we answer the question: are packaged foods that consumers purchase from grocery stores of higher nutritional quality than packaged food purchases from a range of other types of

stores, such as convenience, mass-merchandisers and warehouse-club stores; which collectively represent 65% of calories consumed by Americans?

This project will increase our understanding of the answer to this question by looking at the packaged foods sector of the food supply. First we will describe the nutrient quality of packaged food purchases by type of store in a nationally representative sample of US households. We will also describe changes over time from 2000 to 2012. Secondly we will characterize the combination of stores US households rely on for their food purchases and we will determine whether income and race-ethnicity predict shopping pattern membership. Next we will determine shopping pattern associated with the nutrient profile of total packaged foods food purchases, and whether this varies by income and race-ethnicity. Together, this work will inform our central research question on whether shopping at supermarkets is associated with a better nutrient profile of packaged foods purchased foods, compared to other types of stores, and whether targeting food deserts by increasing supermarket availability is the best policy strategy.

We will take advantage of the 2000-2012 Nielsen Homescan panel dataset, a nationally representative longitudinal sample of 35,000 to 65,000 households sampled each year. Nielsen Homescan collects information on packaged foods purchases from each shopping occasion at the universal product code (UPC) level, using scanner technology. We have linked household-level purchase data from Nielsen Homescan to Nutrition Facts Panels (NFP) data to provide nutrient information on all packaged foods purchased that are brought into the home. This dataset is unique since it collects information on the types of stores where households shop for food (i.e., warehouse club, mass-merchandise, grocery-stores, convenience stores, etc.). In addition, these data provides detailed information on the nutrient content of each packaged food purchased and purchase price. Nielsen Homescan also collects socio-demographic information such as age and

gender of all household members, income, education and race-ethnicity of the household head, allowing us to conduct subpopulation analysis. Our overall goal with this project is to provide empirical evidence for the assumptions underlying the belief that grocery store purchases are of higher nutrient quality, compared to purchases form other types of store.

Research Aims

Aim 1: Describe at what type of stores US households shop for food and whether type of store shopping changed over time using a nationally representative sample of US households. Compare the nutrient profile of households packaged food purchases by type of store. Determine whether temporal trends of the nutrient profile of households packaged food purchases differ across type of store from 2000-2012, using descriptive statistics.

Type of store will be defined as: 1) warehouse-club, 2) mass-merchandise/supercenters, 3) grocery stores, 4) non-chain grocery stores 5) specialty stores, 6) ethnic stores, 7) convenience stores, 8) drug stores and 9) dollar stores and 10) other. Volume of purchases by type of store will be defined as the proportion of purchases from a given store, relative to total purchases. Nutrient profile of purchases will be defined as the energy and nutrient densities (g of total sugar, g of saturated fat and mg of sodium) per 100 grams of packaged food/beverage purchases by type of store. We will also compare the percentage of store-type proportion of calories and volume by food and beverage groups.

We hypothesize that the nutrient profile of purchases will be significantly different by store type and that these differences will be consistent over time.

Aim 2: Characterize the combination of food stores (i.e., food shopping patterns) where US households shop for food over 2000-2012 and determine whether income and race-ethnicity are associated with food shopping patterns in 2012.

2a. Determine shopping patterns using cluster analysis and describe trends over time (2000-2012).

2b. Determine whether there are differences by income and race-ethnicity subpopulations on where US households shop for food in 2012, using multinomial logistic regression.

We hypothesize that U.S. households rely on more than one type of store for their food purchases, and that low-income, non-Hispanic black and Hispanic households are as likely as high-income and non-Hispanic white households to shop at larger retail stores (i.e., grocery chains).

Aim 3: Determine whether food shopping patterns are associated with the nutrient profile of households total packaged foods purchases over 2007-2012 and whether this relationship differs by income and race-ethnicity, using random-effects models.

Nutrient profile will be defined as caloric and nutrient densities (g of total sugar, g of saturated fat and mg of sodium) per 1000g. As secondary outcomes, we will use the proportion of total calories from packaged foods and proportion of total calories from packaged beverages. Determine if the association differs by income and race-ethnicity subpopulations.

We hypothesize that the nutrient profile of total households packaged foods purchases will be similar by shopping patterns. However, low-income, non-Hispanic black and Hispanic households will have a lower nutrient quality profile of their total packaged foods purchases, compared to high-income and non-Hispanic white households, regardless of shopping patterns.

CHAPTER 2. LITERATURE REVIEW

What are food deserts and do they matter?

Food deserts are commonly defined as regions lacking access to healthy foods, like fruits and vegetables, as well as a range of other nutritious foods. [1] The desert component of the term is inherently spatial, and it emphasizes the physical absence of food vendors that sell healthy food options in low-income neighborhoods. [2]

Many programs and policies at the state and national level [3-6] focus on the need to build new supermarkets or grocery stores in food deserts in an effort to improve household food purchases, dietary quality, and reduce health disparities. The main concern is that people living in food deserts have limited access to healthy foods and relatively easier access to unhealthy foods, diminishing the nutritional quality of foods purchased, and ultimately, increasing the risk of obesity and nutrition-related chronic diseases. [1] These programs and policies aimed at ameliorating some of the environmental determinants of diet have been implemented despite the lack of evidence of effectiveness – findings from natural experiments and epidemiological longitudinal studies show that provision of a new supermarket in food deserts [7-11] or proximity to supermarkets may not influence the quality of people's diet. [12] Moreover, a recent review concluded that the food environment was not consistently associated with dietary outcomes. [13] The reasons behind the lack of evidence may be because these strategies rely on the assumption that people shopping at larger retail stores, such as supermarkets or grocery-stores, have a better nutrient profile of food purchases, because supermarkets or grocery-stores sell more variety of foods with higher nutritional quality and at lower prices than other types of stores (i.e.,

convenience stores) [14] and because larger stores have more capacity to handle perishables and produce in safe and efficient ways.

To date, it is unclear whether shopping at supermarkets or grocery-stores is associated with a better nutrient profile of the packaged foods purchases, compared to shopping at other types of stores. In addition, these policy strategies were informed by studies that have focused primarily on shopping at one type of store only, [15-18] rather than looking at the combination of stores that people us to shop for food. In fact, evidence from small epidemiological studies indicates food shopping is complicated and appears to involve traveling to multiple store types. [19] Therefore, in order to implement cost effective and impactful food policy, it is critical that we answer the question: are foods that consumers purchase from supermarkets or grocery-stores of higher nutritional quality than food purchases from a range of other types of stores, such as convenience, mass-merchandisers and warehouse-club stores; which collectively represent 65% of calories consumed by Americans?

Most studies do not collect data on the type of store where people actually shop for food and what foods they purchase

Extensive research conducted in urban settings use geocoding technology [20, 21] to enumerate food stores within a given geographic unit of analysis, such as a zip code area or census tracks. These studies provide measures of food access by characterizing the food environment in different ways. For example, they use density of supermarkets per geographic unit, [22, 23] number of supermarket per geographic unit, [16, 24] or residents´ distance from their home to the location of their principal food store source, as well as the nearest supermarket. [25, 26] Extensive research conducted in urban settings use geographic information systems [20, 21] to look

at the number, type and proximity to retail food stores in a geographically designated area and its association with SES neighborhood characteristics, diet and weight status.

In terms of the food environment and its association with SES neighborhood characteristics, studies have shown that low-income neighborhoods have limited access to supermarkets, compared to wealthier neighborhoods. [15, 23, 27, 28] When looking at race-ethnic disparities in food access, predominantly black, minority or racially mixed neighborhoods have fewer supermarkets compared to predominantly white neighborhoods. [15, 28-31] The association between the food environment and diet is mixed. While some studies support the idea that access to supermarkets is associated with a healthy diet, [16, 26, 32, 33] others have shown that this is not the case. [12, 34, 35] Similarly, studies looking at the food environment and its association to obesity have found mixed results. Some studies report an inverse association between neighborhood supermarket access and body weight, [24, 36-40] while others did not. [41, 42] Studies looking at neighborhood convenience store access and body weight report positive associations, [24, 38, 40, 43] while others report null associations. [36, 44]

The above mentioned studies have major conceptual and methodological flaws. First, they assume people shop in food stores close to where they live. Second, overall they do not collect data on where people actually shop for food and they do not collect data on actual food purchases at each store type. Third, they do not address issues regarding where people choose to live. In other words, people may choose to live in neighborhoods that support their dietary preferences. This is known as residential self-selection. Failing to control for this residential self-selection can create spurious associations between the association of the neighborhood characteristics with weight status, diet and health. Although residential self-selection has been a limitation of past work, in this work we will not make assumptions on the type of stores or the

number of stores in the area where households live. Instead, we will use data on where households have already shopped. To date, no large-scale, longitudinal study has been able to examine the nutrient content of packaged foods purchases and foods and beverage choices by type of store among US households, and whether there have been changes over time.

No large-scale, longitudinal study has examined the combination of food stores that US households rely on for their food purchases

Previous studies investigating the relationship between the food environment and diet usually focus on purchases from one type of store only. However, limited evidence from epidemiologic studies indicates food shopping is complicated and appears to involve traveling to multiple store types. [19, 45] Moreover, counter to the assumptions from previous research, studies have shown that both, low- and high-SES groups, shop for food beyond their residential food environment. [46, 47] To date, only one study has comprehensively captured movement within a food environment by mapping individuals´ daily activity space and travel patterns in order to capture all the possible stores where people may shop for food. [48] A major limitation is that the existing literature has limited geographical scope and has been conducted on small samples, with limited variability by income and race-ethnicity, and has been limited to examination of shopping occasions at a single point in time.

Additionally, the food environment is dynamic. New players are talking a growing percentage of the consumer's food dollars, including mass-merchandisers (i.e., Walmart, Super Target), dollar stores and other types of store. [49] Therefore, focusing only on supermarkets or grocery-stores purchases, or convenience stores ignores other places where US households purchase some or all of their food. To date, no large-scale study has characterized the

combination of stores (e.g., food shopping patterns) that US households rely on for their food purchases and whether this has changed over time.

It is unclear whether the types of stores where US households shop for food and the nature of food purchases differ by race-ethnicity or SES

The literature suggests that residents of non-Hispanic black and low-income neighborhoods have less access to healthy foods, [15, 23, 25, 28] and that living in these neighborhoods is an important risk factor for unhealthy diets. [50, 51] However, as mentioned previously, these studies do not know whether people shopped at stores located within their residential food environment. Most of these studies also rely on dietary assessment methods to measure dietary intake as a proxy for store purchases, but do not capture food purchases themselves. These studies make inferences about the types of stores where people shop for food and associations with diet without directly linking foods consumed to the stores where the foods were purchased. [52]

Few studies have examined differences by income or race-ethnicity in terms of the types of stores where people actually shopped for food and the foods they purchase. In terms of the types of stores where different SES groups shop for food, one small study showed that a high proportion of participants shopped at chain-supermarkets, and the majority of disadvantaged participants did not shop at the supermarket closest to home. [53] A second study showed that the majority of individuals shopped at a supermarket or grocery store, but non-whites and low-income groups traveled long distances to visit these types of stores. [54] In terms of the foods different SES groups' purchase, studies on low-income households found that a larger proportion of beverage purchases consisted of sugar sweetened beverages. [55, 56] Other studies have shown

differences in food and beverage purchases by household race-ethnicity and education. [57, 58]

A major limitation of the literature is that studies were completed with small numbers of households, limiting generalizability and their ability to conduct subgroup analyses. Additionally, studies looking at foods and beverage purchases have focused on specific food or beverage groups, ignoring the entire set of purchases made at the store. [26, 59] In addition, studies have collected data on a single or a limited number of days of purchases,[48] failing to capture the usual stores where individuals shop for food, as well as the foods and beverages purchased.

The majority of the studies conducted in this area are based on the assumption that non-Hispanic blacks, Hispanics, and low-SES households purchase a large proportion of their food at convenience stores, compared to non-Hispanic whites and high-SES households. Additionally, they also assume that non-Hispanic blacks, Hispanics, and low-SES households have a worse nutrient profile of purchases, compared to non-Hispanic whites and high-SES households. However, to our knowledge, these inquiries regarding subpopulation differences have not been directly investigated in a longitudinal study and with a diverse sample of the US households. Policies and interventions focused on reducing disparities and improving dietary quality are likely to be more effective if we understand households' food shopping behaviors and food purchasing patterns for subpopulations in the US.

Advantages of using Homescan along with nutrition facts panel information

We will take advantage of the 2000-2012 Nielsen Homescan panel dataset, [60] a nationally representative longitudinal sample of 35,000 to 65,000 households sampled each year. Homescan uses an open cohort study design; households may exit any time, and new households are enrolled to replace dropouts and rebalance the panel to match demographic and geographic

targets and maintain national representativeness. [61] Nielsen Homescan in unique since it collects information on households PFP (i.e., all foods and beverages with a barcode and nutrition information) from every shopping trip. Although we are only able to examine the packaged foods sector, in 2007, 78% of store-based food expenditures came from packaged foods.[62]

Homescan participating households are given barcode scanners, and household members are instructed to scan the barcodes on all purchased items upon returning home. A major advantage of Nielsen Homescan over other population-level studies is that it collects information on the different food retailers or types of stores where households actually shop for food: 1) warehouse-club (e.g., Costco, Sam's); 2) mass-merchandisers or supercenters, (e.g., Walmart, Super Target); 3) supermarkets/grocery stores (e.g., Kroger, Safeway, Trader Joes, Whole Foods); 4) convenience stores (e.g., Seven Eleven, gas stations); 6) drug stores (e.g., CVS, Walgreens); 8) dollar stores (e.g., Dollar General) and 8) others (e.g., department stores, book stores, etc.). This data allows us to examine the impact of specific retailers or types of store on the food and beverage choices and the nutrient profile of packaged food purchases among US households.

Household-level purchase data by type of store from Nielsen Homescan has been linked to NFP data to provide nutrient information on all packaged foods and beverages brought into the home. [62, 63] These NFP are continuously updated and matched to PFP products, providing a more accurate and time-sensitive measure of nutrition. Scanning of PFP by households occurs continuously through the year. For a household to be included in the panel, they need to report purchases for ≥10 months. A year's worth of purchases more likely reflects the usual types of stores where people shop for food as well as the usual foods and beverages they purchase.

CHAPTER 3. THE NUTRIENT CONTENT OF US HOUSEHOLD FOOD PURCHASES BY STORE TYPES

Overview

Little is known about where households shop for packaged foods, what foods and beverages they purchase, and the nutrient content of these purchases. The objectives are to describe volume trends and nutrient content (food groups and nutrient profiles) of household packaged foods purchases (PFP) by store-type. Cross-sectional analysis of US households' food purchases (Nielsen Homescan) from 2000 to 2012 (n=652,023 household-year observations) with survey weights used for national representativeness. Household PFP trends (% volume) by store-type, household purchases of key food and beverage groups based on caloric contribution by store-type , and mean caloric and nutrient densities (sugars, saturated fat and sodium) of household PFP by store-type are analyzed. Data were collected from 2000-2012. Analyses were conducted in 2014-2015. The proportion of total volume of household PFP significantly increased from 2000 to 2012 for mass-merchandisers (13.1 to 23.9%), convenience-stores (3.6 to 5.9%) and warehouse-club (6.2 to 9.8%), and significantly decreased for grocery-chains (58.5 to 46.3%) and non-chain grocerys (10.3 to 5.2%). Top common sources of calories (%) from household PFP by food/beverage group include: savory snacks, grain-based desserts and regular soft-drinks. The energy, total sugar, sodium and saturated fat densities of household PFP from mass-

merchandisers, warehouse-club and convenience-stores were higher, compared to grocery-stores. In conclusion, PFP from stores with poorer nutrient density (more energy, total sugar, sodium and saturated fat-dense), such as warehouse-club, mass-merchandisers and convenience-stores are growing, representing a potential US public health concern.

Introduction

State and national programs and policies [3-6] focus on building grocery-stores or supermarkets in food deserts to improve household food purchases, dietary quality, and reduce health disparities. A major concern is that people living in food deserts have limited access to healthy foods and relatively easier access to unhealthy foods, diminishing the nutritional quality of foods purchased, and ultimately, increasing the risk of obesity and nutrition-related chronic diseases. [1] These strategies rely on the assumption that people shopping at larger retail stores, e.g., supermarkets, have a better nutrient profile of food purchases because supermarkets sell more variety of foods with higher nutritional quality at lower prices than other stores (e.g., convenience-stores) and because larger stores have more capacity to handle perishables safely and efficiently. [64] Yet, a clear understanding of the types of stores where people actually shop for food, the foods they purchase and the nutrient profile of their purchases is lacking. Furthermore, we have no literature on how store selection for food shopping changes over time.

Most studies looking at associations of the food environment with diet and health lack data on where people shop for food, what they actually purchase, or information on the nutrient

profile of these purchases. [11, 23, 24, 28] Studies on where people shop for food rely on the presence of stores located within people's residential food environment [15, 16] or the location of people's principal food store source.[17, 18] These studies make inferences about the types of stores where people shop for food and associations with diet or health without directly linking foods consumed to the stores where foods were purchased.[52] Additionally, these studies fail to capture all the possible stores where people may shop. The few food purchase studies use small samples [55, 57, 58] and have focused on specific food groups, ignoring the entire set of purchases made at the store. [26, 59]

To address these gaps, we utilized the Nielsen Homescan dataset, a nationally representative sample of US households. Homescan is unique for studying packaged food purchases (PFP - foods and beverages with a barcode) across stores since households' record the store source and all packaged foods and beverages purchased from every shopping occasion over one or more years. Improving our food environment includes a key focus on PFP, which accounts for 78% of store-based food expenditures. [63] This analysis focuses on three research questions: (1) at what types of stores do US households shop for food?; (2) does store-type shopping change over time?; and (3) does nutrient profile and types of foods/beverages purchased by US households vary by store-type?

Methods

Study design and population

We used PFP (i.e., all foods and beverages with a barcode) data from the US Homescan Consumer Panel dataset from 2000-2012. [60] Participating households receive barcode scanners, and are instructed to scan barcodes on all purchased items and report the outlet's name upon returning home after every shopping trip. Scanning occurred continuously through the year and included products purchased from all outlet channels. For inclusion in the panel, households needed to report ≥10 months of purchases. Demographic characteristics and household size were collected by questionnaire. Homescan uses direct mailing (targeting low-income and racial-ethnic minority groups) and Internet to recruit households. Homescan uses an open cohort study design. Households may exit any time, and new households are enrolled to replace dropouts based on demographic and geographic targets. [61] Households were sampled from 76 markets, (52 metropolitan and 24 non-metropolitan areas), and were weighted to be nationally representative.

This study included all households from 2000 to 2012 (n=670,782 household-year observations). We conducted cross-sectional analysis, treating each survey year as an independent nationally representative sample of US households. To ensure we capture usual purchases, we excluded household-quarter observations deemed unreliable (<$135 worth of PFP in four week period for ≥2 member household and <$45 for single-member household) and household-year observations including >1 unreliable quarter. This excluded 2.1% of household-

year observations. The final analytical sample included 652,023 household-year observations. Analyses were conducted in 2014-2015.

Nutrient content of PFP

To determine the nutritional content of household PFP, each uniquely barcoded product captured in Homescan was linked with Nutrition Facts Panel data. Methodology for this process has been described elsewhere. [62, 65] Non-packaged foods were not included (e.g. many produce, meats, breads, prepared foods, etc.) because products without barcodes cannot be scanned. However, produce and meats that are packaged are included (e.g., bag of apples, frozen meats, etc.).

Store categorization

For every shopping occasion made over a year, each household reported the name of the store where they shopped for food. To define store-type, we used Nielsen's store categorization based on the size, annual sales/revenue and proportion of items in stock. Consequently, some of the industry categorizations, such as the supermarkets/grocery-store sector, represent a heterogeneous group of stores. Therefore, we used the name of the store and Internet searches to further classify the supermarkets/grocery-store sector into corporate-owned grocery-chains (≥10 stores); non-chain grocery (<10 stores); ethnic-stores; and specialty-stores, using 2012 information. Based on the mean proportion of volume of PFP from each store-type, we combined ethnic with specialty-stores, and convenience with dollar and drug stores. Finally, we classified stores into 7 mutually exclusive categories: 1) warehouse-club (e.g., Costco, Sam's); 2) mass-

merchandisers-supercenters, hereafter mass-merchandisers (e.g., Walmart, Super-Target); 3) grocery-chains (≥10 units; e.g., Kroger, Safeway); 4) non-chain grocery (<10 units); 5) convenience-drug-dollar, hereafter convenience-stores (e.g., Seven Eleven, CVS, Dollar General); 6) ethnic-specialty; and 7) others (e.g., department stores, book stores). Our analyses focused on the first six store-types because "others" represented a heterogeneous group.

PFP by store-type

To fully capture usual shopping habits, we conducted all analyses at the household-year level. To understand at what store-types US households shop and whether store-type shopping changed over time, we calculated the proportion of volume purchases by store-type. We selected volume because it captures low-caloric and non-caloric foods and beverages possibly missed in the calorie trends.

To understand whether the nutrient profile and types of foods/beverages purchased by US households vary by store-type, we calculated four measures: (1) caloric and nutrient densities (g of total sugar, g of saturated fat and mg of sodium) per 100 g of household PFP by store-type; (2) grams of PFP per-household per-day by store-type; (3) percentage of store-type proportion of calories and volume by food and beverage group **(Supplemental Table 3.1)**; and (4) per-household per-day absolute number of calories and volume by food and beverage group by store-type. We used nutrient densities since households purchased different amounts of packaged foods/beverages by store-types and used the absolute volumes to put density measures in context.

Statistical analyses

All analyses were conducted using Stata 13 (StataCorp LP) using survey commands to generate nationally representative estimates, incorporating Nielsen annual household sampling weights while accounting for repeated observations and market-level clustering.[66]

We calculated the contribution of each store-type as a percentage of total volume purchased. We regressed percent volume on indicator variables for store-type, year and store-type year interactions. We used margins– command in Stata to predict weighted unadjusted mean percentage volume from each store-type across all households from 2000 to 2012. We used regression models to test linear trends. Pairwise comparisons were used to test differences between stores at a given year, using grocery-chains as the referent group. A two-sided $p<0.001$ denotes statistical significance, accommodating multiple comparisons and the large sample size.

To explore nutrient profile differences by store-type, we calculated weighted unadjusted mean caloric and nutrient densities of household PFP in 2000, 2006, and 2012. Analyses were performed separately for each store-type. Only households with PFP from a given store-type were included in the analysis, therefore we cannot perform statistical testing. Densities reflect what households are actually purchasing at each store-type and are driven by what each store-type offers and what customers decide to buy.

To identify top contributors to each store-type, we separately ranked food groups and beverage groups purchased by households using weighted unadjusted mean proportion and absolute number of calories (and volume) in 2000, 2006 and 2012. Analyses were performed

separately for each store-type. Only households that purchased foods/beverages from a given store-type were included in the analysis, therefore we cannot perform statistical tests.

Sensitivity analysis

The nutrient profile of household purchases by store-type may vary due to purchases from products without barcodes or Nutrition Facts Panel information, especially if households purchase different amounts of such products from different store-types. While we do not have nutrient data, we have information on household expenditures on non-packaged foods for a Homescan subsample from 2007-2011. Sensitivity analyses were conducted to determine whether the proportion of non-packaged foods and non-packaged food groups varied by store-type or time. We estimated: (1) mean proportion of household expenditures on non-packaged vs. packaged foods by store-type among the total sample and; (2) mean proportion of household expenditures by non-packaged food groups by store-type among non-packaged food consumers. Analyses were performed separately for each store-type.

Results

Sociodemographic and household characteristics for selected years are shown in **Supplemental Table 3.2**, and sample characteristics by store-type are shown in **Supplemental Table 3.3.** Homescan had a higher proportion of white-non Hispanics, households with some college education, middle income and multiperson households with children, regardless of

survey year. The proportion of Hispanics, black-non Hispanics, and households with college and post college graduates increased over time.

Figure 3.1 shows trends in annual volume (%) from household PFP by store-type from 2000-2012. Volume from grocery-chains and non-chain grocery's significantly decreased over time, while volume from warehouse-club, mass-merchandisers and convenience-stores significantly increased over time. Regardless of year, grocery-chains represented the biggest contributor to total volume from household PFP. Trends in calories (%) were similar to trends in volume.

Figure 3.2 shows the caloric and nutrient profile of household PFP and the absolute number of mean grams per-household per-day from PFP by store-type in 2000, 2006, and 2012. The caloric, total sugar and saturated fat densities of household PFP from mass-merchandisers, warehouse-club and convenience-stores decreased over time, but remained higher than the other store-types in 2012. The caloric, total sugar and saturated fat densities of household PFP from grocery-chains, non-grocery chains and ethnic-specialty stores remained stable over time. The sodium density of household PFP from all store-types, besides non-grocery chains, decreased from 2000 to 2006, but rose again in 2012. Household PFP from non-grocery chains, warehouse-club stores, and convenience-stores had the highest sodium density in 2012. Grocery-chains consistently had the lowest caloric and better nutrient densities.

Table 3.1 shows the list of food and beverage groups household purchased and are ranked by contribution to total calories purchased by store-type in 2000, 2006 and 2012. The

biggest differences are not in the top sources of calories, but rather the proportion of total calories purchases by store-type. Top common sources of calories (%) from household PFP by food group across store-types in all years include: savory snacks and grain-based desserts. One major difference is convenience-stores – more than 35% of calories purchased there come from candy and gum in all years. For the top common sources of beverage calories (%), households purchased about a third of beverage calories from regular soft drinks and from fruit drinks/juices at convenience-stores and mass-merchandisers, respectively in all years. Overall, all other store-types had fresh milk as the dominant beverage. Volume estimates are available in **Supplemental Table 3.4**.

Sensitivity analysis

For a given store-type, the mean proportion of dollars spent by households on non-packaged foods/food groups did not vary over time. However, we observed differences in mean proportion of dollars spent on non-packaged foods across store-types. For example, in 2011, household expenditures on non-packaged foods was higher in ethnic-specialty (36.5%) and non-grocery chains (38.9%), compared to convenience-stores (5.3%) and mass-merchandisers (9.1%) **(Supplemental Figure 3.1)**.

Discussion

There has been a rapid transformation of the food retail sector. [67] In this sample, shopping at grocery-chains decreased over time, while shopping at mass-merchandisers, warehouse-club

and convenience-stores rose over time. However, grocery-chains still account for the majority of household PFP. Our results agree with a marketing report showing that shoppers are increasingly shopping at mass-merchandisers and warehouse-clubs. [49] In addition to increasing shopping at non-grocery stores, purchases at these store-types are of lower nutritional quality. While energy-dense diets have been associated with obesity, elevated insulin levels and metabolic syndrome in US adults, [68, 69] the results here are on purchases, not diets. Relating household PFP to individual intake is challenging considering consumer-level food waste associated with households PFP. [70] Further, no US recommendations for the nutrient content of purchases exist. Future studies should determine whether differences in nutrient densities by store-type translate to higher total energy intake, poor dietary quality, or weight gain at the individual level.

Literature on the relationship between food environment and its association to diet has paid insufficient attention to the types of stores where people shop for food, what they actually purchase and the nutrient profile of those purchases. [71] Our study demonstrates that food and beverage groups such as savory snacks, grain-based desserts, fruit drinks/juices, fresh plain milk, and regular soft-drinks were the top sources of calorie purchases by US households across all types of stores, regardless of time. Our results are consistent with studies of food group intake by US children and adults, where energy-dense and nutrient-poor foods such as SSB, salty snacks and grain-based desserts were major contributors to dietary energy intake. [72-74] These food/beverage groups are major sources of added sugars, saturated fat and sodium. Our study shows that households are purchasing these products across all store-types suggesting that both,

small and large stores, stock large quantities of low-nutrient foods that might contribute to weight gain and affect health. Much of the literature focuses on the relationship between store-type availability with diet and health. However, it may not only be store-type availability that matters, but the fact that unhealthy foods/beverages are ubiquitous and households are purchasing them everywhere. Additionally, more should be done to encourage non-grocery retailers to stock and promote purchases of healthier products at better prices relative to less-healthy foods. [75]

Important strengths of this study are that we know the types of store where households shopped, what foods and beverages they actually purchased and we have linked nutrient data to those purchases. Moreover, we were able to study PFP trends over a period of 13 years. Additionally, to avoid bias from dietary self-reported assessment methods, purchase data were collected by objective scanning of barcodes for PFP. Lastly, we collected data for PFP during the course of an entire year, reflecting households' usual purchases.

Limitations

A key limitation is that our study does not account for the role of individual choice on where households shop, which is a complex decision affected by many factors. The four P's of marketing: product, *price,* promotion, and *placement,* influence food purchasing decisions [76-79] along with individual food preferences, [1] transportation, and time. [45, 80] Our results are a combination of where households choose to shop and what the store offers.

Additionally, we are unable to verify whether all household PFP from all store-types and trips were scanned. Systematic underreporting is possible if households are less likely to scan purchases that occurred "on-the-go" and never made it home, especially from convenience-stores. Our results could underestimate the nutrient profile of purchases from convenience-stores; however, we found that purchases from convenience-stores already have one of the "worst" nutrient profiles. Another limitation is our lack of non-packaged food purchase detailed data, as extensive public health efforts are placed on increasing produce purchases. While unpackaged produce are excluded, purchases from food categories such as frozen, canned and barcoded produce are included, as are most whole grains and legumes. Sensitivity analysis of expenditure of non-packaged foods showed that dollars spent on non-packaged foods/non-packaged foods categories remained stable over time at each store-type. Conversely, we observed differences in non-packaged food expenditures between store-types. This may reflect availability of these types of food at the different store-types as well as individual preferences. Differences in non-packaged foods between store-types may influence the nutrient profile of total purchases, especially if non-packaged foods purchased are of better nutrient quality at certain store-types. It is important to recognize that not all non-packaged food purchases are produce or "healthy." Many of the non-packaged food purchases are deli meats, cheeses or prepared foods, however no nutrient data are available for these items. Additionally, Homescan does not capture away-from-home purchases. The lack of data on non-store sources of food (e.g., food service, schools), or

non-packaged foods means we are unable to describe overall nutrient profile of total food purchases.

Although sampling weights were used, studies have questioned whether household characteristics of Homescan match the sociodemographic characteristics of the US population. [81] However, validation studies found that the accuracy of the Homescan data at measuring purchases at the national level was comparable to other widely used economic datasets. [82] Moreover, elsewhere we showed that trends in Homescan purchase data mirror trends in NHANES food intake from stores. [83]

Conclusions

We found that grocery-chains account for the majority of household PFP. However, growing volume trends of household PFP from store-types with poorer nutrient density (more energy, total sugar, sodium and saturated fat-dense), such as warehouse-club, mass-merchandisers, and convenience-stores, could pose a potential US public health concern. Additionally, less healthy food/beverage groups such as grain-based desserts, salty snacks, fruit drinks/juices and regular soft-drinks are top calorie contributors to household purchases from all types of stores. The results of this study lead to an important policy question: should policy initiatives rely on increasing physical access to stores and helping stores sell different food groups to encourage healthier purchases, or are those efforts negated by people choosing to shop at stores that offer foods in line with their dietary preference? Our results suggest that the same food/beverage groups would be purchased at any store-type; however, people may buy relatively

unhealthier food/beverage products at selected store-types. Future research is needed to account for selection of store-types where households shop and how different race-ethnic and sociodemographic groups are associated with the nutrient quality of PFP by store-type.

Tables and Figures

Table 3. 1.Top packaged food and beverage groups purchased by US households (calories) by store-type, Homescan 2000, 2006 and 2012 [a]

2000

		Grocery chains (n=33,233)			Non-chain grocery (n=19,415)			Ethnic-specialty (n=7,740)			Mass merchandisers (n=30,414)			Convenience stores (n=28,604)			Warehouse clubs (n=17,014)		
		Group	% kcal	mean (SE)	Group	% kcal	mean (SE)	Group	% kcal	mean (SE)	Group	% kcal	mean (SE)	Group	% kcal	mean (SE)	Group	% kcal	mean (SE)
Top packaged foods	1	Savory snacks	8.7	147.5 (1.1)	Ready-to-eat breads	9.0	44.9 (0.8)	Savory snacks	10.3	54.9 (1.8)	Candy and gum	25.9	117.1 (1.1)	Candy and gum	42.4	36.6 (0.3)	Savory snacks	12.9	65.5 (1.1)
	2	Fats and oils	8.7	147.5 (1.2)	Savory snacks	8.9	44.3 (0.8)	Grain based desserts	8.0	42.5 (1.5)	Savory snacks	16.2	73.1 (0.8)	Savory snacks	12.9	11.2 (0.2)	Candy and gum	10.6	53.9 (1.2)
	3	Grain based desserts	7.8	131.7 (1.2)	Grain based desserts	7.9	39.4 (0.7)	Ready-to-eat breads	7.6	40.6 (1.5)	Grain based desserts	13.2	59.7 (0.7)	Grain based desserts	10.4	9.0 (0.2)	Grain based desserts	8.9	45.4 (1.0)
	4	Ready-to-eat breads	7.3	123.4 (0.9)	Fats and oils	7.6	37.8 (0.7)	Fats and oils	6.9	37.0 (1.2)	Ready-to-eat breakfast	6.2	27.9 (0.5)	Nuts and seeds	5.1	4.4 (0.1)	Fats and oils	7.1	36.3 (1.0)
	5	Ready-to-eat breakfast	6.4	108.3 (1.0)	Ready-to-eat breakfast	4.9	24.4 (0.6)	Ready-to-eat breakfast	6.5	34.8 (1.3)	Ready-to-eat breads	4.3	19.5 (0.4)	Ready-to-eat breads	3.9	3.3 (0.1)	Nuts and seeds	5.1	25.7 (0.8)
		All other foods	61.1	1035.9 (1.9)	All other foods	61.7	307.7 (1.4)	All other foods	60.6	322.7 (2.7)	All other foods	34.2	154.3 (1.2)	All other foods	25.3	21.8 (0.2)	All other foods	55.4	282.0 (1.8)
		Total	100.0	1694.4 (11.7)	Total	100.0	498.4 (9.4)	Total	100.0	532.4 (14.7)	Total	100.0	451.6 (7.5)	Total	100.0	86.4 (1.6)	Total	100.0	508.7 (9.8)
Top packaged beverages	1	Fresh plain milk	34.2	112.3 (0.7)	Fresh plain milk	38.3	43.7 (0.5)	Fresh plain milk	31.9	40.7 (0.8)	Soft drinks, regular	30.4	27.6 (0.3)	Soft drinks, regular	29.6	12.5 (0.2)	Fruit drinks and juice	41.4	40.0 (0.5)
	2	Fruit drinks and juice	27.0	88.6 (0.6)	Fruit drinks and juice	24.7	28.2 (0.4)	Fruit drinks and juice	24.8	31.7 (0.7)	Fruit drinks and juice	29.4	26.7 (0.3)	Fresh plain milk	26.6	11.2 (0.2)	Fresh plain milk	19.8	19.1 (0.4)
	3	Soft drinks, regular	22.1	72.5 (0.7)	Soft drinks, regular	20.7	23.7 (0.4)	Soft drinks, regular	16.4	20.9 (0.7)	Fresh plain milk	22.4	20.3 (0.3)	Fruit drinks and juice	19.2	8.1 (0.1)	Alcohol	13.3	12.9 (0.4)
	4	Alcohol	6.4	21.2 (0.4)	Alcohol	6.5	7.4 (0.3)	Alcohol	13.5	17.3 (0.8)	Alcohol	4.2	3.8 (0.1)	Alcohol	12.7	5.4 (0.1)	Soft drinks, regular	7.0	6.8 (0.3)
	5	Tea	2.3	7.5 (0.2)	Dairy drinks	2.3	2.6 (0.1)	Dairy drinks	3.0	3.8 (0.3)	Coffee	3.1	2.8 (0.1)	Soft drinks, diet	3.5	1.5 (0.1)	Concentrates	5.1	4.9 (0.2)
		All other beverages	8.0	26.1 (0.3)	All other beverages	7.6	8.6 (0.2)	All other beverages	10.4	13.3 (0.5)	All other beverages	10.7	9.7 (0.2)	All other beverages	8.3	3.5 (0.1)	All other beverages	13.4	12.9 (0.4.)
		Total	100.0	328.2 (2.9)	Total	100.0	114.1 (2.5)	Total	100.0	127.7 (3.8)	Total	100.0	90.8 (2.0)	Total	100.0	42.1 (1.0)	Total	100.0	96.7 (2.5)

2006

		Grocery chains (n=57,712)			Non-chain grocery (n=29,477)			Ethnic-specialty (n=13,385)			Mass merchandisers (n=54,476)			Convenience stores (n=50,462)			Warehouse clubs (n=29,956)		
		Group	% kcal	mean (s.e.)	Food group	% kcal	mean (s.e.)	Group	% kcal	mean (s.e.)	Group	% kcal	mean (s.e.)	Group	% kcal	mean (s.e.)	Group	% kcal	mean (s.e.)
Top packaged foods	1	Savory snacks	8.9	125.6 (0.7)	Savory snacks	9.1	33.0 (0.5)	Savory snacks	9.9	44.3 (1.1)	Candy and gum	16.5	124.1 (1.3)	Candy and gum	39.2	47.9 (0.3)	Savory snacks	11.4	59.6 (0.8)
	2	Fats and oils	7.7	108.6 (0.7)	Ready-to-eat breads	7.9	28.9 (0.5)	Ready-to-eat breads	7.2	32.1 (0.9)	Savory snacks	13.0	97.4 (0.8)	Savory snacks	13.2	16.2 (0.2)	Candy and gum	8.5	44.1 (0.9)
	3	Grain based desserts	7.3	103.7 (0.7)	Grain based desserts	7.6	27.5 (0.5)	Ready-to-eat breakfast	7.1	31.8 (1.0)	Grain based desserts	9.9	74.3 (0.7)	Grain based desserts	11.0	13.5 (0.2)	Grain based desserts	8.0	41.9 (0.7)
	4	Ready-to-eat breads	7.0	98.9 (0.6)	Fats and oils	6.8	24.7 (0.4)	Fats and oils	6.8	30.4 (0.8)	Ready-to-eat breakfast	7.3	54.9 (0.6)	Nuts and seeds	5.8	7.1 (0.1)	Fats & oils	6.4	33.4 (0.7)
	5	Ready-to-eat breakfast	6.3	89.3 (0.7)	Processed meat	5.2	18.9 (0.4)	Grain based desserts	6.8	30.3 (0.9)	Fats and oils	5.1	38.1 (0.5)	Ready-to-eat breakfast	4.0	4.9 (0.1)	Nuts and seeds	5.8	30.2 (0.6)
		All other foods	62.8	888.6 (1.2)	All other foods	63.5	231.1 (0.9)	All other foods	62.6	278.1 (1.7)	All other foods	48.3	362.9 (1.3)	All other foods	26.8	32.8 (0.3)	All other foods	59.9	312.4 (1.4)
		Total	100.0	1414.8 (8.5)	Total	100.0	364.2 (6.2)	Total	100.0	447.1 (11.4)	Total	100.0	751.7 (7.1)	Total	100.0	122.3 (1.7)	Total	100.0	521.4 (7.1)
ucver ages	1	Fresh plain milk	35.3	90.7 (0.4)	Fresh plain milk	36.7	31.8 (0.3)	Fresh plain milk	26.3	26.6 (0.5)	Fresh plain milk	28.0	36.8 (0.3)	Soft drinks, regular	31.2	15.4 (0.2)	Fruit drinks and juice	35.9	36.7 (0.4)

	2	Fruit drinks and juice	25.1	64.5 (0.4)	Fruit drinks and juice	24.2	21.0 (0.3)	Fruit drinks and juice	23.3	23.5 (0.5)	Fruit drinks and juice	27.9	36.6 (0.3)	Fresh plain milk	28.1	13.8 (0.2)	Fresh plain milk	24.7	25.5 (0.4)
	3	Soft drinks, regular	21.4	55.1 (0.4)	Soft drinks, regular	19.4	16.8 (0.3)	Alcohol	19.2	19.4 (0.5)	Soft drinks, regular	24.7	32.5 (0.3)	Fruit drinks and juice	18.5	9.1 (0.1)	Alcohol	13.9	14.2 (0.3)
	4	Alcohol	7.5	19.3 (0.3)	Alcohol	8.7	7.5 (0.2)	Soft drinks, regular	15.9	16.0 (0.4)	Alcohol	5.4	7.2 (0.2)	Alcohol	10.2	5.0 (0.1)	Soft drinks, regular	8.4	8.6 (0.3)
	5	Dairy drinks	3.7	9.6 (0.2)	Dairy drinks	3.5	3.1 (0.1)	Dairy drinks	4.1	4.1 (0.2)	Concentrates	3.1	4.0 (0.1)	Tea	3.6	1.8 (0.1)	Concentrates	3.9	4.0 (0.2)
		All other beverages	7.0	18.0 (0.2)	All other beverages	7.4	6.4 (0.2)	All other beverages	11.1	11.2 (0.4)	All other beverages	10.9	14.3 (0.2)	All other beverages	8.4	4.2 (0.1)	All other beverages	13.2	13.5 (0.3)
		Total	100.0	257.3 (2.0)	Total	100.0	86.5 (1.8)	Total	100.0	100.8 (2.9)	Total	100.0	131.5 (1.5)	Total	100.0	49.2 (1.0)	Total	100.0	102.1 (2.)

<----------2012---------->

Top packaged foods

	Grocery chains (n=55,880)			Non-chain grocery (n=26,417)			Ethnic-specialty (n=15,449)			Mass merchandisers (n=53,482)			Convenience stores (n=47,703)			Warehouse clubs (n=30,257)		
	Group	% kcal	mean (s.e.)	Group	% kcal	mean (s.e.)	Group	% kcal	mean (s.e.)	Group	% kcal	mean (s.e.)	Group	% kcal	mean (s.e.)	Group	% kcal	mean (s.e.)
1	Savory snacks	9.3	117.7 (0.8)	Savory snacks	9.4	28.4 (0.5)	Savory snacks	9.1	37.7 (0.9)	Candy and gum	12.0	85.1 (0.9)	Candy and gum	35.7	45.4 (0.3)	Savory snacks	10.2	57.4 (0.8)
2	Fats and oils	7.7	97.0 (0.7)	Ready-to-eat breads	7.7	23.2 (0.4)	Fats and oils	6.1	25.2 (0.7)	Savory snacks	10.7	75.6 (0.6)	Savory snacks	13.9	17.7 (0.2)	Grain based desserts	7.4	41.6 (0.7)
3	Grain based desserts	6.9	87.0 (0.6)	Grain based desserts	6.8	20.6 (0.4)	Grain based desserts	6.0	24.9 (0.7)	Grain based desserts	8.1	57.5 (0.5)	Grain based desserts	10.1	12.8 (0.2)	Fats and oils	6.8	38.3 (0.8)
4	Ready-to-eat breads	6.5	82.4 (0.5)	Fats and oils	6.7	20.1 (0.4)	Ready-to-eat breads	5.9	24.6 (0.7)	Ready-to-eat breakfast	6.9	49.2 (0.5)	Nuts & seeds	5.1	6.5 (0.1)	Candy & gum	6.3	35.5 (0.7)
5	Ready-to-eat breakfast	6.0	75.6 (0.6)	Pasta & rice	5.1	15.5 (0.4)	Processed meat	5.8	24.0 (0.8)	Fats and oils	5.7	40.1 (0.5)	Ready-to-eat breakfast	5.0	6.4 (0.1)	Ready-to-eat breakfast	6.1	34.2 (0.7)
	All other foods	63.6	802.6 (1.2)	All other foods	64.4	194.6 (0.8)	All other foods	67.2	280.0 (1.5)	All other foods	56.6	400.6 (1.1)	All other foods	30.2	38.4 (0.3)	All other foods	63.2	355.9 (1.3)
	Total	100.0	1262.4 (8.0)	Total	100.0	302.4 (5.8)	Total	100.0	416.4 (10.3)	Total	100.0	708.1 (6.9)	Total	100.0	127.2 (1.7)	Total	100.0	562.9 (7.5)

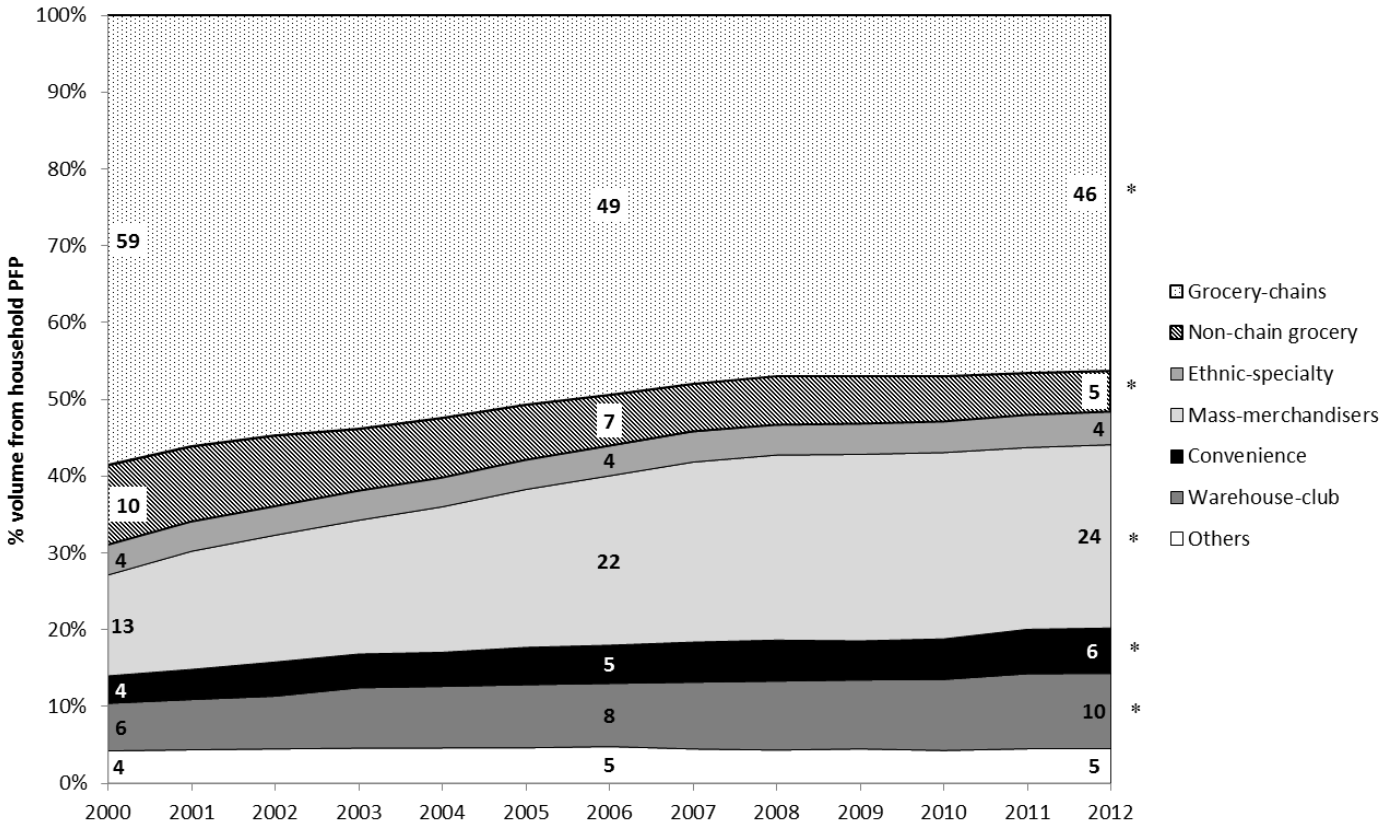
Top packaged beverages

1	Fresh plain Milk	35.7	72.1 (0.4)	Fresh plain milk	33.6	21.0 (0.3)	Fresh plain milk	24.9	20.7 (0.4)	Fresh plain milk	28.8	32.1 (0.2)	Soft drinks, regular	31.7	14.4 (0.2)	Fruit drinks and juice	31.1	29.8 (0.4)
2	Fruit drinks and juice	23.0	46.5 (0.3)	Fruit drinks and juice	24.4	15.2 (0.2)	Fruit drinks and juice	23.4	19.5 (0.4)	Fruit drinks and juice	25.9	28.9 (0.2)	Fresh plain milk	23.5	10.7 (0.1)	Fresh plain milk	26.6	25.5 (0.4)
3	Soft drinks, regular	19.1	38.7 (0.3)	Soft drinks, regular	19.1	11.9 (0.2)	Alcohol	20.0	16.6 (0.4)	Soft drinks, regular	20.6	23.0 (0.2)	Fruit drinks and juice	17.6	8.0 (0.1)	Alcohol	14.3	13.7 (0.3)
4	Alcohol	8.5	17.1 (0.3)	Alcohol	9.4	5.9 (0.2)	Soft drinks, regular	14.6	12.2 (0.3)	Alcohol	8.0	8.9 (0.2)	Alcohol	10.2	4.6 (0.1)	Soft drinks, regular	9.7	9.3 (0.3)
5	Dairy drinks	4.6	9.3 (0.2)	Dairy drinks	4.1	2.5 (0.1)	Dairy drinks	5.4	4.5 (0.2)	Concentrates	4.2	4.7 (0.1)	Tea	5.6	2.5 (0.1)	Tea	4.3	4.1 (0.2)
	All other beverages	9.2	18.5 (0.2)	All other beverages	9.5	5.9 (0.2)	All other beverages	11.7	9.7 (0.3)	All other beverages	12.5	13.9 (0.2)	All other beverages	11.3	5.2 (0.1)	All other beverages	14.0	13.4 (0.3)
	Total	100.0	202.2 (1.7)	Total	100.0	62.4 (1.9)	Total	100.0	83.1 (2.3)	Total	100.0	111.4 (1.3)	Total	100.0	45.4 (0.8)	Total	100.0	95.8 (1.8)

[a] Percentages and means have been weighted to be nationally representative. Data comes from the 2012 Nielsen Homescan panel of household packaged food purchases. An observation represents all purchases made by a single household over a period of ≥10-12 months. The number of year-household observations by store type are not mutually exclusive as some households might have purchased foods at different store types. Our statistical testing focused on the trends analysis. For these analyses, only households with PFPs from a given store type were included; therefore, statistical testing could not be performed.

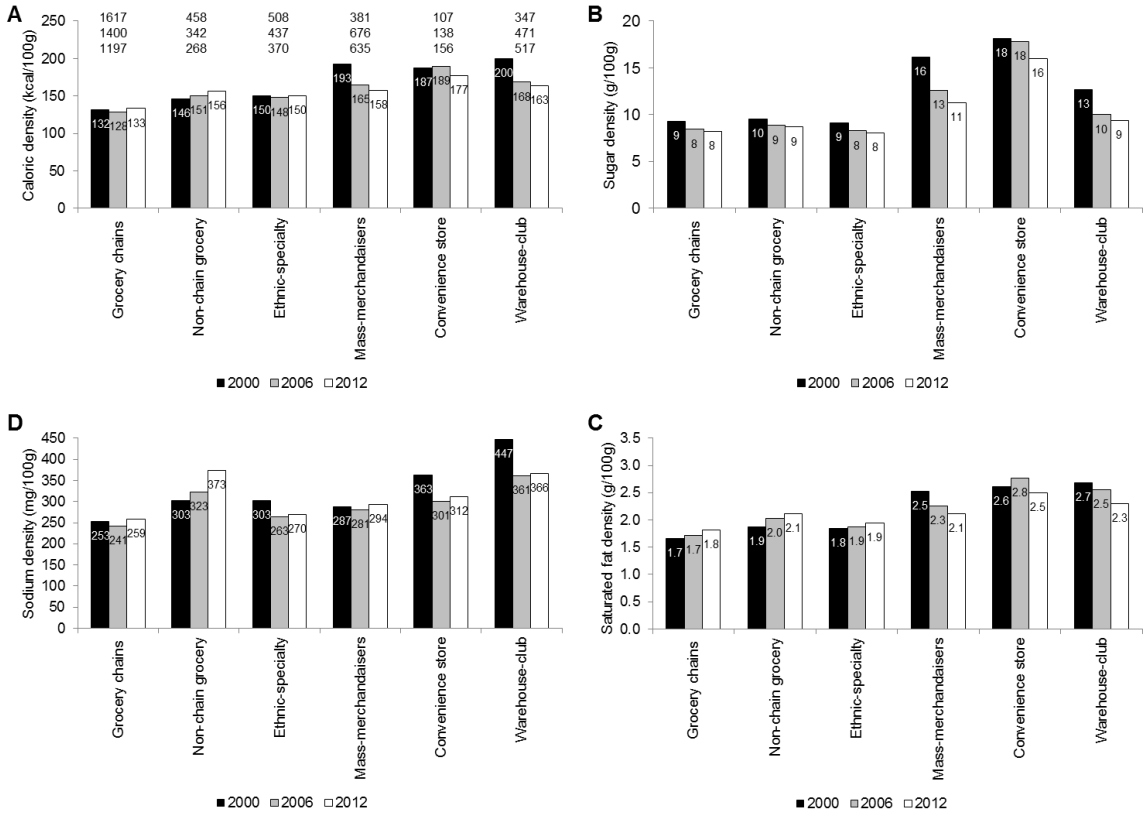
Fruit drinks and juice (includes fruit and vegetable drinks and juice); Tea (bags, loose, ready-to-drink); Dairy drinks (refrigerated sweetened); Concentrates (Beverage powder and concentrates); Soft drinks, regular (>20 kcal/100g); Soft drinks, diet (≤20 kcal/100g).

Figure 3.1. Trends in the proportion of annual volume from household PFP by store-type, Homescan 2000-2012.



Values represent unadjusted means using survey weighted linear regression models. * Denotes significant linear trends in the contribution of a given store-type to purchases (% volume). For all years, comparisons were made between stores, using grocery-chains as the referent group. All comparisons between stores were significantly different at a $p<0.001$ to account for multiple comparisons and sample size. Data comes from the 2000-2012 Nielsen Homescan panel of household packaged food purchases. All values are weighted to be nationally representative. Percentages labeled within the graph represent estimates in 2000, 2006, and 2012. Number of household-year level observations: n=652,023.

Figure 3.2. Caloric, total sugar, sodium and saturated fat densities from household PFP by store-type, Homescan 2000, 2006, and 2012.



(A) Caloric density (kcal/100g); (B) sugar density (g/100g); (C) sodium density (mg/100g); (D) saturated fat density (g/100g). Values represent weighted unadjusted means. Values above bars in panel (A) indicate the mean absolute number of grams households purchased per-day by store-type for 2000, 2006 and 2012 (top, middle, and bottom, respectively). Analyses were performed separately for each store-type. Our statistical testing focused on the trends analysis. For these analyses, we could not statistically compare across store-types due to differences in samples for each store-type. Data comes from the 2000, 2006 and 2012 Nielsen Homescan panel of household packaged food purchases. All values are weighted to be nationally representative.

Supplemental Table 3.1. Homescan food grouping system

	Food/beverage group	Description
1	Cheese	Includes all cheeses.
2	Yogurt	Includes refrigerated yogurt, yogurt shakes and drinks.
3	Frozen/refrigerated dairy-based toppings/condiments	Includes all sour cream, whipping cream, frozen cream substitutes.
4	Shelf-stable creamers, evaporated or condensed milks	Includes all creamers, canned milk.
5	Beef/pork	Includes all fresh frozen and canned pork.
6	Poultry	Includes all fresh frozen and canned poultry.
7	Seafood	Includes all refrigerated, frozen, and canned seafood.
8	Processed Meat	Includes all refrigerated and canned processed meats.
9	Eggs	Includes all fresh eggs.
10	Nuts and seeds	Includes all nuts and seeds
11	Cereals, requires cooking	Includes all cereals that require cooking such as hot cereal, grits, barley, wheat germ, etc.
12	Ready-to-eat breakfast	Includes all ready-to-eat cereals, breakfast cakes, bars and sweet rolls, frozen and refrigerated breakfasts, etc.
13	Pasta & Rice	Includes all boxed, dried, fresh and frozen pasta and rice and well as boxed pasta and rice dinners.
14	Shelf-stable Mexican-style products	Includes all Mexican-style products (Mexican dinners, shells, tortillas, Mexican specialties, etc.)
15	Dry baking mix	Includes all dry baking mixes such as pancake, bread, hushpuppy, rolls and biscuits, pie and crust mixes, etc.
16	Flours	Includes all flours and corn meal.
17	Baking supplies	Includes products such as baking powder, baking soda, starch, food coloring, cocoa, fruit pectin, yeast, etc.
18	Baking supplies, sweet	Includes products such as baking chips, baking chocolate, frosting ready to spread, fruit glazed, etc.
19	Desserts, prepare-at-home	Includes all cake, brownie and muffin mixes, frosting, etc.
20	Dairy-based dessert	Includes ice-cream, ice pops, frozen desserts, canned desserts, etc.
21	Ready-to-eat breads	Includes all fresh and frozen ready-to-eat brands such as beagles, biscuits, breads, buns, etc.
22	Grain-based desserts	Includes all fresh, refrigerated and frozen and boxed cakes, doughnuts, cookies, and bars.
23	Refrigerated/frozen dough products	Includes all refrigerated and frozen dough such as bread, biscuits, dinner rolls, pizza crust, etc.

24	Pizza	Includes all refrigerated and frozen pizza.
25	Fruit, fresh & frozen	Includes all fresh and frozen fruit.
26	Fruit, canned and dried	Includes all canned and dried fruit.
27	Other fruit	Includes dried fruit and products such as maraschino cherries, pie and pastry filling.
28	Vegetables, canned or dried	Includes all canned and dried vegetables.
29	Vegetables, fresh or frozen	Includes all fresh and frozen vegetables.
30	Potatoes and corn	Includes all refrigerated, frozen and canned potatoes and corn
31	Beans and legumes	Includes all dried and canned beans and legumes.
32	Fats and oils	Includes all fats and oils such as butter, margarine and spreads, cooking sprays, lard, cooking oil, shortening, etc.
33	Salad dressing	Includes all salad dressings.
34	Condiments & sauces	Includes all condiments and sauces such as barbecue, catsup, mustard, mayonnaise, pizza sauce, tomato sauce, seasoning mix, etc.
35	Spreads and dips	Includes all mixes, canned, refrigerated and frozen dips and spreads.
36	Savory Snacks	Includes all savory snacks such as crackers, popcorn, chips, pretzels, etc.
37	Sweets, miscellaneous	Includes products such as gelatin, syrups, toppings, etc.,
38	Sweeteners	Includes all types of sugar, molasses and syrups.
39	Nut and fruit spreads	Includes peanut butter, fruit spreads, jams, marmalade, preservatives, etc.
40	Candy and gum	Includes all candy and gum.
41	Baby food	Includes all baby food.
42	Spices, seasoning, & extracts	Includes salt and all spices and seasoning.
43	Frozen entrees	Includes all types of frozen entrees.
44	Ready-to-eat prepared dishes	Includes all ready-to-eat prepared dishes.
45	Canned mixed dishes	Includes all canned and shelf stable mixed dishes.
46	Shelf-stable soups and stews	Includes all shelf stable soups and stews.
47	Fresh plain milk	Includes all fresh plain milk.
48	Refrigerated sweetened dairy drinks	Includes refrigerated products such as favored milk, shakes, eggnog, etc.
49	Shelf-stable milks, milk substitutes and milk-based powders	Includes all shelf stables milks, milk powders and non-refrigerated shakes.
50	Fruit and vegetable drinks and juice	Includes all shelf-stable and frozen fruit and vegetable juices as well as fruit drinks.
51	Beverage powder and concentrates	Includes all beverage powder and concentrates.
52	Soft drinks, regular	Includes all carbonated soft drinks with >20 calories per 100g.
53	Soft drinks, diet	Includes all carbonated soft drinks with ≤20 calories per 100g.

54	Tea	Includes all bags, loose and ready-to-drink teas.
55	Coffee (grounds, beans, ready-to-drink)	Includes all bags, loose and ready-to-drink coffee.
56	Water	Includes all bottled water.
57	Alcohol	Includes all types of alcohol.

Supplemental Table 3.2. Univariate sociodemographic and household characteristics for selected years, Homescan [a]

	2000		2006		2012	
	n	%	n	%	n	%
Total households	33,795		59,890		58, 707	
Race-ethnicity [b]						
Non-Hispanic white	28,491	79.0	49,387	74.3	47,376	71.3
Hispanic	1,799	8.7	3,165	10.3	3,031	12.0
Non-Hispanic black	2,706	10.8	4,978	10.9	5,427	11.2
Non-Hispanic other	799	1.4	2,360	4.5	2,873	5.6
Education [c]						
Less than high school	750	3.6	915	3.0	719	2.7
Graduated high school	6,975	27.8	11,043	29.4	9,562	27.2
Some college	10,554	35.4	18,851	32.6	17,107	32.5
College graduate	10,247	22.9	19,733	23.6	21,086	25.5
Post college graduate	5,269	10.3	9,348	11.5	10,233	12.0
Income [d]						
Low, <185%	4,554	23.3	11,257	25.3	12,671	29.8
Middle, ≥185 to <400%	14,982	42.2	23,415	33.3	24,243	37.3
High, ≥400%	14,259	34.5	25,218	41.4	21,793	32.9
Household size [e]	2.6	0	2.6	0	2.6	0
Household composition [f]						
Single	8,691	25.7	14,942	26.8	14,934	26.4
Multi-person without children	15,644	39.4	28,658	37.4	30,559	40.1
Multi-person with children	9,460	34.9	16,290	35.8	13,214	33.4

[a] Values are presented as counts and column percentages [except for household size (mean ± s.e.)].
Percentages have been weighted to be nationally representative.
Data comes from the 2000, 2006 and 2012 Nielsen Homescan panel of household packaged food purchases.
An observation represents all purchases made by a single household over a period of ≥10-12 months.
[b] Self-reported race-ethnicity of the household head.

[c] Household self-reported maximum level of education.
[d] Ratio of family income to poverty threshold (calculated from self-reported household income) was used to categorize income according to the percentage of the poverty level.
[e] Number of people living in the household.
[f] Children were all household members ≤18y old. Adults were all household members >19y old.

Supplemental Table 3.3. Sociodemographic and household characteristics by store for selected years, Homescan [a]

	Grocery-chains		Non-chain grocery		Ethnic-specialty		Mass-merchandisers		Convenience-store		Warehouse-club	
	n	%	n	%	n	%	n	%	n	%	n	%
	<----------2000---------->											
Total households	33,233		19,415		7,740		30,414		28,604		17,014	
Race-ethnicity [b]												
Non-Hispanic white	28,024	78.9	16,076	77.4	6,289	75.7	25,685	79.2	23,994	78.3	14,108	77.2
Hispanic	1,760	8.8	1,017	8.7	545	12.0	1,630	8.7	1,497	8.6	1,092	11.2
Non-Hispanic black	2,667	10.9	1,769	12.3	670	10.6	2,405	10.7	2,465	11.8	1,329	10.0
Non-Hispanic other	782	1.4	553	1.6	236	1.7	694	1.3	648	1.3	485	1.6
Education [c]												
Less than high school	720	3.6	471	3.9	134	2.9	661	3.5	672	3.8	246	2.4
Graduated high school	6,828	27.7	4,211	29.4	1,270	23.4	6,528	28.8	6,145	28.9	3,063	24.8
Some college	10,355	35.2	5,956	34.6	2,356	35.5	9,610	35.8	9,038	35.5	5,307	36.0
College graduate	10,122	23.1	5,751	22.4	2,504	24.9	9,115	22.4	8,474	22.0	5,495	25.1
Post college graduate	5,208	10.3	3,026	9.8	1,476	13.2	4,500	9.5	4,275	9.7	2,903	11.6
Income [d]												
Low, <185%	4,413	23.0	2,853	24.8	896	20.4	4,133	23.4	3,986	24.0	1,517	15.9
Middle, ≥185 to <400%	14,700	42.1	8,681	42.3	3,244	40.5	13,827	43.2	12,889	42.8	7,238	42.3
High, ≥400%	14,120	34.9	7,881	32.8	3,600	39.1	12,454	33.3	11,729	33.2	8,259	41.7
Household size [e]	2.6	0.0	2.6	0.0	2.4	0.0	2.6	0.0	2.5	0.0	2.8	0.0
Household composition [f]												
Single	8,507	25.5	4,698	24.7	2,006	26.3	7,176	23.1	7,336	25.3	2,969	17.9
Multi-person without children	15,415	39.7	9,296	40.3	3,825	42.8	14,250	39.9	13,449	40.3	8,697	43.4
Multi-person with children	9,311	34.8	5,421	35.0	1,909	30.9	8,988	37.0	7,819	34.4	5,348	38.7
	<----------2006---------->											
Total households	57,712		29,477		13,385		54,476		50,462		29,956	
Race-ethnicity [b]												

Non-Hispanic white	47,530	74.1	23,742	71.1	10,417	67.9	45,074	74.5	41,323	73.5	24,172	71.4
Hispanic	3,033	10.4	1,574	10.6	973	14.3	2,854	10.3	2,682	10.4	1,836	12.4
Non-Hispanic black	4,862	11.0	2,782	12.7	1,295	12.1	4,477	10.9	4,533	11.8	2,491	10.7
Non-Hispanic other	2,287	4.5	1,379	5.5	700	5.7	2,071	4.3	1,924	4.3	1,457	5.5
Education [c]												
Less than high school	859	2.9	502	3.4	143	2.5	833	3.0	808	3.2	278	2.0
Graduated high school	10,607	29.3	5,601	30.6	1,756	22.7	10,317	30.1	9,814	30.9	4,555	25.3
Some college	18,186	32.6	9,057	31.2	3,818	30.0	17,359	33.0	16,205	33.0	9,112	32.6
College graduate	19,023	23.7	9,497	23.0	4,755	28.3	17,842	23.2	16,224	22.4	10,563	26.3
Post college graduate	9,037	11.5	4,820	11.9	2,913	16.5	8,125	10.7	7,411	10.5	5,448	13.8
Income [d]												
Low, <185%	10,730	25.0	5,774	26.8	1,905	20.4	10,296	25.4	9,986	26.9	3,747	17.0
Middle, ≥185 to <400%	22,545	33.3	11,637	33.1	4,690	30.4	21,786	34.1	20,197	34.0	11,019	32.3
High, ≥400%	24,437	41.8	12,066	40.1	6,790	49.3	22,394	40.5	20,279	39.1	15,190	50.7
Household size [e]	2.6	0.0	2.6	0.0	2.5	0.0	2.6	0.0	2.6	0.0	2.7	0.0
Household composition [f]												
Single	14,264	26.3	6,990	25.8	3,531	26.8	12,632	24.6	12,520	26.3	5,447	18.9
Multi-person without children	27,696	37.7	14,731	39.6	6,754	41.2	26,309	37.8	24,465	38.1	15,908	42.7
Multi-person with children	15,752	36.0	7,756	34.6	3,100	32.0	15,535	37.6	13,477	35.6	8,601	38.4
	<----------2012---------->											
Total households	55,880		26,417		15,449		53,482		47,703		30,257	
Race-ethnicity [b]												
Non-Hispanic white	45,026	71.2	20,744	67.9	11,554	63.0	43,226	71.3	38,137	70.2	23,676	67.5
Hispanic	2,877	12.0	1,344	12.0	1,185	17.1	2,773	12.2	2,465	12.2	1,807	14.3
Non-Hispanic black	5,238	11.3	2,750	13.3	1,680	12.6	4,940	11.2	4,848	12.2	2,890	11.3
Non-Hispanic other	2,739	5.6	1,579	6.8	1,030	7.4	2,543	5.3	2,253	5.4	1,884	7.0
Education [c]												
Less than high school	661	2.7	352	3.1	139	2.5	650	2.7	635	3.0	248	2.0
Graduated high school	9,036	26.9	4,382	27.9	1,656	20.2	8,924	27.6	8,193	28.6	3,935	23.2
Some college	16,251	32.6	7,656	32.4	4,035	31.3	15,773	32.9	14,286	33.2	8,480	32.5
College graduate	20,142	25.7	9,335	24.6	5,974	29.6	19,155	25.3	16,742	24.1	11,479	27.9

Post college graduate	9,790	12.1	4,692	12.0	3,645	16.6	8,980	11.5	7,847	11.1	6,115	14.4
Income [d]												
Low, <185%	11,865	29.5	5,960	31.5	2,624	23.7	11,689	30.0	10,869	31.7	4,594	21.5
Middle, ≥185 to <400%	23,074	37.3	10,778	36.7	5,953	36.6	22,398	37.9	19,955	37.6	12,266	38.1
High, ≥400%	20,941	33.2	9,679	31.8	6,872	39.7	19,395	32.1	16,879	30.7	13,397	40.3
Household size [e]	2.6	0.0	2.5	0.0	2.6	0.0	2.6	0.0	2.6	0.0	2.7	0.0
Household composition [f]												
Single	25.13	25.8	6,465	26.1	3,995	24.8	12,816	24.6	12,137	26.0	5,828	19.6
Multi-person without children	29,195	40.4	14,359	42.1	8,116	42.1	28,106	40.3	25,143	40.9	17,193	44.1
Multi-person with children	12,640	33.8	5,593	31.8	3,338	33.1	12,560	35.1	10,423	33.2	7,236	36.3

[a] Values are presented as counts and column percentages [except for household size (mean ± s.e)]. Percentages have been weighted to be nationally representative. Data comes from the 2000, 2006 and 2012 Nielsen Homescan panel of household packaged food purchases. An observation represents all purchases made by a single household over a period of ≥10-12 months. The number of year-household observations by store are not mutually exclusive as some households might have purchased foods at different types of store.

[b] Self-reported race-ethnicity of the household head.

[c] Household self-reported maximum level of education.

[d] Ratio of family income to poverty threshold (calculated from self-reported household income) was used to categorize income according to the percentage of the poverty level.

[e] Number of people living in the household.

[f] Children were all household members ≤18y old. Adults were all household members >19y old.

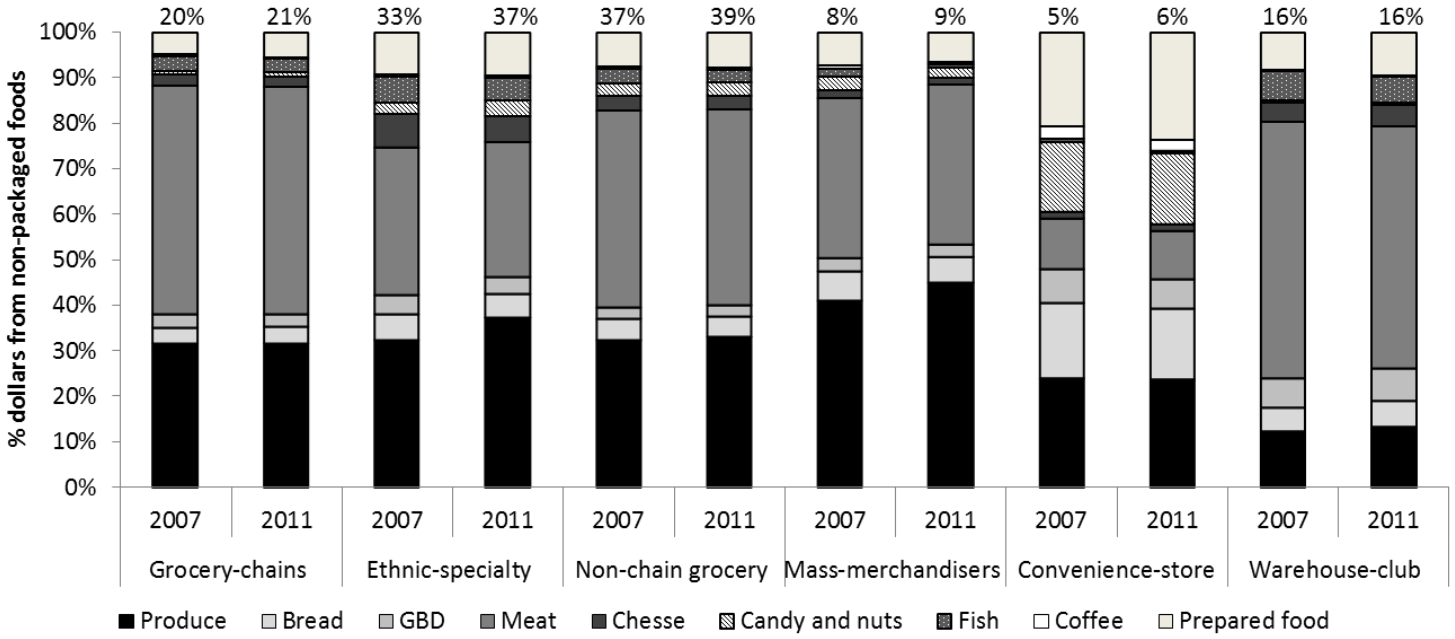
Supplemental Table 3.4. Top packaged food and beverage groups purchased by US households (volume) by store-type, Homescan 2000, 2006, and 2012 [a]

		2000															
		Grocery chains (n=33,233)			Non-chain grocery (n=19,415)			Ethnic-specialty (n=7,740)			Mass merchandisers (n=30,414)			Convenience stores (n=28,604)			Warehouse clubs (n=17,014)		
		Group	% vol	mean (SE)	Group	% vol	mean (SE)	Group	% vol	mean (SE)	Group	% vol	mean (SE)	Group	% vol	mean (SE)	Group	% vol	mean (SE)
Top packaged foods				52.0			18.0			17.2	Candy and		36.0	Candy and		10.5	Savory		17.6
	1	Vegetables	7.0	(0.4)	Vegetables	8.4	(0.3)	Vegetables	7.2	(0.6)	gum	21.9	(0.4)	gum	36.5	(0.1)	snacks	9.1	(0.3)
		Dairy-based		51.5	Ready-to-eat		17.1	Ready-to-eat		16.0	Savory		20.3	Savory		2.9	Candy and		13.0
	2	dessert	7.0	(0.6)	breads	8.0	(0.3)	breads	6.7	(0.7)	snacks	12.3	(0.2)	snacks	10.1	(0.0)	gum	6.7	(0.4)
		Ready-to-eat		46.1	Dairy-based		12.1	Dairy-based		15.2	Grain based		17.7	Grain based		2.5	Grain based		11.7
	3	breads	6.3	(0.4)	dessert	5.6	(0.3)	dessert	6.4	(0.6)	desserts	10.7	(0.2)	desserts	8.6	(0.0)	desserts	6.1	(0.3)
		Condiments and		38.2	Condiments and		11.6	Savory		15.0	Ready-to-eat		9.0	Ready-to-eat		1.2	Frozen		11.1
	4	sauces	5.2	(0.3)	sauces	5.4	(0.3)	snacks	6.3	(0.7)	breakfast	5.4	(0.2)	breads	4.2	(0.0)	entrees	5.7	(0.3)
		Grain based		32.2	Savory		10.8	Grain based		12.5	Ready-to-eat		7.8	Dairy-based		1.2	Condiments and		9.9
	5	desserts	4.4	(0.4)	snacks	5.0	(0.3)	desserts	5.3	(0.6)	breads	4.7	(0.1)	dessert	4.0	(0.0)	sauces	5.1	(0.3)
		All other		518.0	All other		145.2	All other		162.0	All other		74.1	All other		10.5	All other		130.2
		foods	70.2	(0.8)	foods	67.6	(0.5)	foods	68.1	(1.2)	foods	45.0	(0.5)	foods	36.4	(0.1)	foods	67.3	(0.6)
				738.0			214.9			238.0			164.9			28.7			193.4
		Total	100.0	(4.9)	Total	100.0	(3.9)	Total	100.0	(6.4)	Total	100.0	(3.0)	Total	100.0	(0.6)	Total	100.0	(3.3)
Top packaged beverages		Fresh plain		232.8	Fresh plain		90.7	Fresh plain		84.0	Soft drinks,		58.4	Soft drinks,		23.5	Fruit drinks		67.5
	1	milk	26.2	(1.6)	milk	31.3	(1.1)	milk	25.3	(1.9)	regular	22.4	(0.7)	regular	22.6	(0.4)	and juice	32.7	(1.0)
		Soft drinks,		166.5	Fruit drinks		52.7	Fruit drinks		62.4	Soft drinks,		50.6	Fresh plain		21.9	Fresh plain		36.2
	2	regular	18.7	(1.6)	and juice	18.2	(0.9)	and juice	18.8	(1.6)	diet	19.4	(0.7)	milk	21.0	(0.4)	milk	17.5	(0.8)
		Fruit drinks		162.1	Soft drinks,		51.4	Soft drinks,		45.6	Fruit drinks		49.8	Soft drinks,		17.5			22.1
	3	and juice	18.2	(1.3)	regular	17.7	(0.9)	regular	13.7	(1.6)	and juice	19.1	(0.7)	diet	16.8	(0.3)	Alcohol	10.7	(0.7)
		Soft drinks,		146.1	Soft drinks,		37.7	Soft drinks,		42.2	Fresh plain		40.1	Fruit drinks		14.7			18.1
	4	diet	16.4	(1.6)	diet	13.0	(0.8)	diet	12.7	(1.5)	milk	15.4	(0.6)	and juice	14.1	(0.3)	Coffee	8.8	(0.6)
				47.9			16.2			39.6			19.6			10.6			18.1
	5	Water	5.4	(1.0)	Alcohol	5.6	(0.6)	Alcohol	11.9	(1.9)	Water	7.5	(0.5)	Alcohol	10.2	(0.3)	Water	8.8	(0.6)
		All other		133.6	All other		41.2	All other		58.5	All other		42.5	All other		16.0	All other		44.4
		beverages	15.0	(1.5)	beverages	14.2	(0.8)	beverages	17.6	(1.8)	beverages	16.3	(0.7)	beverages	15.4	(0.3)	beverages	21.5	(0.9)
				888.9			289.9			332.4			261.1			104.3			206.4
		Total	100.0	(7.4)	Total	100.0	(6.3)	Total	100.0	(9.5)	Total	100.0	(5.1)	Total	100.0	(2.3)	Total	100.0	(4.8)

		2006															
		Grocery chains (n=57,712)			Non-chain grocery (n=29,477)			Ethnic-specialty (n=13,385)			Mass merchandisers (n=54,476)			Convenience stores (n=50,462)			Warehouse clubs (n=29,956)		
		Group	% vol	mean (SE)	Group	% vol	mean (SE)	Group	% vol	mean (SE)	Group	% vol	mean (SE)	Group	% vol	mean (SE)	Group	% vol	mean (SE)
Top packaged foods		Dairy-based		43.2			14.9			13.4	Candy and		38.4	Candy and		14.0	Savory		17.6
	1	dessert	6.9	(0.4)	Vegetables	9.3	(0.2)	Vegetables	6.7	(0.4)	gum	12.9	(0.5)	gum	34.2	(0.1)	snacks	8.1	(0.3)
				42.2	Ready-to-eat		11.0	Ready-to-eat		12.9	Savory		27.4	Savory		4.2			16.5
	2	Vegetables	6.7	(0.3)	breads	6.9	(0.2)	breads	6.4	(0.4)	snacks	9.2	(0.3)	snacks	10.4	(0.1)	Fruit	7.6	(0.3)
		Ready-to-eat		37.1	Condiments		9.2	Savory		12.0	Grain based		21.9	Grain based		3.7	Frozen		13.0
	3	breads	5.9	(0.2)	and sauces	5.7	(0.2)	snacks	5.9	(0.4)	desserts	7.3	(0.3)	desserts	9.1	(0.0)	entrees	6.0	(0.2)
		Condiments		32.8	Dairy-based		8.5	Dairy-based		11.2	RTE		17.6	Nuts and		1.8	Grain based		12.9
	4	and sauces	5.2	(0.2)	dessert	5.3	(0.2)	dessert	5.5	(0.3)	breakfast	5.9	(0.2)	seeds	4.3	(0.0)	desserts	5.9	(0.3)
		Savory		28.5	Savory		8.5	Ready-to-eat		10.9	Ready-to-eat		14.9	Dairy-based		1.6	Candy and		10.6
	5	snacks	4.6	(0.2)	snacks	5.3	(0.2)	breakfast	5.4	(0.4)	breads	5.0	(0.2)	dessert	4.0	(0.0)	gum	4.9	(0.3)
		All other		441.0	All other		107.8	All other		140.9	All other		178.0	All other		15.5	All other		147.6
		foods	70.6	(0.5)	foods	67.4	(0.4)	foods	70.0	(0.7)	foods	59.7	(0.6)	foods	38.1	(0.1)	foods	67.6	(0.5)
				624.8			160.0			201.3			298.1			40.8			218.3
		Total	100.0	(3.6)	Total	100.0	(2.6)	Total	100.0	(4.9)	Total	100.0	(2.9)	Total	100.0	(0.7)	Total	100.0	(3.0)
Top packaged beverages		Fresh plain		186.6	Fresh plain		62.8	Fresh plain		56.2	Fruit drinks		77.1	Soft drinks,		28.9			76.5
	1	milk	23.7	(1.1)	milk	27.5	(0.7)	milk	18.9	(1.2)	and juice	18.0	(0.7)	regular	22.7	(0.3)	Water	23.7	(1.1)
		Fruit drinks		138.7	Fruit drinks		42.5	Fruit drinks		53.2	Soft drinks,		74.3	Fresh plain		25.7	Fruit drinks		73.3
	2	and juice	17.6	(1.0)	and juice	18.6	(0.6)	and juice	17.8	(1.2)	regular	17.3	(0.8)	milk	20.2	(0.3)	and juice	22.7	(1.0)
		Soft drinks,		132.4	Soft drinks,		35.4			47.0	Fresh plain		73.0	Soft drinks,		18.6	Fresh plain		54.6
	3	regular	16.8	(1.1)	regular	15.5	(0.6)	Alcohol	15.8	(1.5)	milk	17.0	(0.7)	diet	14.6	(0.3)	milk	16.9	(0.9)
		Soft drinks,		126.2	Soft drinks,		27.5	Soft drinks,		37.9	Soft drinks,		68.9	F&V drinks		16.5			27.9
	4	diet	16.0	(1.1)	diet	12.1	(0.5)	regular	12.7	(1.1)	diet	16.1	(0.8)	and juice	13.0	(0.3)	Alcohol	8.7	(0.7)
	5	Water	9.6	75.5	Water	7.5	17.1	Soft drinks,	11.4	34.1	Water	12.8	55.0	Water	10.5	13.4	Coffee	6.3	20.2

				(0.9)			(0.4)			(1.0)			(0.7)			(0.2)			(0.7)
		All other beverages	16.2	127.9 (1.0)	All other beverages	18.8	43.0 (0.7)	All other beverages	23.4	69.7 (1.5)	All other beverages	18.8	80.9 (0.8)	All other beverages	19.0	24.2 (0.3)	All other beverages	21.7	69.8 (1.1)
				787.3			228.3			298.2			429.2			127.3			322.2
		Total	100.0	(5.6)	Total	100.0	(4.4)	Total	100.0	(8.3)	Total	100.0	(4.5)	Total	100.0	(2.1)	Total	100.0	(5.8)
		<----------								**2012**									---------->
		Grocery chains (n=55,880)			Non-chain grocery (n=26,417)			Ethnic-specialty (n=15,449)			Mass merchandisers (n=53,482)			Convenience stores (n=47,703)			Warehouse clubs (n=30,257)		
		Group	% vol	mean (SE)	Group	% vol	mean (SE)	Group	% vol	mean (SE)	Group	% vol	mean (SE)	Group	% vol	mean (SE)	Group	% vol	mean (SE)
				39.7			12.6			14.9	Candy and		25.3			13.2			20.4
Top packaged foods	1	Vegetables	7.2	(0.3)	Vegetables	9.4	(0.2)	Vegetables	8.0	(0.4)	gum	8.8	(0.3)	Candy and gum	30.9	(0.1)	Fruit	8.4	(0.3)
		Dairy-based		33.4	Ready-to-eat		8.7			11.9	Savory		19.0	Savory		4.6	Savory		15.8
	2	dessert	6.0	(0.3)	breads	6.6	(0.2)	Fruit	6.4	(0.4)	Snacks	6.6	(0.2)	snacks	10.7	(0.1)	snacks	6.5	(0.3)
		Ready-to-eat		31.0	Condiments and		8.2	Processed		10.0	Grain based		16.0	Grain based		3.5	Frozen		12.9
	3	breads	5.6	(0.2)	sauces	6.2	(0.2)	meat	5.4	(0.3)	desserts	5.6	(0.2)	desserts	8.2	(0.0)	entrees	5.3	(0.2)
		Condiments and		29.5	Savory		7.3	Savory		9.7	Ready-to-eat		15.7	Ready-to-eat		2.0	Grain based		12.6
	4	sauces	5.3	(0.2)	snacks	5.5	(0.2)	snacks	5.2	(0.3)	breakfast	5.5	(0.2)	breakfast	4.7	(0.0)	desserts	5.2	(0.3)
		Savory		26.0	Dairy-based		6.2	Ready-to-eat		9.4	Ready-to-eat		14.9			1.7			12.3
	5	snacks	4.7	(0.2)	dessert	4.6	(0.1)	breads	5.0	(0.3)	breads	5.2	(0.1)	Soups & stews	3.9	(0.0)	Vegetables	5.1	(0.2)
		All other		394.1	All other		90.2	All other		130.4	All other		194.0	All other		17.8	All other		169.6
		foods	71.2	(0.5)	foods	67.7	(0.3)	foods	70.0	(0.7)	foods	68.3	(0.4)	foods	41.7	(0.1)	foods	69.6	(0.5)
				553.6			133.2			186.4			287.0			42.8			243.7
		Total	100.0	(3.4)	Total	100.0	(2.4)	Total	100.0	(4.4)	Total	100.0	(2.8)	Total	100.0	(0.7)	Total	100.0	(3.3)
		Fresh plain		155.0	Fresh plain		43.9	Fruit drinks		48.5	Fruit drinks		69.2	Soft drinks,		31.3			75.6
Top packaged beverages	1	milk	23.6	(1.0)	milk	24.7	(0.6)	and juice	18.9	(1.1)	and juice	18.0	(0.6)	regular	21.5	(0.4)	Water	22.4	(1.2)
		Fruit drinks		113.8	Fruit drinks		34.2	Fresh plain		44.9	Fresh plain		68.7	Fresh plain		23.1	Fruit drinks		68.6
	2	and juice	17.3	(0.8)	and juice	19.3	(0.6)	milk	17.5	(1.0)	milk	17.9	(0.7)	milk	15.8	(0.3)	and juice	20.4	(1.0)
		Soft drinks,		96.2	Soft drinks,		26.5			41.3	Soft drinks,		55.6	Soft drinks,		20.5	Fresh plain		60.5
	3	regular	14.6	(0.9)	regular	14.9	(0.5)	Alcohol	16.1	(1.2)	regular	14.5	(0.6)	diet	14.0	(0.3)	milk	18.0	(1.0)
		Soft drinks,		90.3	Soft drinks,		18.6	Soft drinks,		28.3	Soft drinks,		50.4			19.2			27.3
	4	diet	13.7	(0.9)	diet	10.5	(0.4)	regular	11.1	(0.9)	diet	13.1	(0.6)	Water	13.2	(0.3)	Alcohol	8.1	(0.7)
				72.9			14.6	Soft drinks,		26.5			49.2	Fruit drinks		17.9			23.7
	5	Water	11.1	(0.8)	Water	8.2	(0.4)	diet	10.4	(0.8)	Water	12.8	(0.6)	and juice	12.3	(0.3)	Coffee	7.0	(0.7)
		All other		129.6	All other		39.9	All other		66.7	All other		90.8	All other		33.7	All other		81.1
		beverages	19.7	(1.0)	beverages	22.4	(0.6)	beverages	26.0	(1.3)	beverages	23.6	(0.8)	beverages	23.2	(0.4)	beverages	24.1	(1.1)
				657.7			177.7			256.2			383.9			145.7			336.8
		Total	100.0	(5.2)	Total	100.0	(3.9)	Total	100.0	(7.1)	Total	100.0	(4.3)	Total	100.0	(2.3)	Total	100.0	(6.2)

Supplemental Figure 3. 1. Expenditure on household non-packaged food purchases by store-type, Homescan 2007 and 2011.



Values represent unadjusted weighted means. Data comes from a subsample of Nielsen Homescan panel of household packaged food purchases for years 2007 and 2011. Analyses were performed separately for each store type. All values are weighted to be nationally representative. Percentages above bars indicate the unadjusted weighted mean proportion of household expenditure on non-packaged food from each store-type calculated including the entire sample by store, both purchasers and non-purchasers of non-packaged foods from each store-type. Percentages within bars indicate the unadjusted weighted mean proportion of household expenditure for the different non-packaged food categories for a given store-type (calculated including purchasers of non-packaged foods from each store-type).

CHAPTER 4. US HOUSEHOLD FOOD SHOPPING PATTERNS: DYNAMIC SHIFTS IN THE PAST 13 YEARS AND SOCIOECONOMIC PREDICTORS

Overview

We examined trends and socio-economic status (SES) predictors of food shopping patterns among US households. Cross-sectional cluster analysis derived shopping patterns using US households' volume food purchases (Nielsen Homescan) by store type from 2000 to 2012. Multinomial logistic regression identified the likelihood key household SES characteristics were associated with shopping patterns in 2012. We found three shopping patterns: grocery cluster, mass-merchandise cluster and combination cluster (with a mixture of large and small stores). The proportion of households belonging to the grocery cluster decreased over time. The mass-merchandise cluster emerged in 2003 and the proportion of households increased over time. In 2012, among low-income households, we found no race-ethnic differences for grocery cluster membership. However, among the low-income, non-whites (vs. non-Hispanic whites) had a significantly lower probability of belonging to the mass-merchandise cluster and only Hispanics had a higher probability of belonging to the combination cluster. In conclusion, these varied shopping patterns and race-ethnic/income differences must be considered in future policy initiatives. Further, it is important to continuing to study the complex rationale for people's food shopping patterns.

Introduction

An important theme in US food research is the reduction of nutrition-related health

disparities. One focus of those efforts is the elimination of food deserts in low-income and racial-ethnic minority neighborhoods. [1, 71, 84] The rationale is that the provision of modern full-service supermarkets in these communities will increase access to healthy foods and in turn will help reduce obesity and chronic disease among minority populations. However, availability of supermarkets does not guarantee that residents will shop there. In fact, a recent review indicates that adding supermarkets in low-income areas does not necessarily increase healthy food consumption or reduces obesity prevalence. [85]

The major gap in the literature on food access for low-income Americans is the focus on physical access to stores and the lack of data on where people actually shop for food or what foods are purchased. Overall, evidence suggests that most individuals do not necessarily shop at the stores closest to where they live and that both, low and high-SES groups shop for food beyond their residential food environments. [46, 47] Few studies have examined differences by income or race-ethnicity in terms of the types of stores where people shop for food. One small study showed that a high proportion of participants shopped at chain-supermarkets, and the majority of disadvantaged participants did not shop at the supermarket closest to home. [53] A third study showed that the majority of individuals shopped at a supermarket or grocery store, but non-whites and low-income groups traveled long distances to visit these type of stores.[54]

To reduce nutrition-related health disparities, we need to understand more about where Americans actually shop for food. It has been shown that physical proximity is not a major driver of where people shop. [86] Evidence suggests that people travel to get to specific types of stores. [45, 46] However, there is limited evidence about which types of stores different income and race-ethnic households use to shop for food. Also, evidence from epidemiologic studies indicates food shopping involves traveling to multiple store types, [19] however that also has not been

incorporated into the research. The existing literature has limited geographical scope and has been conducted on small samples, with limited variability by income and race-ethnicity, and has been limited to examination of shopping occasions at a single point in time.

To the best of our knowledge, no recent study has examined shopping patterns at multiple stores to understand the combination of food stores that US households rely on for their food purchases. To address this research gap, we utilized the nationally representative Nielsen Homescan dataset. Homescan is unique for studying packaged food purchases (PFP) across retail stores since households' record the store source and all the packaged foods and beverages purchased from that given store. Nielsen also follows households for at least one year, more likely reflecting usual shopping habits. This analysis focuses on two research questions: (1) how has the combination of stores that US households use to shop for packaged foods and beverages changed from 2000-2012? and (2) what SES characteristics are associated with recent food shopping patterns?

Subjects and Methods

Study Design and Population

We included PFP data from the US Homescan Consumer Panel dataset from 2000-2012, [60] an ongoing nationally representative survey of US households that captures household purchases of more than 600,000 barcoded products that are sold from all outlet channels including warehouse-club, mass-merchandisers, supermarkets/grocery, convenience, drug, and dollar stores in 76 markets (52 metropolitan and 24 non-metropolitan areas) across the US. Homescan participants are provided with home scanners, with which they scan their purchases from every shopping occasion for $\geqslant$10 – 12 months. [62] We conducted cross sectional analysis,

treating each survey year as an independent nationally representative sample of US households. Homescan used nine demographic variables at the county level (household size, income, head age, head occupation, female head education, male head education, presence of children, race, Hispanic) to develop their survey weights using an iterative proportional fitting procedure.

We included all households for years 2000 (n=34,754), 2003 (n=39,858), 2006 (n=62,187), 2009 (n=60,394) and 2012 (n=60,538), for a total of N=257,732. 2. We excluded 2-4.1% of household-year observations with missing/incomplete data (n=8,420 over the 5 selected years). Standard Homescan practices are to utilize quarters where the households capture usual purchases of packaged foods; thus we excluded purchases during quarters deemed unreliable by study investigators and household-year observations including >1 unreliable quarter. [87, 88] The final analytical sample included 2000 (n=33,976), 2003 (n= 38,613), 2006 (n=59,614), 2009 (n=58,470) and 2012 (n=58,638) household-year observations.

Store Categorization

For every shopping occasion made over a year, each household reported the name of the store where they shopped for food. We defined store type as the place where each household reported purchasing their food. We developed our own classification and classified stores into 7 mutually exclusive categories: 1) warehouse-club (e.g., Costco, Sam's); 2) mass-merchandisers-supercenters, hereafter mass-merchandisers (e.g., Walmart, Super-Target); 3) grocery-chains ($\geqslant$ 10 units; e.g., Kroger, Safeway); 4) non-chain grocery stores (<10 units); 5) convenience-drug-dollar, hereafter convenience (e.g., Seven Eleven, CVS, Dollar General, gas stations); 6) ethnic-specialty (e.g., Compare Foods, Whole Foods Market); and 7) others (e.g., department stores, book stores, etc.).

Shopping Patterns

We used cluster analysis to group households by their shopping habits. We defined shopping habits as the combinations of stores US households use to shop for food based on the amount of PFP by store type. [89, 90] We ran cluster analysis using volume of household PFP by store type separately for years 2000, 2003, 2006, 2009 and 2012. We entered volume of PFP as a percentage of volume for each store, relative to the total volume of PFP, to account for the fact that households purchased different amounts of packaged foods at the different stores. [89] The purpose of the cluster analysis was to place households into mutually exclusive groups, or clusters, such that households in a given cluster were distinctly similar to each other and distinctly different from households in other clusters with respect to their mean proportion of volume from PFP by store types. We performed cluster analysis using SAS FASTCLUST (SAS version 9.3; SAS Institute Inc.). This k-means procedure used Euclidean distances, computed from input variables, to assign cluster membership by minimizing the distance among members in a cluster while maximizing the distance between clusters. Using the procedure, we first selected cluster seeds, a set of points calculated as a first guess of the cluster means. Next, we calculated the Euclidean distance from each subject to each cluster seed, where each subject was assigned to the nearest seed to form temporary clusters. The means of each of the temporary clusters were calculated and replaced the seed values. Distance calculation and member assignment is an iterative process until no further changes occur. [91]

Cluster procedure is sensitive to initial seed, therefore, to use a more objective approach to picking a cluster solution, we conducted 1000 iterations of the cluster procedure using randomly generated initial cluster seeds. Iterations that produced the largest R^2 values indicated the best fit for the data and maximized the inter-to intra-cluster variability ratio. [91, 92]

To determine the most appropriate number of clusters, we examined the pseudo F-statistic [93] for each number of cluster solutions, increasing from 2 to 5 clusters. A higher pseudo F-statistic value indicated better intra-cluster homogeneity and inter-cluster heterogeneity. If the more complex cluster solution generated meaningful subgroups, the more complex cluster solution was chosen, as long as the pseudo F-statistic value was comparable. [94]

Clusters analysis revealed that 3-cluster solution was optimal with R^2=0.55. We named clusters according to the store types that contributed to the most volume (%) from households PFPs within a single cluster: primary grocery, primary mass-merchandise and a combination of the remaining store types.

Covariates

The ratio of family income to poverty threshold was calculated from self-reported household income and was used to categorize households according to the percentage of the Federal Poverty Level as low ⩽185%, middle >185-<400%, or high ⩾400%. Self-reported race-ethnicity was categorized as non-Hispanic whites, Hispanic, non-Hispanic blacks, or other races non-Hispanic. Self-reported highest education attainment was categorized as less than high school, completed high school, some college, graduated college or post-college graduate. We created household composition variables using number of males and number of females by age categories: 2-5y, 6-12y, 13-18y, 19-29y, 30-39y, 40-49y, 50-59y, 60-69y and ⩾70y.

Statistical analysis

We conducted all other analyses by using Stata 13 (StataCorp LP). We used Stata survey commands to incorporate Nielsen survey weights to generate nationally representative estimates. We calculated cross-sectional univariate descriptive statistics by year and by cluster. We report percentages for categorical variables and means for continuous variables.

Multinomial logistic regression

We used a cross-sectional analysis to examine associations between socio-economic characteristics and shopping patterns in 2012, the most recent year of data. We used multinomial logistic regression with three 2012 shopping pattern clusters as outcomes to examine associations with household income and race-ethnicity (model 1), and adjusting for household education and composition (model 2). To assess whether the association between household income and shopping pattern differed by race-ethnicity, we conducted a Wald "chunk" test for the joint significance of the income and race-ethnicity interaction terms with $P<0.05$ considered statistically significant.

To aid interpretability, we used the -margins- command in Stata after the adjusted model to predict the probability (95% CIs) of the cluster outcome based on the model coefficients of the main exposures plus further adjustments performed in the model. Within each income group, we used non-Hispanics white as the referent group. We tested for statistically significant differences using Student's t test with the Bonferroni correction. A two-sided P value of 0.05 was set to denote statistical significance.

Results

We show the volume of household PFP by store and households' socio-economic characteristics for selected years in **Table 4.1**. Per-capita proportion of volume from PFP decreased over time for grocery-chains and non-chain grocery, and increased for warehouse-club, convenience stores, and mass-merchandisers. The sample was predominantly non-Hispanic white and highly educated. The average household size was less than three and the majority of households were composed of only adults.

Using cluster analysis we identified three distinct shopping patterns in each year (**Figure 4.1 and Supplemental Table 4.1**). One cluster was characterized by a high proportion of PFP made predominantly at grocery-chains; this pattern was therefore referred to as the primary grocery cluster. The second cluster was characterized by a high proportion of PFP made at mass-merchandisers (or non-chain grocery stores in 2000), and was therefore referred to as the primary mass-merchandiser cluster. The third cluster was characterized by household purchases of packaged foods at a mixture of stores such as warehouse-club, ethnic-specialty stores, non-chain grocery, grocery chains, and mass-merchandisers. Although the overall proportion of purchases from convenience stores was small, this cluster had a relatively higher proportion of purchases from convenience stores compared to the other two clusters. Therefore, this pattern was referred to as combination cluster. Overall, 50-60% of households were grouped into the primary grocery cluster, regardless of the year. However, over time, there has been a shift towards fewer households categorized in the primary grocery cluster (63.9% in 2000 to 50.2% in 2012) and more households categorized in the primary mass-merchandise cluster (16.5% in 2003 to 22.5% in 2012). We also observed that over this 13-year period, 24.5-27.3% of households used a combination of stores to shop for food.

We present univariate household SES characteristics by cluster and year in **Table 4.2** and **Supplemental Table 4.1.** The proportion of households categorized in the primary grocery cluster was the highest for every race-ethnic and income group, however these proportions decreased over time. For all race-ethnic and income groups, the proportion of households categorized in the primary mass-merchandise cluster and the combination cluster increased over time. For the primary mass-merchandise cluster, the biggest increases occurred for non-Hispanic

white and low-income households, while for the combination cluster, the biggest increases occurred for other non-Hispanic and high income households.

We found a statistically significant interaction between household income and race-ethnicity in our adjusted multinomial logistic model (Wald "chunk" test Chi228.91, 12 , p=0.0041). Predicted probabilities of the adjusted model were similar to the unadjusted results, therefore we only present adjusted model results. **Figure 4.2** shows the predicted probability of shopping pattern (cluster) membership by income and race-ethnic group in 2012. For every income/race-ethnic group, the majority of households shopped at the primary grocery cluster. Among low-income households, for the primary grocery cluster, no differences were observed by race-ethnicity (**Figure 4.2.A**). For the primary mass-merchandise cluster, non-Hispanic blacks (19.2%, 95% CI 16.3-22.0%) and Hispanics (18.2%, 95% CI 14.7-21.7%) had a significantly lower probability of being categorized at the primary mass-merchandise cluster compared to non-Hispanic whites (27.1%, 95% CI 25.8-28.4%, **Figure 4.2.B**). For the combination cluster, only Hispanics (35.4%, 95% CI 31.0-39.8%) had a significantly higher probability of being categorized at the combination cluster than non-Hispanic whites (23.7%, 95% CI 22.5-24.9%, **Figure 4.2.C**).

Comparable to low-income households, we observed similar associations at the primary grocery- and mass-merchandise cluster among middle-income households (Figure 2A-B). However, for the combination cluster, Hispanics (33.8%, 95% CI 30.5-37.1%) and non-Hispanic blacks (33.6%, 95% CI 30.6-33.6%) were more likely to be in the combination cluster compared to non-Hispanic whites (23.3%, 95% CI 22.3-24.3%, **Figure 4.2.C**). Among high income households, for the primary mass-merchandiser cluster, no differences were observed by race-ethnicity (**Figure 4.2.B**). Similar to middle-income households at the combination cluster,

among high-income households, Hispanics (35.8%, 95% CI 32.0-39.5%) and non-Hispanic blacks (35.5%, 95% CI 32.3-38.6%) had a higher probability than non-Hispanic whites (27.2%, 95% CI 26.1-28.3%) of being categorized at the combination store cluster (**Figure 4.2.C**).

Discussion

Despite the growing interest in food deserts, there has been very little empirical research on food purchasing at mass-merchandisers and other non-grocery formats because of the lack of data on households purchases by store type. [49, 95] While grocery-chains still account for the majority of the total volume of food purchases by US households, our cluster analysis revealed that for some households, their main food purchases were not made at grocery-chains but at mass-merchandisers, especially in recent years. In addition, in some cases, shopping for food involved visiting multiple types of stores, including a mixture of large and small stores.

Within the US, policymakers have advocated for improvements in local access to food by building new supermarkets or grocery stores in disadvantaged areas as one way to improve diet quality and reduced health disparities. [3-6] These strategies rely on the assumption that improving access to supermarkets or grocery stores in these areas, will lead consumers to shop for food in these newly placed stores. However, evidence from the UK [9, 96, 97] and the US [10, 11] have shown that simply introducing supermarkets in communities does not necessarily result in increased shopping at such stores or in dietary habits improvements. While a large proportion of US households still make their majority of their food purchases at grocery stores, as shown in our cluster analysis, other households primarily shop at mass-merchandisers or at multiple types of stores. Therefore, policy strategies focusing only on supermarkets or grocery stores ignore other places where US households increasingly purchase some or all of their food. [98] This appears to

be true for racial minority households. Regardless of income level, we observed that racial minority households were more likely to shop at a combination of large and small stores compared to non-Hispanic white households.

Among low- and middle-income households, we found no race-ethnic differences in the probability of shopping at the primary grocery cluster. The literature suggests that residents of low-income and predominantly African-American neighborhoods are less likely to have access to grocery stores or supermarkets, compared to wealthier and white neighborhoods. [15, 23, 28] However, other research suggests that such disparities are smaller, absent, or reversed. [13, 25, 99, 100] Additionally, studies suggest that residents of low-income neighborhoods shop outside their residential neighborhoods. [101-103] We provide two possible explanations for our primary grocery cluster findings. It is possible that in our sample, racial minorities and economically disadvantaged households overcome barriers to shop at grocery stores, or as shown in previous studies, there are no large disparities in access to grocery stores. While we were unable to examine neighborhood characteristics and physical access/proximity to stores, one of the strengths of our study is that we used information on the types of store where households actually shopped for food to describe shopping patterns and subpopulations differences. We found that among middle- and low-income households belonging to the cluster characterized by primary purchases at mass-merchandise stores, racial minorities had a lower probability of belonging to the mass-merchandise cluster. These findings may reflect regional differences. Racial minorities may be more likely to live in large metropolitan areas, while mass-merchandise stores are usually located in suburban/rural areas. We also found that at all income levels, racial minorities were more likely to shop at a combination of store types. However, it is hard to determine whether those differences reflect true shopping pattern differences, or whether there is

differential patterning by race-ethnicity captured in our combination cluster.

There is a lack of research on the impact of shopping at non-traditional retailers on the nutrient quality of purchases and whether purchases made at grocery stores or supermarkets are of higher nutrient quality compared to other types of store. Future research should address these critical questions. Additionally, scholars have suggested that placement of new stores in underserved areas may not be as important to reduce health disparities as simultaneously offering better prices for healthy foods relative to less-healthy foods and by actively marketing healthy foods. [75]

We did not study underlying factors related to store choice, rather we described shopping patterns using household purchase data. We acknowledge that the decision to shop at a specific store, or combination of stores, is complex and it is influenced by many factors such as: food preferences; the location of the store in relationship to the consumer and the consumer travel patterns; [48] individual characteristics of consumers (e.g., income, car ownership, time costs), as well as neighborhood characteristics (e.g., availability of public transportation, availability of sidewalks, crime rates). [54, 100, 104]

Limitations

The application of pattern techniques to nutritional epidemiology studies offers advantages, such as the identification of combinations of stores where US households shop for food and may better represent shopping behaviors. However, cluster analysis is a data-driven method that involves subjectivity in deciding on the number of clusters to retain and when naming the resulting clusters. Homescan does not capture non-store sources of foods (e.g., restaurants, farmers-markets, vending), therefore, our shopping patterns do not capture all places where US households can purchase their food. Although we were unable to include purchases

from products without barcodes (e.g., loose produce, meats), we know whether a household shopped at a given store. Households that participate in Homescan must scan all groceries at home. The process of recording might be time consuming, which could result in underreporting of data. This would be a problem if households systematically and differently underreported PFP from a specific type of store. In terms of the sample, the average proportion of white non-Hispanic, high-income and highly educated households in Homescan is higher than the US population. [81] Nonetheless, validation studies found the accuracy of Homescan at measuring purchases at the national level was comparable to other widely used economic datasets. [82]

A major strength of our study is that we know the type of store and the amount of PFP where households actually shopped for food. Furthermore, we included relevant food sources such as pharmacies, gas stations, and other retail stores whose primary business is not food. [105] For each household we used purchase data for at least a year, reflecting usual shopping habits. The large sample size allowed us to explore predictors of shopping patterns by income and race-ethnic subpopulations.

Conclusions

The majority of US households shopped at grocery stores, but a growing proportion shopped at mass-merchandisers. Additionally, an important proportion of households shopped at a combination of stores, including warehouse-club and ethnic and specialty stores. Regardless of income and race-ethnicity group, households predominantly shopped at grocery stores. However, among low- and middle-income households, non-whites were less likely to shop at mass-merchandise stores. These varied shopping patterns and race-ethnic/income differences must be considered in future policy initiatives. Further, it is important to continuing to study the complex rationale for people's food shopping patterns. Lastly, to ensure that lower-income households

and racial minorities increase their purchases of healthier foods, it may be important to consider strengthening the nutrition offerings and relative prices of healthier foods for all types of stores.

Tables and Figures

Table 4.1. Household socio-economic characteristics, sample sizes and volume of packaged food purchases by store-type for selected years, Homescan [a]

	2000	2006	2012
Total households, n	33,976	59,614	58,638
Volume of PFP by store-type			
Warehouse-club	5.6 ± 0.4	7.8 ± 0.6	9.4 ± 0.7
Convenience-store	3.7 ± 0.2	4.7 ± 0.2	5.6 ± 0.2
Ethnic/specialty	4.0 ± 1.2	4.0 ± 1.2	4.4 ± 1.3
Grocery-chain	59.7 ± 1.6	50.8 ± 1.7	47.7 ± 1.6
Mass-merchandisers	12.4 ± 1.1	21.4 ± 1.6	23.4 ± 1.4
Non-chain grocery	10.4 ± 0.8	6.7 ± 0.6	5.3 ± 0.5
Others	4.3 ± 0.2	4.6 ± 0.2	4.2 ± 0.2
Household income [b]			
Low	4,541 (23.1)	11195 (25.3)	12629 (29.8)
Middle	15,069 (42.3)	23322 (33.3)	24214 (37.3)
High	14,366 (34.7)	25097 (41.4)	21795 (32.9)
Race-ethnicity [c]			
Non-Hispanic white	28,686 (79.2)	49188 (74.4)	47384 (71.5)
Hispanic	1,798 (8.7)	3148 (10.3)	3021 (11.9)
Non-Hispanic black	2,696 (10.7)	4937 (10.8)	5390 (11.1)
Non-Hispanic other	796 (1.4)	2341 (4.4)	2843 (5.5)
Education [d]			
Less than high-school	740 (3.6)	911 (3.0)	718 (2.7)
Graduated high-school	6,996 (27.8)	11016 (29.5)	9532 (27.1)
Some college	10,606 (35.3)	18772 (32.6)	17078 (32.6)
Graduated college	10,330 (23.1)	19620 (23.5)	21091 (25.5)
Post college graduate	5,304 (10.2)	9295 (11.4)	10219 (12.1)
Household type [e]			

Single	8765 (26.5)	14978 (26.9)	14978 (26.5)
Adults, no kids	15694 (40.0)	28435 (37.3)	30457 (40.0)
Adult(s) and kid(s)	9,517 (33.4)	16201 (35.8)	13203 (33.4)
Household size [f]	2.5 ± 0.0	2.6 ± 0.0	2.6 ± 0.0

[a] All data were derived from the 2000, 2006, and 2012 survey years of Homescan. Per-capita mean proportion of volume ± SE from packaged food purchases (PFP) by store-type. Percentages have been weighted to be nationally representative. Households' socio-economic values are presented as counts and column percentages for the different survey years [household size (mean ± SE)]. Percentages have been weighted to be nationally representative. All data were derived from the 2000, 2006, and 2012 survey years of Homescan.

[b] Ratio of family income to poverty threshold, calculated from self-reported household income, was used to categorize income according to the percentage of the Federal Poverty Level (low ≤185%; middle >185-<400%; or high ≥400%).

[c] Self-reported race-ethnicity of the household head.

[d] Household self-reported highest educational attainment.

[e] Children were all household members ≤18y old. Adults were all household members >19y old.

[f] Number of people living in the household.

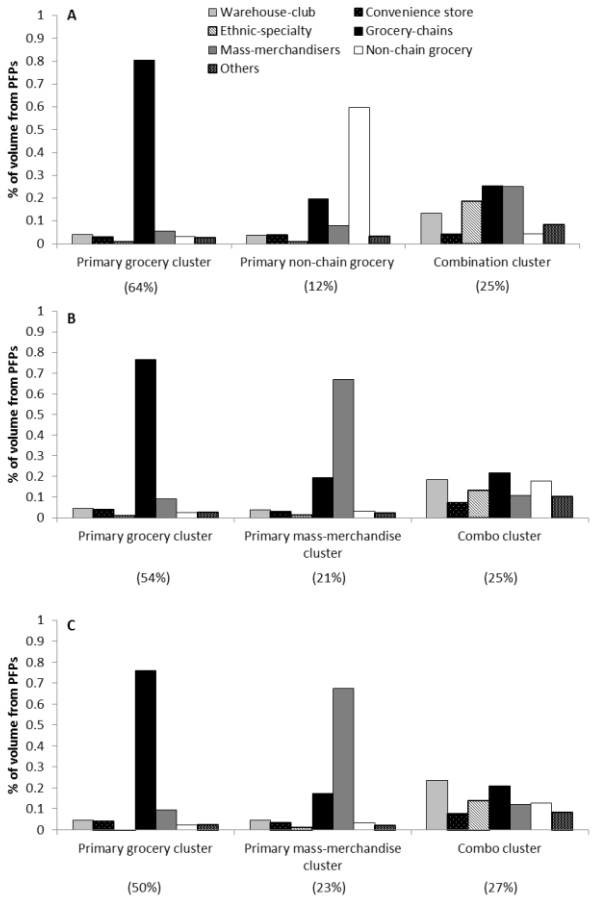
Table 4.2. Univariate households socio-economic characteristics by food shopping pattern (cluster) for selected years, Homescan [a]

	Food shopping clusters [b]								
	2000			2006			2012		
	Primary-grocery	Primary non-chain grocery	Combination	Primary-grocery	Primary-mass-merchandiser	Combination	Primary-grocery	Primary-mass-merchandiser	Combination
Total households, n (%)	22,354 (63.9)	3,306 (11.5)	8,316 (24.5)	31,929 (53.7)	12,980 (21.0)	14,705 (25.4)	29,747 (50.2)	12,845 (22.5)	16,046 (27.3)
Household income [c]									
High	66.5 ± 2.3	7.9 ± 0.9	25.6 ± 2.3	56.7 ± 2.3	16.9 ± 1.9	26.5 ± 1.9	51.6 ± 2.4	18.4 ± 1.7	29.9 ± 2.1
Middle	62.2 ± 2.2	12.0 ± 1.1	25.7 ± 2.1	51.9 ± 2.2	23.3 ± 2.2	24.8 ± 1.7	50.4 ± 2.1	23.1 ± 1.8	26.5 ± 1.8
Low	63.1 ± 2.3	16.1 ± 1.3	20.9 ± 1.9	51.2 ± 2.2	24.5 ± 2.1	24.3 ± 1.6	48.3 ± 2.1	26.1 ± 1.9	25.6 ± 1.7
Race-ethnicity [d]									
Non-Hispanic white	63.6 ± 2.1	11.9 ± 1.0	24.6 ± 2.0	54.1 ± 2.3	22.5 ± 2.0	23.4 ± 1.5	51.2 ± 2.2	24.2 ± 1.8	24.6 ± 1.7
Hispanic	65.1 ± 4.2	9.4 ± 1.4	25.5 ± 4.2	51.8 ± 3.5	15.2 ± 2.9	33.0 ± 3.6	48.7 ± 3.1	16.5 ± 2.2	34.7 ± 3.2
Non-Hispanic black	65.5 ± 2.6	11.3 ± 1.9	23.2 ± 2.2	52.2 ± 2.7	18.6 ± 2.5	29.2 ± 2.5	47.8 ± 2.6	19.9 ± 1.9	32.3 ± 2.0
Non-Hispanic other	63.5 ± 4.1	9.7 ± 2.2	26.7 ± 3.9	55.1 ± 2.0	14.6 ± 2.1	30.3 ± 2.1	44.6 ± 2.0	17.8 ± 2.3	37.6 ± 2.6
Education [e]									
Post college graduate	67.4 ± 2.3	7.2 ± 1.0	25.4 ± 2.2	57.1 ± 2.3	14.5 ± 1.9	28.4 ± 2.0	52.3 ± 2.5	16.4 ± 1.4	31.2 ± 2.1
Graduated college	66.0 ± 2.2	9.8 ± 1.0	24.2 ± 2.1	55.1 ± 2.3	18.8 ± 2.0	26.2 ± 1.9	50.9 ± 2.2	19.4 ± 1.8	29.7 ± 2.1
Some college	63.3 ± 2.4	11.1 ± 1.0	25.6 ± 2.2	53.1 ± 2.2	22.1 ± 2.0	24.7 ± 1.6	49.2 ± 2.1	23.7 ± 1.8	27.1 ± 1.8
Graduated high-school	61.6 ± 2.1	14.5 ± 1.3	24.0 ± 2.1	52.2 ± 2.4	23.6 ± 2.1	24.2 ± 1.6	50.3 ± 2.1	26.2 ± 2.0	23.4 ± 1.7
Less than high-school	64.4 ± 3.2	16.4 ± 2.3	19.2 ± 2.6	51.0 ± 3.0	23.6 ± 2.6	25.3 ± 2.3	45.3 ± 2.9	24.5 ± 3.0	30.2 ± 2.5
Household type [f]									
Single	64.3 ± 2.4	12.6 ± 1.1	23.1 ± 2.0	55.4 ± 2.2	18.1 ± 1.7	26.5 ± 1.7	51.7 ± 2.2	21.4 ± 1.7	27.0 ± 1.9
Adults, no kids	63.2 ± 2.1	10.6 ± 1.0	26.2 ± 2.4	53.7 ± 2.3	19.8 ± 2.0	26.5 ± 1.8	50.2 ± 2.3	22.3 ± 1.8	27.5 ± 1.8
Adult(s) and kid(s)	64.5 ± 2.4	11.8 ± 1.1	23.7 ± 1.8	52.4 ± 2.3	24.3 ± 1.6	23.3 ± 1.6	49.1 ± 2.1	23.5 ± 2.0	27.4 ± 1.9
Household size) [g]	2.5 ± 0.0	2.6 ± 0.0	2.5 ± 0.0	2.5 ± 0.0	2.7 ± 0.0	2.5 ± 0.0	2.6 ± 0.0	2.6 ± 0.0	2.6 ± 0.0

[a] All data were derived from the 2000, 2006, and 2012 survey years of Homescan. Households socio-economic characteristics are presented as row percentages ± SE by shopping pattern (or cluster) for the different survey years [except for household size (mean ± SE)] and have been weighted to be nationally representative.
[b] We used cluster analysis to group households by their shopping habits. We defined shopping habits as the combinations of stores US households use to shop for food based on the volume from packaged food purchases (PFPs) by store type.

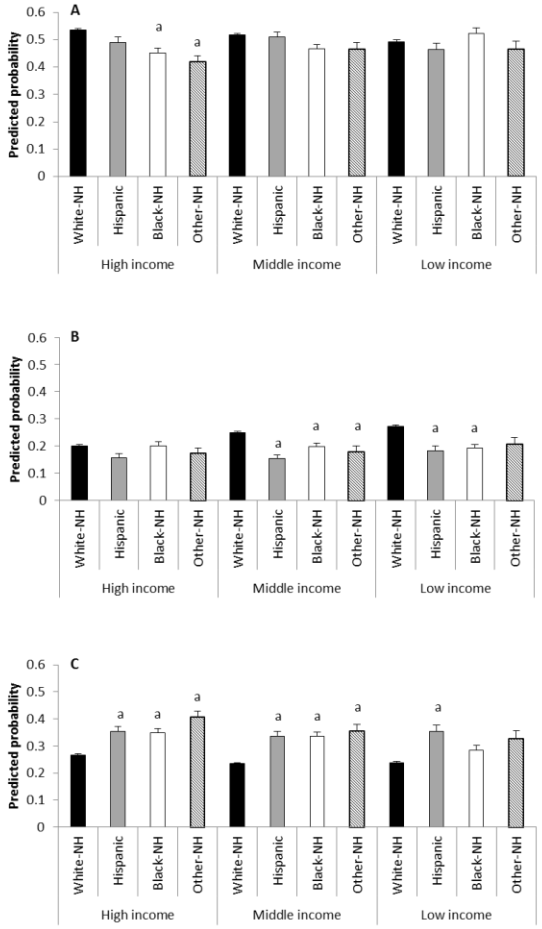
[c] Ratio of family income to poverty threshold, calculated from self-reported household income, was used to categorize income according to the percentage of the Federal Poverty Level (low ≤185%; middle >185-<400%; or high ≥400%).
[d] Self-reported race-ethnicity of the household head.
[e] Household self-reported highest educational attainment.
[f] Children were all household members ≤18y old. Adults were all household members >19y old.
[g] Number of people living in the household.

Figure 4.1. Households shopping patterns, Homescan 2000, 2006 and 2012.



All data were derived from the 2000, 2006, and 2012 survey years of Homescan.(A) 2000; (B) 2006; (C) 2012. Values represent means. Values below bars indicate the proportion of households classified in each cluster, weighted to be nationally representative.

Figure 4.2. Predicted probability of shopping pattern (cluster) membership by income and race-ethnic group, Homescan 2012



All data were derived from the 2012 survey year of Homescan.(A) Primary grocery cluster; (B) Primary mass-merchandiser cluster; (C) Combination cluster. Ratio of family income to poverty threshold, calculated from self-reported household income, was used to categorize household income according to the percentage of the Federal Poverty Level (low ≤185%; middle >185-<400%; or high ≥400%). Race-ethnicity (white non-Hispanic; Hispanic; black non-Hispanic; and other races non-Hispanic). Values represent predicted probabilities from multinomial logistic regression, adjusted for households' maximum level of education and household composition, and weighted to be nationally representative. The sample size was n= 58,638. For each cluster, within each income group, comparisons were made using white non-Hispanics as the referent category. Statistically significant differences are denoted by the letter a; all at a $p \leq 0.05$ (Bonferroni-adjusted t-test).

Supplemental Table 4.1. Mean proportion of packaged food purchases (PFP) by food shopping cluster, Homescan [a]

	Food shopping cluster [b]														
	2000			2003			2006			2009			2012		
	Primary-grocery	Non-chain grocery	Combination	Primary-grocery	Primary-Mass	Combination	Primary-grocery	Primary-Mass	Combination	Primary-grocery	Primary-Mass	Combination	Primary-grocery	Primary-Mass	Combination
Volume of PFP by store															
Warehouse-club	4.2	3.9	13.5	4.7	4.1	16.1	4.6	3.8	18.4	4.7	4.2	20.3	4.6	4.6	23.6
Convenience-store	3.0	4.0	4.2	3.8	2.8	6.3	3.8	2.8	7.2	3.9	3.2	7.2	4.4	3.7	8.0
Ethnic/specialty	0.9	0.9	18.8	0.9	1.4	15.8	0.8	1.2	13.4	0.8	1.3	13.7	0.9	1.5	14.2
Grocery-chain	80.5	19.9	25.5	77.9	23.3	23.3	76.6	19.3	21.9	76.0	17.9	21.0	75.8	17.3	20.9
Mass-merchandisers	5.6	8.1	25.2	7.1	61.8	8.3	9.1	67.1	11.0	9.6	67.4	12.1	9.4	67.5	12.0
Non-chain grocery	3.2	59.8	4.4	2.7	4	21.1	2.4	3.3	17.8	2.5	3.5	16.3	2.2	3.1	12.7
Others	2.7	3.5	8.4	2.9	2.6	9.1	2.7	2.5	10.3	2.6	2.4	9.5	2.7	2.3	8.6

[a] All data were derived from the 2000, 2003, 2006, 2009 and 2012 survey years of Homescan. Values are means.
[b] We used cluster analysis to group households by their shopping habits. We defined shopping habits as the combinations of stores US households use to shop for food based on the volume from packaged food purchases (PFP) by store type. Primary-mass (primary mass-merchandise).

Supplemental Table 4.2. Households socio-economic characteristics and store-specific volume of packaged food purchases by shopping pattern, Homescan [a]

	2000			2003			2006			2009			2012		
	Grocery [b]	Non-chain grocery	Combination	Grocery	Mass	Combination	Grocery	Mass	Combination	Grocery	Mass	Combination	Grocery	Mass	Combination
Total households, n (%)	22,354 (63.9)	3,306 (11.5)	8,316 (24.5)	23,027 (58.5)	6,006 (16.5)	9,580 (25.0)	31,929 (53.7)	12,980 (21.0)	14,705 (25.4)	29,817 (50.6)	13,414 (23.2)	15,239 (26.2)	29,747 (50.2)	12,845 (22.5)	16,046 (27.3)
Household income [c]															
High	66.5 ± 2.3	7.9 ± 0.9	25.6 ± 2.3	61.6 ± 2.3	13.6 ± 1.7	24.7 ± 1.8	56.7 ± 2.3	16.9 ± 1.9	26.5 ± 1.9	52.9 ± 2.4	18.9 ± 1.9	28.2 ± 1.9	51.6 ± 2.4	18.4 ± 1.7	29.9 ± 2.1
Middle	62.2 ± 2.2	12.0 ± 1.1	25.7 ± 2.1	56.3 ± 2.1	18.6 ± 1.9	25.1 ± 1.8	51.9 ± 2.2	23.3 ± 2.2	24.8 ± 1.7	49.9 ± 2.3	24.4 ± 2.1	25.7 ± 1.9	50.4 ± 2.1	23.1 ± 1.8	26.5 ± 1.8
Low	63.1 ± 2.3	16.1 ± 1.3	20.9 ± 1.9	56.2 ± 2.1	18.8 ± 1.7	25.1 ± 1.8	51.2 ± 2.2	24.5 ± 2.1	24.3 ± 1.6	48.5 ± 1.9	27.3 ± 2.1	24.2 ± 1.5	48.3 ± 2.1	26.1 ± 1.9	25.6 ± 1.7
Race-ethnicity [d]															
Non-Hispanic white	63.6 ± 2.1	11.9 ± 1.0	24.6 ± 2.0	58.7 ± 2.1	17.6 ± 1.7	23.7 ± 1.5	54.1 ± 2.3	22.5 ± 2.0	23.4 ± 1.5	51.7 ± 2.2	24.8 ± 1.9	23.6 ± 1.5	51.2 ± 2.2	24.2 ± 1.8	24.6 ± 1.7
Hispanic	65.1 ± 4.2	9.4 ± 1.4	25.5 ± 4.2	57.0 ± 3.6	12.2 ± 2.5	30.8 ± 3.4	51.8 ± 3.5	15.2 ± 2.9	33.0 ± 3.6	50.4 ± 3.3	16.3 ± 2.7	33.3 ± 3.4	48.7 ± 3.1	16.5 ± 2.2	34.7 ± 3.2
Non-Hispanic black	65.5 ± 2.6	11.3 ± 1.9	23.2 ± 2.2	58.8 ± 2.5	14.1 ± 1.8	27.0 ± 2.6	52.2 ± 2.7	18.6 ± 2.5	29.2 ± 2.5	45.6 ± 2.9	23.1 ± 2.5	31.3 ± 2.0	47.8 ± 2.6	19.9 ± 1.9	32.3 ± 2.0
Non-Hispanic other	63.5 ± 4.1	9.7 ± 2.2	26.7 ± 3.9	57.8 ± 2.4	12.2 ± 2.4	30.0 ± 3.0	55.1 ± 2.0	14.6 ± 2.1	30.3 ± 2.1	46.7 ± 2.1	16.5 ± 2.6	36.8 ± 2.4	44.6 ± 2.0	17.8 ± 2.3	37.6 ± 2.6
Education [e]															
Less than high-school	64.4 ± 3.2	16.4 ± 2.3	19.2 ± 2.6	56.1 ± 2.3	16.8 ± 2.5	27.1 ± 2.3	51.0 ± 3.0	23.6 ± 2.6	25.3 ± 2.3	49.0 ± 2.8	25.0 ± 3.2	26 ± 2.5	45.3 ± 2.9	24.5 ± 3.0	30.2 ± 2.5
Graduated high-school	61.6 ± 2.1	14.5 ± 1.3	24.0 ± 2.1	56.5 ± 2.2	19.5 ± 1.9	24.0 ± 1.6	52.2 ± 2.4	23.6 ± 2.1	24.2 ± 1.6	50 ± 2.3	26.4 ± 2.1	23.6 ± 1.7	50.3 ± 2.1	26.2 ± 2.0	23.4 ± 1.7
Some college	63.3 ± 2.4	11.1 ± 1.0	25.6 ± 2.2	58.4 ± 2.2	16.3 ± 1.7	25.2 ± 1.8	53.1 ± 2.2	22.1 ± 2.0	24.7 ± 1.6	49.8 ± 2.2	24.4 ± 2.0	25.8 ± 1.6	49.2 ± 2.1	23.7 ± 1.8	27.1 ± 1.8
Graduated college	66.0 ± 2.2	9.8 ± 1.0	24.2 ± 2.1	59.2 ± 2.3	16.0 ± 1.9	24.9 ± 1.9	55.1 ± 2.3	18.8 ± 2.0	26.2 ± 1.9	51.5 ± 2.4	20.8 ± 2.0	27.7 ± 2.1	50.9 ± 2.2	19.4 ± 1.8	29.7 ± 2.1
Post college graduate	67.4 ± 2.3	7.2 ± 1.0	25.4 ± 2.2	62.9 ± 2.2	11.1 ± 1.5	26.0 ± 1.9	57.1 ± 2.3	14.5 ± 1.9	28.4 ± 2.0	52.7 ± 2.4	17.4 ± 2.0	29.9 ± 2.0	52.3 ± 2.5	16.4 ± 1.4	31.2 ± 2.1
Household type [f]															
Single	64.3 ± 2.4	12.6 ± 1.1	23.1 ± 2.0	60.6 ± 2.1	14.1 ± 1.6	25.3 ± 1.7	55.4 ± 2.2	18.1 ± 1.7	26.5 ± 1.7	52.8 ± 2.2	20.8 ± 1.8	26.4 ± 1.8	51.7 ± 2.2	21.4 ± 1.7	27.0 ± 1.9
Adults, no kids	63.2 ± 2.1	10.6 ± 1.0	26.2 ± 2.4	57.7 ± 2.2	16.2 ± 1.8	26.1 ± 1.9	53.7 ± 2.3	19.8 ± 2.0	26.5 ± 1.8	50.7 ± 2.4	22.1 ± 2.0	27.2 ± 1.9	50.2 ± 2.3	22.3 ± 1.8	27.5 ± 1.8
Adult(s) and kid(s)	64.5 ± 2.4	11.8 ± 1.1	23.7 ± 1.8	57.8 ± 2.1	18.8 ± 2.1	23.4 ± 1.5	52.4 ± 2.3	24.3 ± 1.6	23.3 ± 1.6	48.8 ± 2.1	26.3 ± 2.3	24.9 ± 1.6	49.1 ± 2.1	23.5 ± 2.0	27.4 ± 1.9
Household size [g]	2.5 ± 0.0	2.6 ± 0.0	2.5 ± 0.0	2.5 ± 0.0	2.6 ± 0.0	2.6 ± 0.1	2.5 ± 0.0	2.7 ± 0.0	2.5 ± 0.0	2.5 ± 0.0	2.6 ± 0.0	2.6 ± 0.0	2.6 ± 0.0	2.6 ± 0.0	2.6 ± 0.0

[a] Households socio-economic characteristics are presented as row percentages ± SE by shopping pattern (or cluster) for the different survey years [except for household size (mean ± SE)] and have been weighted to be nationally representative. All data were derived from the 2000, 2003, 2006, 2009 and 2012 survey years of Homescan

[b] We used cluster analysis to group households by their shopping habits. We defined shopping habits as the combinations of stores US households use to shop for food based on the volume from packaged food purchases (PFP) by store-type. Grocery (primary grocery), mass (primary mass-merchandise).

[c] Ratio of family income to poverty threshold, calculated from self-reported household income, was used to categorize income according to the percentage of the Federal Poverty Level (low ≤185%; middle >185-<400%; or high ≥400%).

[d] Self-reported race-ethnicity of the household head.

[e] Household self-reported highest educational attainment.

[f] Children were all household members ≤18y old. Adults were all household members >19y old.

[g] Number of people living in the household.

CHAPTER 5. FOOD SHOPPING PATTERNS ARE NOT ASSOCIATED WITH THE NUTRIENT QUALITY OF PACKAGED FOOD PURCHASES OR FOODS AND BEVERAGES PURCHASED

Overview

The literature suggests there are race-ethnic disparities in what Americans eat. Additionally, studies have shown that residents of black and low-income neighborhoods have less access to food stores that sell healthy foods. Yet, it is unclear whether shopping at grocery-stores or supermarkets is associated with a better nutrient profile of food purchases, compared to shopping at other types of stores and whether there are differences by race-ethnicity. The objectives were to examine whether the mix of food stores where people shop were associated with the nutrient profile of PFP and the foods and beverages purchased and to determine whether these associations differ across race-ethnic groups. We used packaged foods and beverages purchased by US households (Nielsen Homescan) from 2007-2012. Cluster analysis was used to categorize households according to the types of food stores where they shop for food, which we refer to as shopping patterns. We used longitudinal random-effects linear regression models to examine the association between shopping patterns and the nutrient quality and types of packaged food/beverage purchased by race-ethnic groups among US households. Following a primary-grocery shopping pattern was not associated with a better nutrient profile of household PFP or the food and beverage groups household purchased, compared to shopping at a primary-mass-merchandiser or a combination shopping pattern. These results were consistent across race-ethnic groups. However, for any given shopping pattern, non-Hispanic black households purchased foods with higher energy, total sugar and sodium densities, compared to non-Hispanic white and

Hispanic households. We found no meaningful differences in the nutrient profile of purchased packaged foods and beverages and the food and beverage groups purchased by shopping patterns. These null findings were consistent across race-ethnic groups. The ubiquity of unhealthy packaged foods/beverages that are high in sugars, sodium and fat regardless of store-type may thwart efforts to improve eating habits.

Introduction

The literature suggests there are race-ethnic disparities in what Americans eat. [106] Among US adults, non-Hispanic blacks have a poorer dietary quality, compared to non-Hispanic whites and Mexican-Americans. [107] The literature also shows that residents of non-Hispanic-black and low-income neighborhoods have less access to food stores that sell healthy foods (i.e., grocery-stores or supermarkets). [15, 23, 25, 28] Based on these two facts, it has been suggested that the type of stores where people shop for food influences what people eat. [50, 51]

Under the assumption that differential food access might be responsible for nutritional disparities, programs and policies at the state and national level [3-6] have focused on building grocery-stores or supermarkets in food deserts, or areas with poor access to healthy foods, to improve household food purchases, dietary quality, and reduce health disparities. These strategies rely on the assumption that people shopping at larger retail stores (e.g., grocery-stores or supermarkets) have a better nutrient profile of food purchases because supermarkets sell more variety of foods with higher nutritional quality at lower prices than other stores (e.g., convenience-stores) and because larger stores have more capacity to handle perishables safely and efficiently. [64] These programs and policies have been implemented despite the lack of evidence of effectiveness. In fact, findings from natural experiments and longitudinal studies

show that improving neighborhoods' retail food infrastructure [7-11] or proximity to supermarkets [12] may not produce desired changes in food purchasing and consumption patterns. Moreover, a recent review concluded that the food environment was not consistently associated with dietary outcomes. [13]

Most studies looking at the food environment and its association to diet and health do not collect data on *where* people shop for food, *what* they actually purchase, nor have they examined the *nutrient profile* of these purchases. [23, 24, 28] Therefore, it is unclear whether shopping at grocery-stores or supermarkets is associated with a better nutrient profile of food purchases, compared to shopping at other types of stores and whether there are differences by race-ethnicity. Studies looking at the food environment rely on the presence of stores located within people's residential food environment [15, 16] or the location of people's principal food store source. [17, 18] However, these studies do not include data on whether people actually shopped at stores located within their residential food environment. Additionally, these studies make inferences about the types of stores where people shop for food and associations with diet without directly linking foods/beverages consumed to the stores where foods/beverages were purchased. [52] Another major gap is that policy strategies aimed to address food disparities were informed by studies focusing primarily on shopping at a single store, rather than looking at the combination of stores where people shop for food. There is evidence suggesting food shopping is complicated and appears to involve traveling to multiple store-types. [10]

To address these research gaps, we used the longitudinal, nationally representative Nielsen Homescan dataset. Homescan is uniquely advantageous for studying packaged food purchases (PFP) across types of stores because households record the store source and all of their packaged food and beverage purchased. Another unique aspect of the data is that Homescan

follows households for at least one year, better reflecting the types of stores households usually frequent and the foods/beverages households usually purchase. Previous studies looking at food purchases collect data on a limited number of days [48] or have focused on specific food groups, [26, 59] ignoring the entire set of purchases made at the store. Finally, studies that have measured food/beverage purchases have been conducted in small samples, [55, 57, 58] limiting their ability to look at differences by race-ethnicity. The objectives of this study were to examine whether the mix of food stores where people shop, which we refer to as food shopping patterns, were associated with the nutrient profile of PFP and the foods and beverages purchased and to determine whether these associations differ across race-ethnic groups.

Subjects and Methods

Study Design and Population

We used packaged food purchase (i.e., all foods and beverages with a barcode and nutrition information) data from the US Homescan Consumer Panel dataset from 2007-2012,[60] a nationally representative survey of US households. Participating households were given barcode scanners, and household members were instructed to scan the barcodes on all purchased items upon returning home after every shopping trip. Scanning occurred continuously through the year and included products purchased from the following stores: warehouse-club, mass-merchandisers, supermarkets/grocery, convenience, drug, and dollar stores. The name of the store was reported by participants.

Homescan uses an open cohort study design; households may exit any time, and new households are enrolled to replace dropouts and rebalance the panel to match demographic and geographic targets and maintain national representativeness. [61] For a household to be included in

the panel, they needed to report purchases for ≥10 months. Demographic characteristics and household size were collected by questionnaire. From 2007-2012, length of follow up ranged from 10-months to 6-years (mean 3.1-years). Households were sampled from 76 markets, defined as 52 metropolitan and 24 non-metropolitan geographical areas.

This study included households in the dataset from 2007 to 2012 (n=368,934 household-year observations). In order to ensure we captured usual purchases, we excluded household-quarter observations deemed unreliable (i.e., <$135 worth of PFP in four week period for ≥2 member household and <$45 for single-member household) and household-year observations including >1 unreliable quarter, resulting in the exclusion of 3.36% of household-year observations. The final analytical sample included 356,535 household-year observations.

Store-type categorization

For every shopping occasion made over a year, each household reported the name of the store where they shopped for food. We defined store-type as the different types of stores where each household reported purchasing their food for each shopping occasion made over a year. We developed our own classification to categorize store-types into 7 mutually exclusive categories: 1) warehouse-club (e.g., Costco, Sam's); 2) mass-merchandisers-supercenters, hereafter mass-merchandisers (e.g., Walmart, Super-Target); 3) grocery-chains (≥10 units; e.g., Kroger, Safeway); 4) non-chain grocery-stores (<10 units); 5) convenience-drug-dollar, hereafter convenience (e.g., Seven Eleven, CVS, Dollar General, gas stations); 6) ethnic-specialty (e.g., Compare Foods, Whole Foods Market); and 7) others (e.g., department stores, book stores, etc.).

Nutrient information and food/beverage groups

To determine the nutritional content of household PFP, each barcoded product captured in Homescan was linked with Nutrition Facts Panel data. Methodology for this process has been

described elsewhere. [62, 65] Non-packaged foods (i.e., foods without barcodes or without nutrition information) were not included. Examples include loose produce, meats sold by weight, bakery items, prepared foods, etc. However, produce and meats that are packaged were included (e.g., bag of apples, bagged salad, frozen meats, etc.). Information on ingredients lists and product attributes for each barcoded product were used to categorize all foods and beverages purchased in Homescan into 52 food and 14 beverage groups [61] (**Supplemental table 5.1**).

Food shopping patterns

We used cluster analysis to group households by their food shopping patterns. We defined food shopping patterns as the mix of food stores where US households shop based on the amount of PFP by store-type. [89, 90] We ran cluster analysis using volume of household PFP by store-type for every year. We entered volume of PFP as a percentage of volume from each store-type relative to the total volume of PFP, to account for the different amounts purchased at different store-types. [89] We performed cluster analysis using SAS FASTCLUST (SAS version 9.3; SAS Institute Inc.). This k-means procedure used Euclidean distances, computed from input variables, to assign cluster membership by minimizing the distance among members in a cluster while maximizing the distance between clusters in an iterative process using 1000 replications and random selected seeds. [91] Iterations that produced the largest R^2 values indicated the best fit for the data and maximized the inter-to intra-cluster variability ratio. [91, 92] To determine the most appropriate number of clusters, we examined the pseudo F-statistic [93] for each number of cluster solutions, increasing from 2 to 5 clusters. A higher pseudo F-statistic value indicated better intra-cluster homogeneity and inter-cluster heterogeneity. If the more complex cluster solution generated meaningful subgroups, the more complex cluster solution was chosen, as long as the pseudo F-statistic value was comparable. [94]

In our previous cluster analysis of these data, we identified three distinct food shopping patterns: 1) primary-grocery cluster, characterized by households purchasing the majority of their packaged foods and beverages at grocery-chains (e.g., Kroger, Safeway) ; 2) primary-mass-merchandiser cluster, characterized by households purchasing the majority of their packaged foods and beverages at mass-merchandisers (e.g., Walmart, Super Target); and 3) combination cluster, characterized by households purchasing their packaged foods and beverages at a combination of store-types such as warehouse-club, ethnic-specialty stores, non-chain grocery, grocery-chains, and mass-merchandisers **(Table 5.1)**.

Covariates

Self-reported race-ethnicity of the household head was categorized as non-Hispanic whites, Hispanic, non-Hispanic blacks, or other races non-Hispanic. Because "other races non-Hispanic" represented a very heterogeneous group, results were not focused on this group. The ratio of family income to poverty threshold was calculated from self-reported household income and was used to categorize households according to the percentage of the Federal Poverty Level as low ≤185%, middle >185-<400%, or high ≥400%. Self-reported highest educational attainment of the male or female head of household was categorized as less than high school, completed high school, some college, graduated college or post-college graduate. We created household composition variables using number of males and females by age categories: 2-5y, 6-12y, 13-18y, 19-29y, 30-39y, 40-49y, 50-59y, 60-69y and ≥70y. We created market-year level store-type specific food and beverage price indices to control for the fact that some store-types may offer the same products at lower prices. Considering foods and beverages separately, we identified a standard basket of packaged foods and beverages that were sold across store-types, markets and years. Then, using information on prices paid by participant households, we created

store-type-market-year level food and beverage price indices. Year and market were entered as a set of indicator variables.

Statistical analysis

All analyses were performed using Stata 13 (StataCorp LP). For descriptive analyses, we used survey commands to account for study design and weighting to generate nationally representative results. We calculated univariate descriptive statistics for the total sample and by shopping patterns from 2007-2012.

Outcome specification: As primary outcomes, we used continuous measures of the nutrient profile of household PFP from foods and beverages separately: energy density and nutrient density (g total sugars, mg sodium and g saturated fat) per 1000g. As secondary outcomes, considering foods and beverages separately, we used the proportion of calories from food groups relative to total food purchases and the proportion of calories from beverage groups relative to total beverage purchases. We used yearly measures of purchases to better capture usual shopping habits.

Exposure specification: Our main exposures were shopping patterns derived from the cluster analysis: primary-grocery, primary-mass-merchandise and a combination cluster.

Model specification: We used longitudinal random-effects models to investigate the association between shopping patterns and the nutrient profile of total household PFP and food/beverage groups purchased over the period studied. We used longitudinal random-effects models to account for the fact that we have multiple year-observations per household. We estimated separate models for foods and beverages. To assess whether the association between shopping patterns and nutrient profile of household PFP and food/beverage group purchased differed by race-ethnicity or by income, we conducted Wald “chunk” tests for the joint

significance of the income-shopping patterns interaction terms and for the race-ethnicity-shopping patterns interaction terms with $P<0.05$ considered statistically significant. All models were adjusted for maximum level of education, income, household composition, store-type specific food and beverage price indices, year and market. To aid interpretability, we used the margins- command in Stata to predict the mean (SE) energy and nutrient densities of PFP and the mean (SE) proportion of calories from key food and beverage groups for each shopping pattern by race-ethnic group. These predictions were based on the model coefficients of the main exposures plus further adjustments performed in the model. Within each race-ethnicity group, we used the primary-grocery cluster as the referent shopping pattern. We tested for statistically significant differences using Student's t tests. A two-sided p-value of 0.001 was set to denote statistical significance to account for multiple comparisons and big sample size.

Results

Sociodemographic characteristics

From 2007 to 2012, households from Homescan were predominantly non-Hispanic white, highly educated and in the middle and upper income categories. The average household size was <3 and the majority of households were composed of only adults. The primary-grocery cluster was the largest, while the other clusters each represented about a quarter of the population. The sociodemographic characteristics of the shopping patterns vary by household income, race-ethnicity, and household education. Compared to the primary-grocery cluster and the combination cluster, the primary-mass-merchandiser cluster shoppers were more likely to be low-income and had a lower educational distribution. Compared to the primary-grocery cluster and the primary-mass-merchandiser cluster, the combination cluster shoppers were less likely to

be non-Hispanic whites, with greater representation of Hispanics, non-Hispanic blacks, and others **(Table 5.1)**.

On average, households purchased 2,341grams/day of PFP (1,035 grams/day of foods and 1,306 grams/day of beverages). We found a statistically significant interaction between shopping patterns and race-ethnicity in our random-effects longitudinal model using energy density of foods as the outcome (p interaction =0.002) in our fully adjusted model. We did not find a statistically significant interaction between shopping patterns and income in our fully adjusted model. Predicted probabilities of the adjusted model were similar to the unadjusted results (**Supplemental tables 5.2-5.3**), therefore we only present adjusted model results. Since we are studying many outcomes, to be consistent across models, we included the main effect for race-ethnicity and an interaction terms between race-ethnicity and shopping pattern exposures in all models.

Associations between shopping patterns and household PFP

Considering foods and beverages separately, **Figures 5.1.A-D** shows the nutrient profile of packaged foods by shopping patterns across race-ethnic groups. After adjusting for confounders, we found no meaningful differences in energy, sugar, saturated fat, and sodium densities among the food shopping patterns overall, despite finding some statistically significant differences. Additionally, within race-ethnic groups, we do not found differences in the relationship between shopping patterns and the nutritional profiles of foods purchased. Similar results were seen for the nutrient profile of packaged beverages (**Figures 5.2.A-D). Table 5.2** shows the mean proportion of calories purchased from key food and beverage groups by shopping patterns across race-ethnic groups. Overall, after adjusting for confounders, we found that shopping patterns were not associated with differences in the proportion of calories

purchased from key food and beverage groups across race-ethnic groups. In other words, each race-ethnic group was purchasing similar distributions of products regardless of where they were shopping.

Race-ethnic differences in the associations between shopping patterns and household PFP

Across the different food shopping patterns, non-Hispanic black households purchased packaged foods with higher energy, sugar, and sodium density, compared to non-Hispanic white and Hispanic households. The saturated fat content of packaged foods purchases does not appear to be higher in non-Hispanic blacks compared to non-Hispanic white and Hispanic households (**Figures 5.1.A-D)**. In terms of beverage purchases, across the different food shopping patterns, non-Hispanic black households purchased packaged beverages with higher sugar density and lower sodium density, compared to non-Hispanic white and Hispanic households (**Figures 5.2.A-D)**. Across the different food shopping patterns, the different race-ethnic groups purchased a similar proportion of calories from food groups. However, for beverage groups, the contribution of calories from SSB and fruit juices to total calories from beverages purchased across shopping patterns was higher for non-Hispanic black households, compared to non-Hispanic white and Hispanic households. Non-Hispanic black households also purchased a lower proportion of calories from plain milk (i.e., unsweetened/unflavored whole and low fat milk) across shopping patterns, compared to non-Hispanic white and Hispanic households.

Discussion

Our results suggest that in the Homescan sample, following a primary-grocery shopping pattern was not associated with a lower energy, total sugar, saturated fat or sodium densities of household PFP or the food and beverage groups they purchased, compared to shopping at a

primary-mass-merchandiser or employing a combination shopping pattern. These null findings were consistent across race-ethnic groups. From the supply side perspective, one study suggest that poor diets of many race-ethnic groups are attributable to limited access to stores that sell healthy foods, especially grocery stores or supermarkets. [108] Our study allowed us to examine a metric that reflects both availability and demand. We found that, no matter what shopping pattern different race-ethnic groups employed, the nutrient profile of their purchases and what foods and beverages they purchased were very similar. In fact, households purchased the same proportion of calories from salty snacks, grain-based-desserts, candy, processed meat, SSB, etc., regardless of where they shopped. As others have pointed out, the availability [109] and in-store marketing strategies [75] of "less healthy" foods might be a stronger determinant of what is purchased, rather than availability of "healthy foods".

Studies have suggested that within a given store-type, stores located in predominantly black and lower-income neighborhoods have less availability of healthy foods [52] or lower relative availability of healthier food alternatives [110] compared to similar stores located in predominantly white and higher-income neighborhoods. However, a recent study [111] found that even when looking at purchases from the same store, low-income households purchased foods that were less healthful compared to high-income households. Although not directly comparable, these results, together with our findings and results from natural experiments suggest that disparities in the healthfulness of food purchases are not necessarily driven by differential access to stores that sell heathy foods. The relationship between the food environment and people's diet quality is complex and likely to be bidirectional. Additionally, food preferences, budget constraints, differences in price sensitivities, car ownership, and food marketing are likely to influence food shopping behaviors. Moreover, qualitative research suggests that efforts to

improve neighborhood food environments should address not only food availability and prices, but also the physical and social barriers such as unfair treatment, deteriorated conditions and lack of safety at stores. [112]

One of our key findings was that, even after accounting for different shopping patterns, there were race-ethnic differences in the nutritional profiles of packaged food purchases. Specifically, across the three shopping patterns, non-Hispanic black households purchased foods with higher energy, total sugar and sodium densities, compared to non-Hispanic white and Hispanic households. Non-Hispanic black households also purchased a higher proportion of their beverage calories from SSB and juice drinks, and fewer calories from plain milk. In terms of food groups, after accounting for different shopping patterns, non-Hispanic blacks purchased a similar proportion of calories from the different food groups as did non-Hispanic whites and Hispanics. Heterogeneity within food groups might be a possible explanation for why we observed differences in the nutrient profile of foods purchased but no differences in the food groups purchased by non-Hispanic black households, compared to the other race-ethnic groups. For example, it is possible that some race-ethnic groups purchased products within a same food group that had different levels of preparation (e.g., dry rice vs frozen rice that is ready to eat). Additionally, different race-ethnic groups might have purchased foods with better nutrient profiles (e.g., regular vs. low sodium canned vegetables) or they purchased different types of products within a same food group (e.g., popcorn vs. pretzels). Overall, our race-ethnic findings imply that cultural factors, taste preferences and economic and time constrains might be more influential to the nutrient profile of purchases and what foods and beverages people purchased, than shopping patterns. Therefore, additional actions need to be considered to improve the

quality and types of foods/beverages purchased regardless of store-type, especially for non-Hispanic blacks.

A major strength is that our study is unique in measuring where households actually shopped for food as well as the foods/beverage purchased there, along with nutrient information on those purchases. Additionally, we collected data for household PFP during the course of an entire year, reflecting households' usual purchases.

Limitations

A key limitation is that where individuals choose to shop for food is also a result of individual choice and is a complex decision affected by many factors, both observable and unobservable, that overlap with the purchase decision. The four P's of marketing, product, price, promotion, and placement, influence food purchasing decisions [76-79, 113] along with individual food preferences, [1] transportation, and time. [45, 80] This is known as self-selection, [114] and although these are all different types of selection mechanism, at the end, the choice of where consumers shop for food (i.e., type of store) and what foods/beverages they purchase is non-random. Due to this self-selection mechanism, we expected an upward bias in the association between the primary-grocery shopping pattern and the nutrient profile of PFP. In other words, individuals that are highly motivated to eat a healthy diet may also be more likely to go to a higher quality store and purchase "healthier" foods/beverages once they get there. However, even with this hypothesized upward bias, we still do not observe meaningful differences in the nutrient profile of PFP and what foods and beverages people purchased by shopping patterns.

Our analysis focused on calories, total sugars, saturated fat and sodium of PFPs, not consumption. Additionally, these components do not capture all aspects of foods/beverages that affect dietary quality or health. Another limitation is our lack of non-packaged food purchase

data, such as fresh fruits and vegetables or unprocessed meats. Additionally, Homescan did not capture away-from-home purchases. The lack of data on non-store sources of food (e.g., food service, schools), or non-packaged foods means we were unable to describe overall nutrient profile of total food purchases. However, approximate 65% of calories consumed by Americans come from the store-types captured in Homescan.

Households that participate in Homescan must scan all groceries at home. The process of recording might be time consuming, which could result in underreporting of data. This would be a problem if households systematically and differently underreported PFP from a specific store-type or if misreporting differed by sociodemographic characteristics. Additionally, when we observe a household shopping in a given store, we only have data for the products they actually purchased, not the full variety of products offered at the store. [111]

The Homescan sample does not perfectly match the US population based on demographic characteristics. Despite the large sample size, households with low-education and low-income are underrepresented. [81] Therefore, these results may not be generalizable to the US population. [115] Finally, given that households volunteered to participate, there is always the possibility of participation bias.

Conclusions

We found no meaningful differences in the nutrient profile of purchased packaged foods and beverages and the food and beverage groups purchased by shopping patterns. These null findings were consistent across race-ethnic groups. The ubiquity of unhealthy packaged foods/beverages that are high in sugars, sodium and fat regardless of store-type may thwart efforts to improve eating habits. Additionally, policy initiatives that focus on increasing physical access to stores or helping stores sell healthier products to encourage healthier purchases may be

ineffective because other factors may be more important determinants of foods/beverages purchases than where people shop or what is available in the store.

Tables and Figures

Table 5.1. Mean proportion of volume by store-type by food shopping patterns and counts and proportions of sociodemographic characteristics by food shopping patterns of US households participating in the 2007-2012 Homescan panel[a]

	Primary-grocery[b]	Primary-mass-merchandiser	Combination	Total
Total households, n	182,345 (50.8)	80,855 (22.9)	93,411 (26.3)	356,535
Volume of households PFP by store-type, % [b]				
Warehouse-club	4.6	4.3	21.2	8.9
Convenience-store	4.1	3.3	7.6	4.9
Ethnic/specialty	0.8	1.4	13.7	4.3
Grocery-chain	76.0	18.0	21.1	48.5
Mass-merchandiser	9.5	67.3	12.0	23.2
Non-chain grocery	2.3	3.3	15.2	5.9
Others	2.6	2.3	9.2	4.3
Household income [c]				
Low	33,215 (25.3)	18,405 (30.6)	16,196 (24.4)	67,796 (26.3)
Middle	76,839 (37.1)	37,900 (40.0)	38,468 (36.6)	153,176 (37.6)
High	72,291 (37.6)	24,550 (29.3)	38,747 (39.0)	135,563 (36.1)
Household race-ethnicity [d]				
Non-Hispanic whites	151,231 (74.0)	68,874 (77.8)	71,656 (65.3)	291,696 (72.6)
Hispanics	8,898 (10.9)	3,107 (8.2)	6,083 (14.4)	18,088 (11.2)
Non-Hispanic blacks	14,868 (10.1)	6,214 (10.2)	9,907 (13.1)	30,984 (10.9)
Non-Hispanic others	73,48 (5.0)	2,660 (3.8)	5,765 (7.2)	15,767 (5.3)
Household education [e]				
Less than high-school	2,231 (2.6)	1,181 (2.9)	1,137 (2.7)	4,547 (2.7)
Graduated high-school	31,233 (27.8)	16,864 (32.0)	13,871 (24.9)	61,960 (28.0)
Some college	52,406 (31.6)	26,086 (33.8)	27,086 (32.1)	105,563 (32.2)
Graduated college	64,502 (25.5)	26,646 (22.4)	33,287 (26.4)	124,400 (25.0)

Post college graduate	31,973 (12.6)	10,078 (8.9)	18,030 (13.8)	60,065 (12.1)
Household type [f]				
Single	50,571 (27.7)	18,503 (24.3)	23,713 (26.7)	92,727 (26.7)
Adults, no kids	89,376 (38.6)	40,783 (37.4)	48,909 (39.9)	179,053 (38.7)
Adult(s) and kid(s)	42,398 (33.7)	21,569 (38.3)	20,789 (33.4)	84,755 (34.7)
Household size [g]	2.5 ± 0.0	2.6 ± 0.0	2.6 ± 0.0	2.6 ± 0.0

[a] Data from the 2007-2012 Homescan longitudinal panel of household purchases of packaged foods. Volume of household PFP by store-type for the total sample and by food shopping patterns is presented as the proportion of PFP from a given store-type, relative to the total household PFP over the period studied. Proportion of the number of households by food shopping patterns is presented as row percentages. Households socio-economic values for the total sample and by food shopping patterns are presented as counts and column percentages and household size is presented as mean ± SE. Percentages and mean for the household size have been weighted to be nationally representative.

[b] We used cluster analysis to group households by their food shopping patterns. We defined shopping patterns as the combinations of store-types US households use to shop for food based on the volume from packaged food purchases (PFP) by store-type. We found 3 food shopping patterns or clusters: 1) primary-grocery cluster, characterized by households purchasing the majority of their packaged foods and beverages at grocery-chains (e.g., Kroger, Safeway) ; 2) primary-mass-merchandiser cluster, characterized by households purchasing the majority of their packaged foods and beverages at mass-merchandisers (e.g., Walmart, Super Target); and 3) combination cluster, characterized by households purchasing their packaged foods and beverages at a combination of store-types.

[c] Ratio of family income to poverty threshold, calculated from self-reported household income, was used to categorize income according to the percentage of the Federal Poverty Level (low ≤185%; middle >185-<400%; or high ≥400%).

[d] Self-reported race-ethnicity of the household head.

[e] Household self-reported highest educational attainment.

[f] Children were all household members ≤18y old. Adults were all household members >19y old.

[g] Number of people living in the household.

Table 5.2. Mean proportion of calories purchased from key food and beverage groups by shopping pattern across race-ethnic groups, Homescan 2007-2012 [a]

	Non-Hispanic whites [b]			Hispanics			Non-Hispanic blacks		
	Primary-grocery [c]	Primary-mass-merchandiser	Combination	Primary-grocery	Primary-mass-merchandiser	Combination	Primary-grocery	Primary-mass-merchandiser	Combination
Foods [d]									
Salty snacks	9.6 (0.0)	9.7 (0.0)	9.6 (0.0)	9.2 (0.1)	9.5 (0.1)	9.3 (0.1)	9.0 (0.1)	9.3 (0.1)	9.1 (0.1)
Breads and tortillas	7.9 (0.0)	7.7 (0.0)	7.7 (0.0)	8.9 (0.1)	8.5 (0.1)	8.5 (0.1)	7.3 (0.0)	7.1 (0.1)	7.0 (0.0)
Grain-based desserts	9.4 (0.0)	9.7 (0.0)	9.3 (0.0)	8.8 (0.1)	9.2 (0.1)	8.9 (0.1)	8.4 (0.1)	8.8 (0.1)	8.4 (0.1)
Candy and sweet snacks	6.2 (0.0)	6.7 (0.0)	6.8 (0.0)	5.5 (0.1)	6.2 (0.1)	6.0 (0.1)	5.0 (0.1)	5.4 (0.1)	5.6 (0.1)
Cheese	4.4 (0.0)	4.3 (0.0)	4.4 (0.0)	4.2 (0.0)	4.0 (0.1)	4.1 (0.0)	3.1 (0.0)	3.0 (0.0)	3.0 (0.0)
Processed meat	3.0 (0.0)	3.1 (0.0)	2.9 (0.0)	3.2 (0.0)	3.2 (0.0)	3.0 (0.0)	4.0 (0.0)	3.9 (0.0)	3.9 (0.0)
Vegetables, unsweetened/unflavored	0.5 (0.0)	0.5 (0.0)	0.6 (0.0)	0.5 (0.0)	0.5 (0.0)	0.5 (0.0)	0.5 (0.0)	0.5 (0.0)	0.5 (0.0)
Vegetables, canned	0.5 (0.0)	0.5 (0.0)	0.5 (0.0)	0.5 (0.0)	0.5 (0.0)	0.5 (0.0)	0.4 (0.0)	0.3 (0.0)	0.4 (0.0)
Nuts and nut butters, sweetened/flavored	4.2 (0.0)	4.4 (0.0)	4.7 (0.0)	3.6 (0.1)	3.9 (0.1)	4.1 (0.1)	3.3 (0.0)	3.4 (0.1)	3.7 (0.1)
Ready-to-eat cereal	4.6 (0.0)	4.6 (0.0)	4.6 (0.0)	4.6 (0.0)	4.6 (0.1)	4.5 (0.1)	4.0 (0.0)	4.2 (0.1)	4.0 (0.1)
Beverages [d]									
SSB	26.9 (0.1)	27.8 (0.1)	26.7 (0.1)	29.2 (0.3)	29.1 (0.4)	28.6 (0.3)	37.3 (0.2)	37.2 (0.3)	37.3 (0.3)
Plain milk	36.6 (0.1)	36.4 (0.1)	35.5 (0.1)	34.5 (0.3)	34.2 (0.4)	34.2 (0.3)	24.1 (0.2)	24.3 (0.3)	22.9 (0.3)
Fruit juices	12.5 (0.0)	12.1 (0.01)	12.1 (0.1)	13.6 (0.2)	13.7 (0.3)	13.5 (0.2)	16.8 (0.1)	16.9 (0.2)	16.9 (0.2)

[a] Data from the 2007-2012 Homescan longitudinal panel of household purchases of packaged foods. Values are expressed as predicted means (SE) and were obtained from longitudinal random-effects models that were adjusted for income, maximum level of education, household composition, store-type specific food and beverage price indices, year and market.

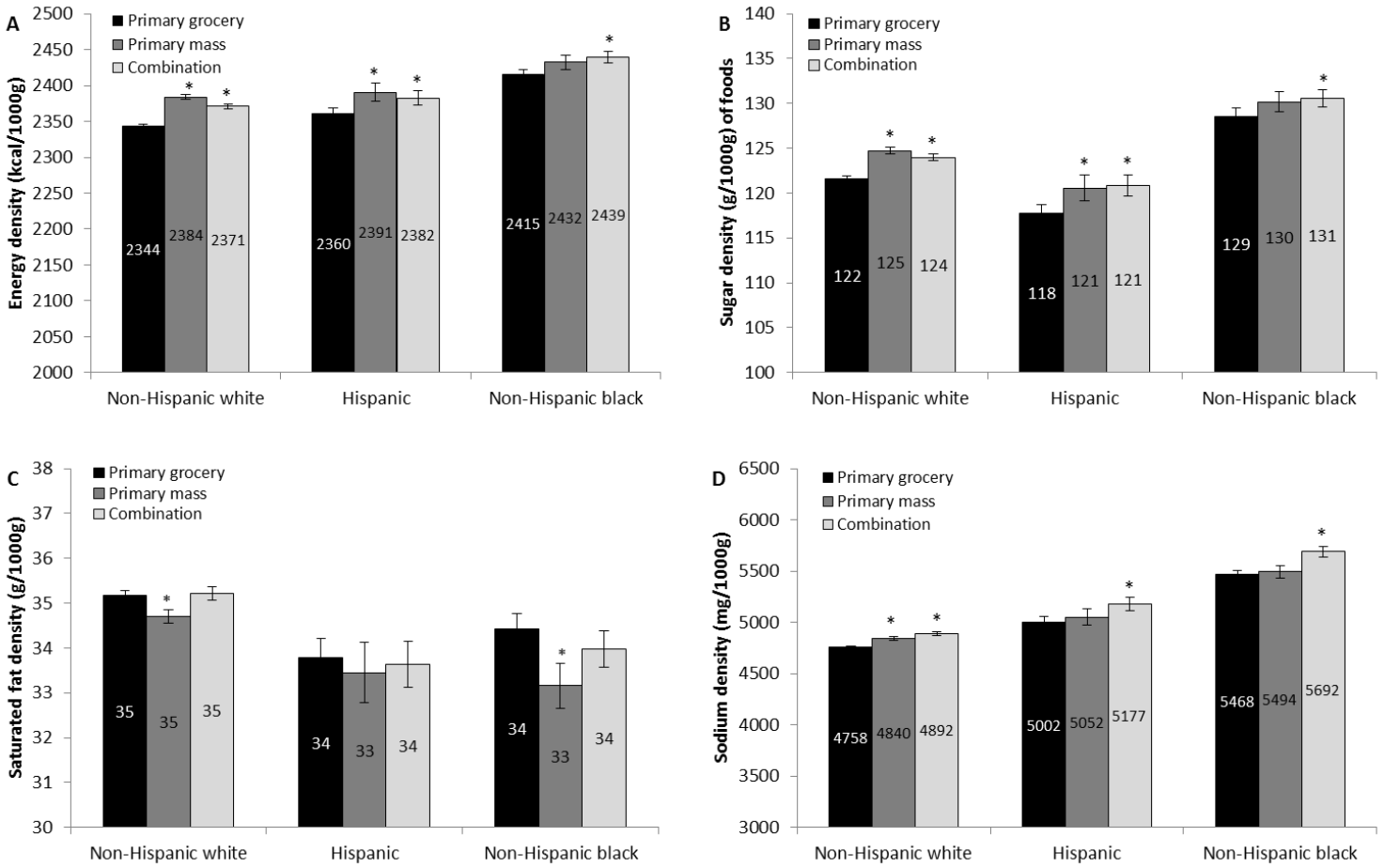
[b] Self-reported race-ethnicity of the household head.

[c] We used cluster analysis to group households by their food shopping patterns. We defined shopping patterns as the combinations of store-types US households use to shop for food based on the volume from packaged food purchases (PFP) by store-type. We found 3 food shopping patterns or clusters: 1) primary-grocery cluster, characterized by households purchasing the majority of their packaged foods and beverages at grocery-chains (e.g., Kroger, Safeway) ; 2) primary-mass-merchandiser cluster, characterized by households purchasing the majority of their packaged foods and beverages at mass-merchandisers (e.g., Walmart, Super Target); and 3) combination cluster, characterized by households purchasing their packaged foods and beverages at a combination of store-types.

[d] Information on ingredients lists and product attributes were used to categorize all foods and beverages purchased in Homescan into 52 food and 14 beverage groups at the barcode level.[61] Considering foods and beverages separately, we used the proportion of calories from food groups, relative to total food purchases and the proportion of calories from beverage groups, relative to total beverage purchases. Salty snacks include: potato chips, crackers, corn chips, pretzels, tortilla chips, pita chips, popcorn, sandwich crackers, rice cakes, snack mixes with crackers, etc. Breads and torrillas include: bread, rolls, hot dog/hamburger buns, sandwich rolls, sandwich wraps, bagels, tortillas, taco shells, etc. Grain-based desserts include: ready-to-bake cookies, brownies, sweet rolls, ready-to-eat cookies, brownies, snack cakes, cupcakes, baking mixes, etc. Candy and sweet snacks include: candy, chocolate, candy bars, fruit snacks, fudge, gum, mints, popsicle, candy-coated nuts or seeds, etc. Cheese includes: Cheddar, Swiss, mozzarella, Parmesan, Romano, feta, ricotta, blue cheese, cottage cheese, american cheese, cream cheese, processed cheese spreads, spray cheese, non-dairy/imitation cheese, etc. Processed meats include: Refrigerated, frozen or canned/shelf-stable processed meat such as bacon, sausage, bratwurst, hot dogs, smoked, cured turkey, ham, roast beef, pastrami, chicken, etc. Vegetables, unsweetened/unflavored include: includes fresh, refrigerated, frozen and dried vegetables. Bagged or packaged lettuce/salad blends, fresh baby carrots, carrot sticks, celery sticks, whole

carrots, celery, heads of lettuce, tomatoes, mushrooms, cauliflower, onions, peppers, green beans. Plain frozen broccoli, carrots, green beans, sugar snap peas, snow peas, spinach, greens, vegetable mixtures, etc. Vegetables, canned include: canned green beans, tomatoes, spinach, greens, carrots, mushrooms, water chestnuts, pumpkin, tomato paste, etc. Nuts and nut butters, sweetened/flavored include: raw, blanched, dry-roasted, or oil-roasted nuts or seeds (salted, flavored, frosted, or honey-roasted), such as peanuts, almonds, cashews, pecans, walnuts, pistachios, macadamia nuts, brazil nuts, pine nuts, hazelnuts, sunflower seeds, pumpkin seeds, flax seeds, and nut mixtures, nut-based trail mix, etc. Ready-to-eat cereal includes: Corn flakes, frosted flakes, raisin bran, frosted shredded wheat, toasted oat cereal, crispy rice, chocolate flavored cereals, bran flakes, fruit flavored cereals, puffed rice, shredded wheat, granola, etc. SSB include: Caloric and low-calorie cola, root beer, ginger ale, other soft drinks, energy drinks, tonic, flavored seltzer or carbonated water, carbonated fruit drinks, sports drinks, fruit-flavored drinks and flavored waters, etc. Plain milk includes: fresh or shelf-stable plain milk, both whole and low-fat milk. Fruit juices include: 100% or <100%, not from-concentrate or from-concentrate, sweetened juice, frozen fruit juice concentrate, sparkling fruit juice and cider, etc.

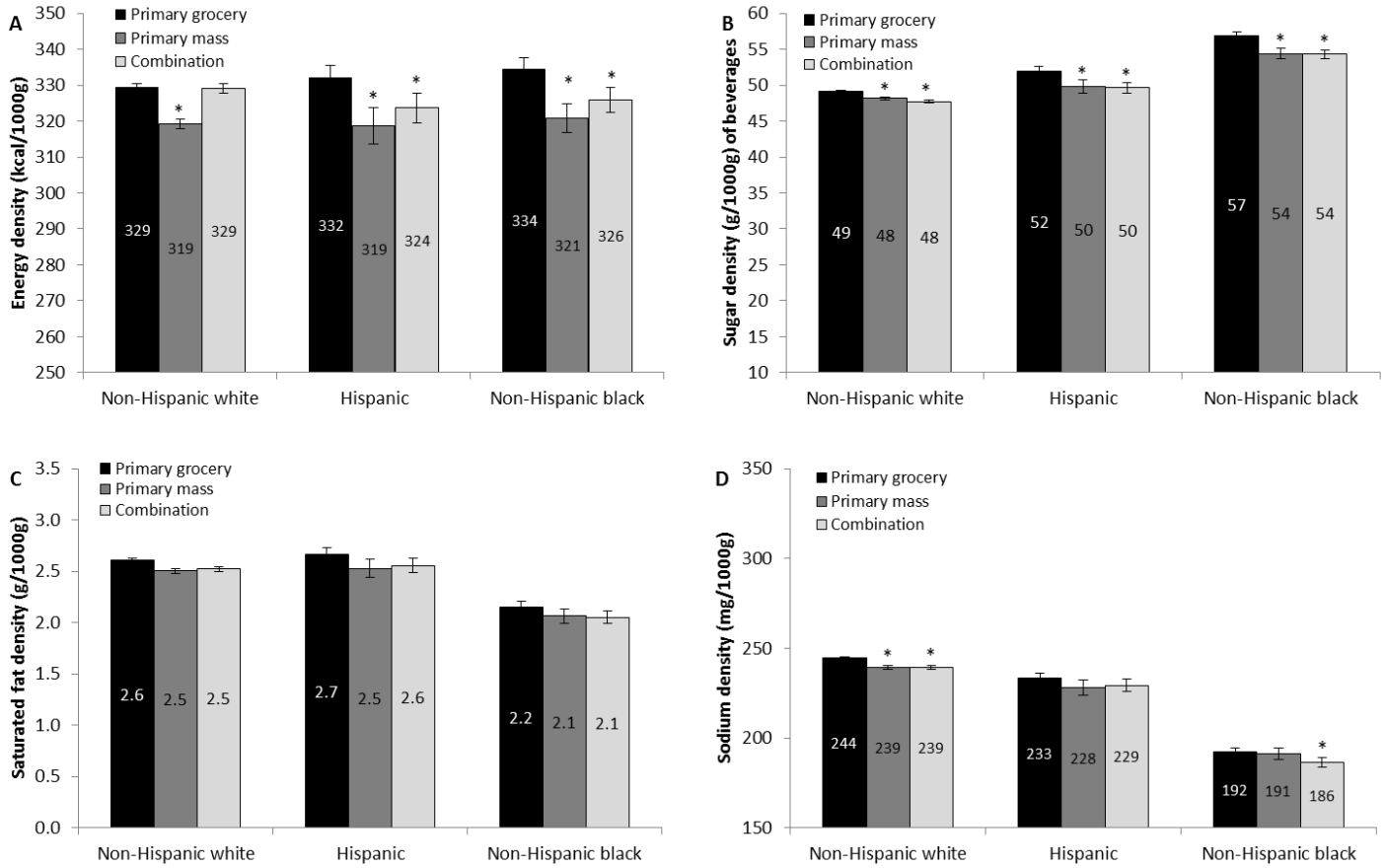
Figure 5.1. Energy and nutrient densities of packaged foods by shopping patterns across race-ethnic groups, Homescan 2007-2012



(A) energy density (kcal/1000g); (B) sugar density (g/1000g); (C) saturated fat density (g/1000g); (D) sodium fat density (mg/1000g). Values represent predicted means (SE) and were obtained from longitudinal random-effects models that were adjusted for income, maximum level of education, household composition, store-type specific food and beverage price indices, year and market. We used cluster analysis to group households by their food shopping patterns. We defined shopping patterns as the combinations of store-types US households use to shop for food based on the volume from packaged food purchases (PFP) by store-type. We found 3 food

shopping patterns or clusters: 1) primary-grocery cluster, characterized by households purchasing the majority of their packaged foods and beverages at grocery-chains (e.g., Kroger, Safeway) ; 2) primary-mass-merchandiser cluster, characterized by households purchasing the majority of their packaged foods and beverages at mass-merchandisers (e.g., Walmart, Super Target); and 3) combination cluster, characterized by households purchasing their packaged foods and beverages at a combination of store-types. Race-ethnic groups were created based on self-reported race-ethnicity of the household head. Within each race-ethnicity group, we used the primary-grocery cluster as the referent shopping pattern. We tested for statistically significant differences using Student's t tests. (*) A two-sided p-value of 0.001 was set to denote statistical significance to account for multiple comparisons and big sample size. Data comes from the 2007-2012 Nielsen Homescan panel of household packaged food purchases.

Figure 5.2. Energy and nutrient densities of packaged beverages by shopping patterns across race-ethnic groups, Homescan 2007-2012



(A) energy density (kcal/1000g); (B) sugar density (g/1000g); (C) saturated fat density (g/1000g); (D) sodium fat density (mg/1000g). Values represent predicted means (SE) and were obtained from longitudinal random-effects models that were adjusted for income, maximum level of education, household composition, store-type specific food and beverage price indices, year and market. We used cluster analysis to group households by their food shopping patterns. We defined shopping patterns as the combinations of store-types US households use to shop for food based on the volume from packaged food purchases (PFP) by store-type. We found 3 food shopping patterns or clusters: 1) primary-grocery cluster, characterized by households purchasing the majority of their packaged foods

and beverages at grocery-chains (e.g., Kroger, Safeway) ; 2) primary-mass-merchandiser cluster, characterized by households purchasing the majority of their packaged foods and beverages at mass-merchandisers (e.g., Walmart, Super Target); and 3) combination cluster, characterized by households purchasing their packaged foods and beverages at a combination of store-types. Race-ethnic groups were created based on self-reported race-ethnicity of the household head. Within each race-ethnicity group, we used the primary-grocery cluster as the referent shopping pattern. We tested for statistically significant differences using Student's t tests. (*) A two-sided p-value of 0.001 was set to denote statistical significance to account for multiple comparisons and big sample size. Data comes from the 2007-2012 Nielsen Homescan panel of household packaged food purchases.

Supplemental Table 5.1. Food grouping system for Homescan barcode-level data for PFP

Food and beverage groups	Description
Cheese	Cheddar, Swiss, mozzarella, Parmesan, Romano, feta, ricotta, blue cheese, cottage cheese; american cheese, cream cheese, processed cheese spreads, spray cheese, non-dairy/imitation cheese; fried cheese sticks, cheese soufflé.
Yogurt	Yogurt (plain or sweetened/flavored); Yogurt drinks, shakes, or smoothies; kefir.
Other dairy products	Sour cream, cream, half-and-half, whipping cream, creamer (liquid or powdered), whipped cream, whipped topping, evaporated milk, sweetened condensed milk.
Dairy-based desserts	Ice cream; sherbet; ice milk; frozen yogurt; ice cream bars, cones, sandwiches; pudding; cheesecake; tiramisu; mousse.
Meat, unsweetened/unflavored	Fresh, refrigerated, frozen or canned unsweetened/unflavored meat. Plain raw or pre-cooked chicken, turkey, steak, pot roasts, ground meat, fish, shrimp, crab, other seafood, pork roasts or tenderloin; sliced or shaved lunch meat not containing nitrates, nitrites, mechanically separated meat, or fillers and not cured or smoked; canned or shelf-stable meat with no added sweetener, flavor, salt, or oil, such as tuna, salmon, crab meat, sardines, clams, or other seafood.
Meat, sweetened/flavored	Fresh, refrigerated, frozen or canned sweetened/flavored meat. Seasoned or marinated raw or pre-cooked chicken, turkey, steak, pot roast meat, ground meat, burger patties, fish, shrimp, crab, other seafood, pork chops; canned or shelf-stable (envelope, cup, jar) tuna, salmon, chicken, crab, sardines, anchovies, or other seafood; chicken nuggets, tenders, or patties; fried chicken; fish sticks; breaded shrimp or clam strips; breaded fish fillets; country fried steak patties; breaded fried pork patties; breaded veal patties.
Processed meat	Refrigerated, frozen or canned/shelf-stable processed meat. Bacon; sausage; bratwurst; hot dogs; smoked, cured, or chopped/formed lunch meat such as turkey, ham, roast beef, pastrami, chicken, corned beef, bologna, salami, pepperoni, luncheon loaf; ham (whole, steaks, diced, ground); Canadian bacon; refrigerated dry sausage links or sticks; soft salami, liverwurst, or bologna in chubs or chunks; smoked salmon, trout, pork chops, turkey, chicken; salted cod: spam; luncheon loaf; Vienna sausage; summer sausage, dried salami, or pepperoni; canned ham; beef jerky or meat jerky; smoked salmon, tuna, mussels, herring, sardines, trout, or other seafood; real bacon bits or pieces; corned beef; deviled ham or ham spread (cured ham with spices).
Meat-based dishes	Refrigerated, frozen or canned/shelf-stable meat-based dishes. Includes beef, pork, poultry, seafood, and processed meat with any type of sauce, glaze, cheese, bacon, added bread crumbs, or vegetables and mixed dishes with meat as the main component and not served with stuffing, grains, rice, or pasta. Prepared RTH meat-based dishes (stuffed chicken breasts, buffalo wings, fried breaded patties with gravy, meat loaf, ribs, meatballs, BBQ, pot roast with gravy, crab cakes, stuffed fish or seafood, meat with sauce); meat-based frozen meals (Salisbury steak, turkey and gravy); uncooked meat-based dishes (salmon pinwheels, stuffed flounder, meatloaf mix, bacon-wrapped filets); RTE seafood, chicken, tuna, or ham salad; sardines in sauce, oysters in sauce, Vienna sausage in sauce, pre-made tuna salad, meat-based pate or spreads (e.g., chicken liver spread, smoked

Food and beverage groups	Description
	salmon spread), corned beef hash, roast beef in gravy.
Eggs	Fresh eggs, liquid egg whites, hard-boiled eggs; egg substitutes and egg dishes such as prepared egg salad or deviled eggs; prepared egg-based dishes (e.g., quiche, omelets, egg soufflés); frozen meals with eggs and meat.
Egg substitutes and egg dishes	Egg substitutes; prepared egg salad or deviled eggs; prepared egg-based dishes (e.g., quiche, omelets, egg soufflés); frozen meals with eggs and meat.
Legumes, unsweetened/unflavored	Dried pinto, great northern, lima, black, navy, kidney, red, white, garbanzo, pink, cranberry, cannellini, soldier, and soy beans and mixtures of several bean types; dried green or yellow split peas, black-eyed peas, dal, and lentils. Fresh or refrigerated plain pre-steamed edamame, lentils, or bean sprouts; tofu and tempeh.
Legumes, sweetened/flavored	Dried legumes with dehydrated vegetables and/or seasoning. Fresh or refrigerated seasoned or marinated pre-steamed edamame, lentils, or bean sprouts; tofu and tempeh. Frozen black beans, great northern beans, lima beans, butter beans, black-eyed peas, field peas, crowder peas, purple hull peas, edamame/soybean pods, and mixtures of legumes and vegetables.
Legumes, canned	Canned cooked beans with no added sweeteners, flavors, or oil/fat such as garbanzo beans, kidney beans, pinto beans, black beans, lima beans, butter beans, northern beans, navy beans, red beans, cannellini beans, black-eyed peas, or soy beans. Canned or shelf-stable cooked beans with added sweeteners or flavors, including garbanzo beans, kidney beans, red beans, cannellini beans, lima beans, butter beans, pinto beans, black beans, pink beans, great northern beans, navy beans, white beans, lentils, black-eyed peas, pigeon peas, field peas, "refried" beans with no added oil, bean mixtures; jarred three-bean salad.
Nut and nut butters, plain	Raw, blanched, dry-roasted, or oil-roasted nuts or seeds (plain), including peanuts, almonds, cashews, pecans, walnuts, pistachios, macadamia nuts, brazil nuts, pine nuts, hazelnuts, sunflower seeds, pumpkin seeds, flax seeds, and nut mixtures; unflavored/unsweetened peanut butter, almond butter, soy nut butter, sunflower butter; almond or nut-based pastry filling.
Nut and nut butters, sweetened/flavored	Raw, blanched, dry-roasted, or oil-roasted nuts or seeds (salted, flavored, frosted, or honey-roasted), including peanuts, almonds, cashews, pecans, walnuts, pistachios, macadamia nuts, brazil nuts, pine nuts, hazelnuts, sunflower seeds, pumpkin seeds, flax seeds, and nut mixtures; nut-based trail mix (mixtures of nuts with seeds, dried fruit, chocolate, and/or candy pieces); nut-based bars made from nuts or seeds but no grains (e.g., Larabars, Bumble Bars, and Clif nectar bars); nut clusters or crunch snacks; nut-based dessert toppings; Sweetened/flavored peanut butter, almond butter, soy nut butter, sunflower butter; almond or nut-based pastry filling.
Legume-based dishes	Refrigerated, frozen, canned or shelf-stable legume-based dishes. Prepared legume-based dishes including baked beans; legumes or legume and vegetable mixtures in sauce; legume-based frozen meals (e.g., bean chili, meals with vegetarian meat, chana masala, falafel); soy- or bean-based vegetarian burgers, "meat," or "lunch meat"; tofu with sauce. Prepared legume-based dishes including baked beans; beans in tomato sauce; beans with pork or hot dogs; refried beans; black-eyed peas with stewed tomatoes; beans with rice; soy-based vegetarian/meatless canned dishes; legume-based meal kits for making baked beans, chili, or falafel.

Food and beverage groups	Description
Breads and tortillas	Bread, rolls, hot dog/hamburger buns, sandwich rolls, sandwich wraps, bagels, cinnamon/raisin bread, English muffins, bread sticks, pita bread, pizza crusts; refrigerated ready-to-bake rolls, bread sticks, garlic bread, pizza crusts, dough; frozen dough, bread, bread sticks, rolls, bagels, garlic bread, English muffins, hot dog/hamburger buns, pizza crusts; shelf-stable tortillas, taco shells, bread crumbs, canned brown bread, croutons, grain-based imitation bacon bits; mixes for bread, rolls, or pizza crust.
Quick breads	Fresh banana bread, walnut bread, or fruit bread; refrigerated ready-to-bake biscuits, corn bread; frozen RTH pancakes, waffles, French toast; frozen ready-to-bake biscuits, corn bread, phyllo dough; baking mixes for pancakes, biscuits, corn bread, fruit breads, hush puppies, matzo balls.
Grain-based desserts	Refrigerated ready-to-bake cookies, brownies, sweet rolls, Danish, pie crusts; frozen cake, pie, cobbler, turnovers, coffee cake, honey buns, toaster pastries, brownies, cookies, doughnuts, cream puffs, éclairs, tarts, muffins, pastry shells, pie crusts. Shelf-stable RTE cookies, brownies, snack cakes (e.g., Ding Dongs, Twinkies), cupcakes, oatmeal crème pies, single-serve fruit snack pies, graham crackers, animal crackers, crispy rice bars, granola bars, cereal bars, snack bars, meal replacement bars, doughnuts, coffee cake, Danish, sweet rolls, honey buns, toaster pastries, scones, muffins, cake, turnovers, éclairs, tarts, croissants, puff pastry, ice cream cones or bowls. Baking mixes for cake or cupcakes, brownies, cookies, muffins, coffee cake, gingerbread, dessert bars, cobbler/crisps, no-bake pies, pie crust, scones, shortcake, prepared pie crusts, pastry shells, or tart shells.
Pasta	Fresh or dried, whole-grain or refined grain pasta or noodles; flavored pasta (e.g., spinach pasta); egg noodles; gnocchi; couscous.
Pasta dishes	Refrigerated or frozen uncooked ravioli or tortellini; refrigerated RTE macaroni salad or pasta salad; refrigerated of frozen pasta dishes or dinners (e.g., lasagna, ravioli, manicotti, spaghetti with meatballs, macaroni and cheese, fettucine alfredo, lo mein, tuna noodle casserole, pasta dinner with meat/vegetables); frozen pasta and vegetable side dishes. Dried uncooked ravioli or tortellini; pasta dish meal kits (e.g., boxed macaroni-and-cheese, "helper"-type kits); instant pasta dish mixes including dried pasta (e.g., microwaveable macaroni-and-cheese, pasta with sauce, Asian noodle bowls). Canned or shelf-stable prepared RTH pasta dishes including ravioli, spaghetti with sauce, spaghetti and meatballs, or pasta with sauce. Asian noodle bowls, ramen noodles with sauce, pad thai, lasagna kits, or other dried pasta dishes.
Rice and grains	Regular, parboiled, or pre-cooked/quick-cooking dried white rice, brown rice, wild rice, quinoa, bulgur wheat, barley, grain mixtures; flavored rice; prepared RTH rice.
Rice dishes	Prepared RTH rice dishes (e.g., fried rice, cheddar broccoli rice, rice pilaf, rice with vegetables and sauce, risotto), rice-based dinners (e.g., rice with meat and/or vegetables, enchilada with rice, sweet and sour chicken with rice, jambalaya, peppers stuffed with rice, sushi). Instant/microwaveable rice dish mixes with dried rice (e.g., rice with sauce, pilaf, fried rice), rice dish meal kits with dried rice (e.g., kits for jambalaya, dirty rice, "helper"-type kits), prepared RTH rice dishes (e.g., rice with beans, Spanish rice).
Cereal, hot	Oatmeal, grits, cream of wheat, cream of rice, and other hot cereals.

Food and beverage groups	Description
Cereal, RTE	Corn flakes, frosted flakes, raisin bran, frosted shredded wheat, toasted oat cereal (e.g., Cheerios), crispy rice (e.g., Rice Krispies), chocolate flavored cereals (e.g., Cocoa Puffs), bran flakes, fruit flavored cereals (e.g., Froot Loops), puffed rice, shredded wheat, granola.
Fruit, unsweetened/unflavored	Fresh, refrigerated, frozen or dried fruit unsweetened/unflavored. Bags or containers of fresh apples, oranges, lemons, cherries, figs, grapes, berries, apricots, avocado, coconuts; refrigerated apple slices or fresh cut fruit (e.g., melon, pineapple, or fruit mixtures). Frozen strawberries, raspberries, blueberries, blackberries, peaches, pineapple, melon, mango, cherries, cranberries, and fruit mixtures. Dried raisins, cranberries, dates, plums (i.e., prunes), apricots, figs, mango, pineapple, cherries, blueberries, apples, coconut, and mixtures of dried fruit; dried/baked apple chips.
Fruit, sweetened/flavored	Fresh, refrigerated, frozen or dried fruit sweetened/flavored. Packaged refrigerated sweetened cut fruit in juice/syrup (e.g., peaches, pineapple, grapefruit, mandarin oranges, and fruit mixtures). Frozen strawberries, raspberries, blueberries, blackberries, peaches, pineapple, melon, mango, cherries, cranberries, and fruit mixtures. Dried raisins, cranberries, dates, plums (i.e., prunes), apricots, figs, mango, pineapple, cherries, blueberries, apples, coconut, and mixtures of dried fruit; dried/baked apple chips. Canned fruit topping or pie filling, candied fruit (e.g., citron, candied orange or lemon peel), baked/fried cinnamon apples.
Fruit, canned	Canned/shelf-stable peaches, pears, pineapple, mandarin oranges, apricots, grapefruit, cherries, plums, other fruits, fruit cocktail, fruit mixtures, fruit salads (in heavy syrup, light syrup, or juice, or water); apple sauce; cranberry sauce; canned coconut; pickled fruit.
Vegetables, unsweetened/unflavored	Fresh, refrigerated, frozen or dried vegetables unsweetened/unflavored. Bagged or packaged lettuce/salad blends, fresh baby carrots, carrot sticks, celery sticks, whole carrots, celery, heads of lettuce, tomatoes, mushrooms, cauliflower, onions, snow peas, sugar snap peas, collard or mustard greens, peppers, green beans. Plain frozen broccoli, carrots, green beans, sugar snap peas, snow peas, spinach, greens, Brussels sprouts, cauliflower, asparagus, and vegetable mixtures. Plain dried tomatoes, sun-dried tomatoes, mushrooms, vegetable mixtures, and seaweed wraps or sheets.
Vegetables, sweetened/flavored	Fresh, refrigerated, frozen or dried vegetables sweetened/flavored. Refrigerated pre-chopped vegetables in microwaveable/steaming packages; vegetable trays with dip; celery or carrot sticks with dip. Frozen broccoli, carrots, green beans, sugar snap peas, snow peas, spinach, greens, Brussels sprouts, cauliflower, asparagus, vegetable mixtures (with added fat, salt, seasoning, or sweeteners). Dried tomatoes, sun-dried tomatoes, mushrooms, vegetable mixtures, and seaweed wraps or sheets (with added fat, salt, seasoning, or sweeteners).
Vegetables, canned	Canned green beans, tomatoes, spinach, greens, carrots, mushrooms, water chestnuts, pumpkin, tomato paste with no added salt, seasoning, fat, or sweeteners. Canned or jarred green beans, carrots, mushrooms, spinach, greens, tomatoes, tomato puree, tomato paste, or vegetable mixtures with added salt, seasoning, fat, or sweeteners; canned tomato sauce; olives; pickles; pickled vegetables; marinated/roasted antipasto vegetables or mixed vegetable salads; jarred roasted red peppers.

Food and beverage groups	Description
Starchy vegetables, unsweetened/unflavored	Fresh potatoes or sweet potatoes; fresh/refrigerated potatoes, shelled green peas, or ears of corn in microwave steaming bags; stew mix with potatoes and vegetables; refrigerated shredded hash brown potatoes or home fries, diced potatoes, or roasted potatoes. Dried corn, green peas, or potatoes (i.e., for making hash browns).
Starchy vegetables, frozen	Frozen potatoes; sweet potatoes/yams; corn; corn on the cob; green peas; mixtures of potatoes, corn, or green peas and vegetables (e.g., corn with mixed vegetables, peas and carrots, corn with peppers, peas with mushrooms); potato wedges or roasted potatoes; shredded or diced hash brown potatoes.
Starchy vegetables, canned	Canned or shelf-stable potatoes, corn, green peas, mashed or pureed sweet potatoes/yams, or shelf-stable potato flakes (i.e., for making mashed potatoes) with no added salt, seasoning, fat, or sweeteners. Canned or shelf-stable potatoes; corn; green peas; sweet potatoes/yams with sugar or in syrup; hominy; potato, corn, or green pea based vegetable mixtures (e.g., peas and carrots, mixed vegetables, green beans with potatoes, corn with peppers, succotash, or peas with mushrooms); or shelf-stable pre-seasoned potato flakes (i.e., for making mashed potatoes) with added salt, seasoning, fat, or sweeteners.
Vegetable-based dishes, refrigerated/frozen	Refrigerated, frozen, canned or shelf-stable vegetable-based dishes (e.g., eggplant parmesan, green bean casserole, creamed spinach, broccoli au gratin, glazed carrots, vegetables with sauce, stuffed mushrooms, vegetable-based burgers); fried breaded vegetables (e.g., onion rings, fried okra); pre-made salad bowls (e.g., chef salad, Caesar salad); RTE coleslaw; greens with meat, vegetables in tomato sauce; olives stuffed with cheese or meat.
Starchy vegetable-based dishes	Refrigerated, frozen, canned and instant/mixes starchy vegetable-based dishes. Prepared starchy vegetable-based dishes (mashed potatoes, stuffed baked potatoes, potato skins, au gratin potatoes, sweet potato casserole, candied yams, hash brown casserole, roasted potatoes in cheese or sauce, creamed corn, corn soufflé, starchy vegetables in sauce); starchy-vegetable based frozen dinners (starchy vegetable as primary ingredient, such as mashed potatoes with beef or shepherd's pie); RTE potato salad; microwaveable steaming containers of raw vegetables with sauce. Prepared starchy vegetable-based dishes (creamed corn, candied yams, starchy vegetables in sauce, starchy vegetable-based meals). Instant potato mixes for mashed potatoes, potatoes au gratin, or scalloped potatoes including butter, milk, sour cream, or cheese; helper-type dinner kits for potato-based skillet meals or casseroles.
Fried potatoes	Frozen French fries, sweet potato fries, hash browns, hash brown patties, tater tots, potato pancakes, home fries.
Fats and oils	Butter (salted and unsalted, sticks or spreads), margarine (sticks or spreads), butter and margarine blends, shortening, hydrogenated shelf-stable lard. Oil (such as olive, vegetable, canola, corn, peanut, soybean, or sunflower), cooking spray, flavored oil.
Sugars and sweeteners	Granulated sugar, brown sugar, powdered sugar, molasses, sorghum syrup, corn syrup, flavored granulated sugar, honey, artificial sweeteners, stevia.
Syrups and toppings	Pancake syrup, pure maple syrup, flavored syrups for coffee drinks or Italian soda, fruit syrups, chocolate or fruit-flavored dessert or milk syrup, dessert topping (e.g., caramel, butterscotch, hot fudge, strawberry topping, marshmallow cream),

Food and beverage groups	Description
	caramel dip, hazelnut spread (Nutella), icing, cake decorations, pastry filling, marzipan; jam, preserves, marmalade, fruit or pumpkin butter, jelly, lemon curd.
Candy and sweet snacks	Candy, chocolate, candy bars, marshmallows, fudge, toffee, baking chocolate, morsels, sprinkles, gum, mints, popsicles, sorbet, ices, gelatin, candy-making kits; fruit snacks, fruit leather, fruit bars, fried apple or banana chips, chocolate- or yogurt-covered fruit, maraschino cherries, caramel apples, candied apples, fruit salads with gelatin, ambrosia; chocolate- or yogurt-covered nuts or seeds; candy-coated nuts or seeds.
Flour	Flour (whole-grain and refined grain), masa, corn meal, semolina; breading/batter mixes.
Herbs, spices, and baking products	Herbs, spices, and blends with no added salt, sweetener, or oil (e.g., fresh herbs, pepper, garlic powder, paprika, oregano, chili powder, curry powder); flavor extracts, yeast, baking soda, baking powder, corn starch, cocoa powder, pectin, fruit protectors, cream of tartar, canning/pickling chemicals (citric acid, lime, alum), food coloring, egg replacers, dried egg whites, capers.
Salt	Salt (regular rock salt or sea salt, iodized or not iodized).
Seasoning products	Mixtures of herbs and spices with added sweeteners, oil/fat, or salt including seasoning products (e.g., seasoned salt, garlic salt, lemon pepper, hamburger seasoning, spice pastes) and sauce/seasoning mixes (e.g., for meatloaf, tacos, chili, spaghetti sauce, salad dressing, marinades).
Soups and stews	Noodle- or rice-based soups (e.g., chicken noodle, chicken and rice, ramen noodles); meat-based soups (e.g., meat-based chili, beef stew, beef vegetable soup); vegetable-based soups (e.g., vegetable soup, tomato soup, French onion soup, cream of mushroom, gazpacho); starchy-vegetable based soups (e.g., potato soup, corn chowder, cream of potato); legume-based soups (e.g., split pea, lentil, black bean, bean-based chili); dairy-based soups (e.g., cheddar cheese soup, broccoli cheese, clam chowder, cream of mushroom); broth, stock, bouillon.
Grain-based dishes	Frozen pizza; frozen grain-based dishes (e.g., burritos, sandwiches, breakfast sandwiches, pot pies, sandwich pockets, egg rolls, corn dogs, puff pastry appetizers, rice/gluten-based meatless burgers or "meat"); grain-based frozen dinners (tortilla-based dishes, pancake/biscuit breakfast meals, hamburger/pizza meals); refrigerated grain-based dishes (e.g., breakfast sandwiches, RTE sandwiches, Lunchables, wheat-gluten based meatless burgers or "meat", ready-to-bake pizza); canned/shelf-stable grain-based dishes (crackers and tuna salad kits, chicken and dumplings); grain-based meal kits (e.g., pizza making kits, taco shell or nacho kits); stuffing mix.
Salty snacks	Potato chips, potato crisps, sweet potato chips, corn nuts, crispy green peas; crackers, snack crackers, corn chips, pretzels, tortilla chips, cheese-flavored tortilla chips, cheese puffs, pita chips, popcorn (unpopped kernels, microwaveable, or pre-popped), sandwich crackers, rice cakes, snack mixes with crackers; soy nuts, chocolate- or yogurt-covered soynuts; pork rinds.
Condiments, dips, and spreads	Ketchup, barbecue sauce, tartar sauce, cocktail sauce, mustard, taco sauce, soy sauce, steak sauce, hot sauce, pickle relish, fruit relish, marmite, horseradish, sandwich spread; dip mix; salsa, guacamole, spinach dip, vegetable-based spreads and tapenades;

Food and beverage groups	Description
	chip or vegetable dip (e.g., French onion, ranch, dill); crab dip, smoked salmon dip; black bean dip, hummus. Mayonnaise and "Miracle Whip". Vinegar, cooking wine, Worcestershire sauce, teriyaki sauce, fish sauce, marinades, glazes, stir fry sauce, pizza sauce, etc.
Sauces (used as toppings)	Jarred tomato-based pasta sauce; prepared gravy, curry sauce; alfredo sauce, cheese sauce; pesto sauce, béarnaise sauce, butter sauce, horseradish sauce; white or red clam sauce.
Salad dressing	Salad dressing (shelf-stable and refrigerated); cole slaw dressing.
Baby food	Baby food, toddler food, baby cereals and biscuits, baby juice, baby milk.
Water	Plain bottled water; carbonated water (e.g., seltzer, club soda, mineral water, sparkling water); ice.
Coffee	Whole or ground coffee beans; pods or discs for single-cup brewers; coffee substitute (chicory, carob, barley); instant coffee.
Tea	Tea leaves or bags, herbal teas, plain ready-to-drink tea.
Coffee/ tea beverages	Coffee beverages (coffee with milk or creamer, such as latte or cappuccino, including ready-to-drink or instant mixes): ready-to-drink tea (sweetened or flavored), instant tea mixes, tea drinks (tea with milk or creamer, such as chai tea latte, including ready-to-drink or instant mixes).
Sugar-sweetened beverages	Caloric and low-calorie cola, root beer, ginger ale, other soft drinks, energy drinks, tonic, flavored seltzer or carbonated water, carbonated fruit drinks, sports drinks (RTD and powdered mixes), fruit-flavored drinks and flavored waters (RTD and powdered mixes), fruit drinks[2] (fruit punch, lemonade, Sunny Delight, Hawaiian Punch, Hi-C, Capri Sun, Tropicana Twister; includes RTD, powdered mixes, and frozen concentrate), vegetable drinks.
Fruit juice	Fruit juice, including 100% or <100%, not from-concentrate or from-concentrate (orange, grapefruit, apple, grape, pineapple, prune juices; juice blends; coconut water); sweetened juice (sweetened cranberry juice, fruit nectars, and juice blends); frozen fruit juice concentrate; sparkling fruit juice and cider.
Vegetable juice	Vegetable juice, including 100% or <100%, not from-concentrate or from-concentrate (tomato juice, tomato/vegetable juice blends, carrot juice); sweetened vegetable and fruit juice blends.
Milk, plain	Fresh or shelf-stable plain milk; dry milk.
Milk, sweetened	Fresh or shelf-stable sweetened milk (chocolate, or flavored); hot chocolate/cocoa mix; instant breakfast; powder for flavored milk; milk drinks (e.g., containing oil, thickeners, or mostly water, such as Yoohoo); milk drink mixes (e.g., hot chocolate mixes with non-dairy creamer).

Food and beverage groups	Description
Milk beverages	Buttermilk, egg nog, milk substitutes (e.g., plain or flavored soy, almond, rice, oat, or hemp milk), milk substitute drinks (e.g., plain or flavored soy, almond, rice, oat, or hemp milk with added oils), powdered mixes for milk substitutes (atole, horchata, malted milk), coconut milk.
Beer	Beer, ale, malt liquor, stout, porter, malt beverage.
Wine	Regular wine, sparkling wine, dessert wine, sake, sangria, vermouth, de-alcoholized wine.
Liquor	Whiskey, bourbon, brandy, gin, liqueurs, bitters, rum, scotch, tequila, vodka.
Mixed alcoholic beverages	Premade alcoholic cocktails and coolers.

Information on ingredients lists and product attributes were used to categorize all foods and beverages purchased in Homescan into 52 food and 14 beverage groups. [61]

Supplemental Table 5.2. Mean unadjusted densities for PFP and proportion of calorie purchases from key food and beverage groups by shopping pattern by race-ethnic group, Homescan 2007-2012 [a]

	Non-Hispanic whites [b]			Hispanics			Non-Hispanic blacks		
	Primary-grocery [c]	Primary-mass-merchandiser	Combination	Primary-grocery	Primary-mass-merchandiser	Combination	Primary-grocery	Primary-mass-merchandiser	Combination
Foods [d]									
Calorie	2350.6 (1.3)	2397.6 (1.7)	2372.8 (1.6)	2375.5 (4.5)	2409.8 (6.6)	2389.2 (5.2)	2423.8 (3.8)	2446.0 (5.1)	2444.4 (4.3)
Total sugar	122.1 (0.1)	126.0 (0.2)	124.1 (0.2)	116.9 (0.5)	120.5 (0.7)	119.5 (0.6)	129.7 (0.4)	131.9 (0.6)	131.3 (0.5)
Saturated fat	35.1 (0.1)	35.0 (0.1)	35.2 (0.1)	33.7 (0.2)	33.6 (0.2)	33.4 (0.3)	34.1 (0.2)	33.1 (0.3)	33.7 (0.2)
Sodium	4744.0 (7.2)	4915.0 (9.8)	4877.4 (9.5)	5045.8 (26.9)	5160.3 (41.7)	5181.7 (31.9)	5486.2 (21.8)	5593.4 (31.2)	5713.0 (25.4)
Beverages [d]									
Calorie	329.3 (0.5)	319.2 (0.7)	329.4 (0.6)	332.9 (1.8)	320.1 (2.6)	325.0 (2.1)	329.4 (1.6)	314.7 (2.1)	320.6 (1.7)
Total sugar	49.5 (0.1)	48.9 (0.1)	48.0 (0.1)	52.5 (0.3)	50.8 (0.5)	50.0 (0.4)	57.0 (0.3)	54.4 (0.4)	54.2 (0.3)
Saturated fat	2.6 (0.0)	2.6 (0.0)	2.5 (0.0)	2.7 (0.0)	2.6 (0.0)	2.6 (0.0)	2.1 (0.0)	2.1 (0.0)	2.0 (0.0)
Sodium	244.0 (0.4)	240.9 (0.5)	239.3 (0.5)	227.3 (1.5)	224.3 (2.2)	222.8 (1.7)	185.7 (1.2)	185.9 (1.7)	179.8 (1.4)
Food groups [e]									
Salty snacks	9.6 (0.0)	9.7 (0.0)	9.6 (0.0)	9.2 (0.1)	9.6 (0.1)	9.2 (0.1)	9.1 (0.1)	9.4 (0.1)	9.2 (0.1)
Breads and tortillas	8.0 (0.0)	7.7 (0.0)	7.6 (0.0)	9.1 (0.1)	8.7 (0.1)	8.6 (0.1)	7.2 (0.0)	6.9 (0.1)	6.8 (0.0)
GBD	9.4 (0.0)	9.8 (0.0)	9.3 (0.0)	8.8 (0.1)	9.3 (0.1)	8.9 (0.1)	8.7 (0.1)	9.2 (0.1)	8.7 (0.1)
Candy	6.2 (0.0)	6.6 (0.0)	6.7 (0.0)	5.2 (0.1)	5.8 (0.1)	5.7 (0.1)	5.0 (0.1)	5.2 (0.1)	5.5 (0.1)
Cheese	4.4 (0.0)	4.3 (0.0)	4.4 (0.0)	4.3 (0.0)	4.1 (0.1)	4.2 (0.0)	3.1 (0.0)	3.1 (0.0)	3.0 (0.0)
Processed meat	3.0 (0.0)	3.2 (0.0)	2.9 (0.0)	3.2 (0.0)	3.3 (0.0)	3.0 (0.0)	3.9 (0.0)	3.9 (0.0)	3.8 (0.0)
Vegetables	0.5 (0.0)	0.5 (0.0)	0.6 (0.0)	0.5 (0.0)	0.4 (0.0)	0.4 (0.0)	0.5 (0.0)	0.5 (0.0)	0.5 (0.0)
Vegetables, canned	0.5 (0.0)	0.5 (0.0)	0.5 (0.0)	0.4 (0.0)	0.4 (0.0)	0.5 (0.0)	0.3 (0.0)	0.3 (0.0)	0.3 (0.0)
Nuts and nut butters	4.2 (0.0)	4.3 (0.0)	4.7 (0.0)	3.4 (0.1)	3.6 (0.1)	3.9 (0.1)	3.2 (0.0)	3.1 (0.1)	3.5 (0.1)
RTE cereal	4.6 (0.0)	4.6 (0.0)	4.0 (0.0)	4.8 (0.0)	4.7 (0.1)	4.7 (0.1)	4.0 (0.0)	4.2 (0.1)	4.0 (0.1)
Beverage groups [e]									
SSB	27.3 (0.1)	28.9 (0.4)	27.0 (0.1)	30.0 (0.3)	30.5 (0.4)	29.1 (0.3)	38.1 (0.2)	38.4 (0.3)	37.9 (0.3)
Plain milk	36.7 (0.1)	36.8 (0.1)	35.5 (0.1)	34.0 (0.3)	34.1 (0.4)	33.5 (0.3)	23.6 (0.2)	24.0 (0.3)	22.3 (0.3)
Fruit juices	12.5 (0.0)	11.6 (0.01)	12.1 (0.1)	13.4 (0.2)	13.2 (0.3)	13.6 (0.2)	16.8 (0.1)	16.6 (0.2)	17.0 (0.2)

[a] Data from the 2007-2012 Homescan longitudinal panel of household purchases of packaged foods. Values are expressed as predicted means (SE) and were obtained from longitudinal random-effects models that included main effects for shopping patterns, main effects for race-ethnicity and interaction terms between race-ethnicity and shopping patterns.
[b] Self-reported race-ethnicity of the household head.
[c] We used cluster analysis to group households by their food shopping patterns. We defined shopping patterns as the combinations of store-types US households use to shop for food based on the volume from packaged food purchases (PFP) by store-type. We found 3 food shopping patterns or clusters: 1) primary-grocery cluster, characterized by households purchasing the majority of their packaged foods and beverages at grocery-chains (e.g., Kroger, Safeway) ; 2) primary-mass-merchandiser cluster, characterized by households purchasing the majority of their packaged foods and beverages at mass-merchandisers (e.g., Walmart, Super Target); and 3) combination cluster, characterized by households purchasing their packaged foods and beverages at a combination of store-types.
[d] We used continuous measures of the nutrient profile of household PFP from foods and beverages separately: energy density and nutrient density (g total sugars, mg sodium and g saturated fat) per 1000g. We used yearly measures of purchases to better capture usual shopping habits.
[e] Information on ingredients lists and product attributes were used to categorize all foods and beverages purchased in Homescan into 52 food and 14 beverage groups at the barcode level. Considering foods and beverages separately, we used the proportion of calories from food groups, relative to total food purchases and the proportion of calories from beverage groups, relative to total beverage purchases. Salty snacks include: potato chips, crackers, corn chips, pretzels, tortilla chips, pita chips, popcorn, sandwich crackers, rice cakes, snack mixes with crackers, etc. Breads and torrillas include: bread, rolls, hot dog/hamburger buns, sandwich rolls, sandwich wraps, bagels, tortillas, taco shells, etc. Grain-based desserts include: ready-to-bake cookies, brownies, sweet rolls, ready-to-eat cookies, brownies, snack cakes, cupcakes, baking mixes, etc. Candy and sweet snacks include: candy, chocolate, candy bars, fruit snacks, fudge, gum, mints, popsicle, candy-coated nuts or seeds, etc. Cheese includes: Cheddar, Swiss, mozzarella, Parmesan, Romano, feta, ricotta, blue cheese, cottage cheese, american cheese, cream cheese, processed cheese spreads, spray cheese, non-dairy/imitation cheese, etc. Processed meats include: Refrigerated, frozen or canned/shelf-stable processed meat such as bacon, sausage, bratwurst, hot dogs, smoked, cured turkey, ham, roast beef, pastrami, chicken, etc. Vegetables, unsweetened/unflavored include: includes fresh, refrigerated, frozen and dried vegetables. Bagged or packaged lettuce/salad blends, fresh baby carrots, carrot sticks, celery sticks, whole carrots, celery, heads of lettuce, tomatoes, mushrooms, cauliflower, onions, peppers, green beans. Plain frozen broccoli, carrots, green beans, sugar snap peas, snow peas, spinach, greens, vegetable mixtures, etc. Vegetables, canned include: canned green beans, tomatoes, spinach, greens, carrots, mushrooms, water chestnuts, pumpkin, tomato paste, etc. Nuts and nut butters, sweetened/flavored include: raw, blanched, dry-roasted, or oil-roasted nuts or seeds (salted, flavored, frosted, or honey-roasted), such as peanuts, almonds, cashews, pecans, walnuts, pistachios, macadamia nuts, brazil nuts, pine nuts, hazelnuts, sunflower seeds, pumpkin seeds, flax seeds, and nut mixtures, nut-based trail mix, etc. Ready-to-eat cereal includes: Corn flakes, frosted flakes, raisin bran, frosted shredded wheat, toasted oat cereal, crispy rice, chocolate flavored cereals, bran flakes, fruit flavored cereals, puffed rice, shredded wheat, granola, etc. SSB include: Caloric and low-calorie cola, root beer, ginger ale, other soft drinks, energy drinks, tonic, flavored seltzer or carbonated water, carbonated fruit drinks, sports drinks, fruit-flavored drinks and flavored waters, etc. Plain milk includes: fresh or shelf-stable plain milk, both whole and low-fat milk. Fruit juices include: 100% or <100%, not from-concentrate or from-concentrate, sweetened juice, frozen fruit juice concentrate, sparkling fruit juice and cider, etc.

Supplemental Table 5.3. Mean unadjusted weighted densities for PFP and proportion of calorie purchases from key food and beverage groups by shopping pattern by race-ethnic group, Homescan 2007-2012 [a]

	Non-Hispanic whites [b]			Hispanics			Non-Hispanic blacks		
	Primary-grocery	Primary-mass-merchandiser	Combination	Primary-grocery	Primary-mass-merchandiser	Combination	Primary-grocery	Primary-mass-merchandiser	Combination
Foods [d]									
Calorie	2361.5 (2.6)	2433.7 (3.4)	2373.9 (3.8)	2395.8 (7.3)	2432.5 (11.8)	2404.5 (9.7)	2454.2 (7.1)	2487.0 (10.4)	2487.1 (10.2)
Total sugar	122.3 (0.3)	129.7 (0.4)	123.5 (0.4)	114.3 (0.8)	120.9 (1.3)	116.9 (1.1)	134.3 (1.0)	135.6 (1.3)	135.4 (1.2)
Saturated fat	35.2 (0.1)	35.0 (0.1)	35.2 (0.1)	33.5 (0.3)	33.4 (0.4)	32.8 (0.4)	34.4 (0.3)	33.1 (0.3)	33.4 (0.3)
Sodium	4797.2 (11.7)	5027.3 (15.6)	4959.4 (20.2)	5203.3 (40.0)	5283.5 (57.5)	5344.7 (64.2)	5564.2 (39.0)	5647.7 (57.1)	5914.7 (58.3)
Beverages [d]									
Calorie	335.6 (1.2)	318.3 (1.5)	338.1 (1.7)	340.3 (3.4)	322.4 (4.6)	339.9 (3.9)	335.0 (2.6)	305.5 (3.9)	326.8 (3.5)
Total sugar	50.9 (0.2)	51.1 (0.3)	47.9 (0.3)	54.7 (0.6)	53.1 (0.8)	52.4 (0.7)	59.8 (0.5)	55.0 (0.8)	56.7 (0.7)
Saturated fat	2.7 (0.0)	2.8 (0.0)	2.6 (0.0)	2.8 (0.1)	2.9 (0.1)	2.7 (0.1)	2.1 (0.0)	2.1 (0.1)	1.8 (0.0)
Sodium	241.5 (0.8)	240.9 (1.1)	236.1 (1.2)	220.3 (2.3)	225.7 (3.2)	218.8 (2.8)	182.4 (1.8)	183.5 (2.7)	170.0 (2.0)
Food groups [e]									
Salty snacks	9.7 (0.0)	9.8 (0.1)	9.4 (0.1)	9.1 (0.1)	8.4 (0.2)	9.7 (0.1)	8.7 (0.1)	9.5 (0.2)	9.1 (0.1)
Breads and tortillas	8.1 (0.0)	7.7 (0.0)	7.7 (0.0)	9.9 (0.1)	9.2 (0.1)	9.2 (0.2)	7.3 (0.1)	6.7 (0.1)	6.5 (0.1)
GBD	9.6 (0.0)	10.3 (0.1)	9.1 (0.1)	8.6 (0.1)	9.6 (0.2)	8.8 (0.2)	8.8 (0.1)	9.7 (0.2)	8.8 (0.1)
Candy	6.1 (0.0)	6.4 (0.0)	6.7 (0.1)	4.9 (0.1)	5.5 (0.1)	5.3 (0.1)	4.8 (0.1)	5.2 (0.1)	5.4 (0.1)
Cheese	4.4 (0.0)	4.2 (0.0)	4.4 (0.0)	4.2 (0.1)	4.1 (0.1)	4.1 (0.1)	3.0 (0.0)	2.8 (0.1)	2.7 (0.1)
Processed meat	3.0 (0.0)	3.4 (0.0)	3.0 (0.0)	3.4 (0.1)	3.6 (0.1)	3.1 (0.1)	4.1 (0.1)	3.9 (0.1)	3.9 (0.1)
Vegetables	0.5 (0.0)	0.4 (0.0)	0.6 (0.0)	0.4 (0.0)	0.4 (0.0)	0.5 (0.0)	0.4 (0.0)	0.5 (0.0)	0.5 (0.0)
Vegetables, canned	0.5 (0.0)	0.4 (0.0)	0.5 (0.0)	0.4 (0.0)	0.4 (0.0)	0.4 (0.0)	0.3 (0.0)	0.3 (0.0)	0.3 (0.0)
Nuts and nut butters	3.9 (0.0)	4.0 (0.0)	4.6 (0.0)	3.1 (0.1)	3.2 (0.1)	3.5 (0.1)	3.8 (0.1)	3.1 (0.1)	3.4 (0.1)
RTE cereal	4.7 (0.0)	4.6 (0.0)	4.8 (0.1)	4.9 (0.1)	4.9 (0.1)	4.9 (0.1)	4.2 (0.1)	4.3 (0.1)	4.0 (0.1)
Beverage groups [e]									
SSB	28.2 (0.2)	32.4 (0.2)	26.6 (0.2)	32.6 (0.5)	34.1 (0.7)	29.8 (0.6)	41.0 (0.5)	42.1 (0.7)	40.8 (0.6)
Plain milk	36.4 (0.2)	37.7 (0.2)	34.9 (0.2)	32.4 (0.5)	34.8 (0.7)	32.4 (0.6)	22.8 (0.4)	24.0 (0.6)	19.7 (0.4)

Fruit juices	12.5 (0.1)	10.4 (0.01)	12.1 (0.1)	12.8(0.3)	12.4 (0.4)	14.0 (0.4)	16.3 (0.3)	15.8 (0.4)	16.8 (0.4)

[a] Data from the 2007-2012 Homescan longitudinal panel of household purchases of packaged foods. Values are expressed as predicted means (SE) and were obtained from OLS linear regression models that included main effects for shopping patterns, main effects for race-ethnicity and interaction terms between race-ethnicity and shopping patterns. Models were weighted to be nationally representative

[b] Self-reported race-ethnicity of the household head. We clustered at the household level to account for the non-independence of household observations over time. Models

[c] We used cluster analysis to group households by their food shopping patterns. We defined shopping patterns as the combinations of store-types US households use to shop for food based on the volume from packaged food purchases (PFP) by store-type. We found 3 food shopping patterns or clusters: 1) primary-grocery cluster, characterized by households purchasing the majority of their packaged foods and beverages at grocery-chains (e.g., Kroger, Safeway) ; 2) primary-mass-merchandiser cluster, characterized by households purchasing the majority of their packaged foods and beverages at mass-merchandisers (e.g., Walmart, Super Target); and 3) combination cluster, characterized by households purchasing their packaged foods and beverages at a combination of store-types.

[d] We used continuous measures of the nutrient profile of household PFP from foods and beverages separately: energy density and nutrient density (g total sugars, mg sodium and g saturated fat) per 1000g. We used yearly measures of purchases to better capture usual shopping habits.

[e] Information on ingredients lists and product attributes were used to categorize all foods and beverages purchased in Homescan into 52 food and 14 beverage groups at the barcode level. Considering foods and beverages separately, we used the proportion of calories from food groups, relative to total food purchases and the proportion of calories from beverage groups, relative to total beverage purchases. Salty snacks include: potato chips, crackers, corn chips, pretzels, tortilla chips, pita chips, popcorn, sandwich crackers, rice cakes, snack mixes with crackers, etc. Breads and torrillas include: bread, rolls, hot dog/hamburger buns, sandwich rolls, sandwich wraps, bagels, tortillas, taco shells, etc. Grain-based desserts include: ready-to-bake cookies, brownies, sweet rolls, ready-to-eat cookies, brownies, snack cakes, cupcakes, baking mixes, etc. Candy and sweet snacks include: candy, chocolate, candy bars, fruit snacks, fudge, gum, mints, popsicle, candy-coated nuts or seeds, etc. Cheese includes: Cheddar, Swiss, mozzarella, Parmesan, Romano, feta, ricotta, blue cheese, cottage cheese, american cheese, cream cheese, processed cheese spreads, spray cheese, non-dairy/imitation cheese, etc. Processed meats include: Refrigerated, frozen or canned/shelf-stable processed meat such as bacon, sausage, bratwurst, hot dogs, smoked, cured turkey, ham, roast beef, pastrami, chicken, etc. Vegetables, unsweetened/unflavored include: includes fresh, refrigerated, frozen and dried vegetables. Bagged or packaged lettuce/salad blends, fresh baby carrots, carrot sticks, celery sticks, whole carrots, celery, heads of lettuce, tomatoes, mushrooms, cauliflower, onions, peppers, green beans. Plain frozen broccoli, carrots, green beans, sugar snap peas, snow peas, spinach, greens, vegetable mixtures, etc. Vegetables, canned include: canned green beans, tomatoes, spinach, greens, carrots, mushrooms, water chestnuts, pumpkin, tomato paste, etc. Nuts and nut butters, sweetened/flavored include: raw, blanched, dry-roasted, or oil-roasted nuts or seeds (salted, flavored, frosted, or honey-roasted), such as peanuts, almonds, cashews, pecans, walnuts, pistachios, macadamia nuts, brazil nuts, pine nuts, hazelnuts, sunflower seeds, pumpkin seeds, flax seeds, and nut mixtures, nut-based trail mix, etc. Ready-to-eat cereal includes: Corn flakes, frosted flakes, raisin bran, frosted shredded wheat, toasted oat cereal, crispy rice, chocolate flavored cereals, bran flakes, fruit flavored cereals, puffed rice, shredded wheat, granola, etc. SSB include: Caloric and low-calorie cola, root beer, ginger ale, other soft drinks, energy drinks, tonic, flavored seltzer or carbonated water, carbonated fruit drinks, sports drinks, fruit-flavored drinks and flavored waters, etc. Plain milk includes: fresh or shelf-stable plain milk, both whole and low-fat milk. Fruit juices include: 100% or <100%, not from-concentrate or from-concentrate, sweetened juice, frozen fruit juice concentrate, sparkling fruit juice and cider, etc.

CHAPTER 6. SYNTHESIS

Overview of Findings

This research investigated the role of the types of stores where US households shop for food on the nutrient profile of packaged food purchases and what foods and beverages households purchased. We used data from the US Homescan Consumer Panel dataset from 2000-2012. Homescan is a longitudinal panel of households who use barcode scanners to record all food and beverage purchases from retail food stores that enter the home. This unique dataset collects information on the types of stores where individuals from a household shop for food, as well as the foods and beverages purchased at each type of store, along with nutrient information of those purchases from every shopping occasion.

A major gap in the literature is that most studies looking at the food environment and its association to diet and health do not collect data on *where* people shop for food, *what* they actually purchase, nor have they examined the *nutrient profile* of these purchases. [23, 24, 28] Rather, the majority of studies looking at the food environment rely on the presence of stores located within people's residential food environment [15, 16] or the location of people's principal food store source. [17, 18] However, these studies do not know whether people shopped at the stores located within their residential food environment. Additionally, these studies make inferences about the types of stores where people shop for food and associations with diet without directly linking foods and beverages consumed to the stores where foods and beverages were purchased. In this study, we look beyond availability and examined both where, what and the nutrient profile of purchases. After classifying households shopping occasion by type of store, we examined trends

in volume of packaged food purchases by type of store from 2000-2012. Further, we described the nutrient profile and groups of packaged foods and beverages purchased by type of store in 2000, 2006 and 2012.

Evidence also suggests that people do not shop for food at a single type of store and that food shopping is complicated and appears to involve traveling to multiple types of stores. [10] Therefore, we used cluster analysis to group households by their food shopping patterns from 2000-2012. We defined food shopping patterns as the mix of types of food stores where US households shop. We derived food shopping patterns based on the amount (% volume) of household PFP by type of store. Because it is not clear whether different income and race-ethnic subpopulations shop for food at different food shopping patterns, we examined associations between socio-economic characteristics and food shopping patterns in 2012, the most recent year of data.

Finally, the literature suggests there are race-ethnic disparities in what Americans eat. [106] Among US adults, non-Hispanic blacks have a poorer dietary quality, compared to non-Hispanic whites and Mexican-Americans. [107] The literature also shows that residents of non-Hispanic-black and low-income neighborhoods have less access to food stores that sell healthy foods (i.e., grocery-stores or supermarkets). [15, 23, 25, 28] Based on these two facts, it has been suggested that the type of stores where people shop for food influences what people eat. [50, 51] Yet, it is unclear whether shopping primarily at grocery-stores is associated with a better nutrient profile of total purchases, compared to shopping at other types of stores and whether there are differences by race-ethnicity. Thus, we examined whether food shopping patterns were associated with the nutrient profile of household PFP and the foods and beverages purchased and determined whether these associations differed across race-ethnic groups from 2007-2012.

Packaged food and beverage purchases by types of stores among US households from 2000-2012

We found that the volume of household PFP from grocery-chains and non-chain grocery stores significantly decreased over time, while volume from warehouse-club, mass-merchandisers and convenience-stores significantly increased over time. Regardless of year, grocery-chains represented the biggest contributor to total volume from household PFP. In addition to increasing shopping at non-grocery stores, purchases at warehouse-club, mass-merchandisers and convenience-stores were of lower nutritional quality. While the caloric, total sugar, sodium and saturated fat densities of household PFP from mass-merchandisers, warehouse-club and convenience-stores decreased over time, they remained higher than the other types of stores in 2012. Regardless of time, the top common sources of calories (%) from household PFP by food group across types of stores included: savory snacks and grain-based desserts. One major difference was convenience-stores – more than 35% of calories purchased there came from candy and gum in all years. For the top common sources of beverage calories (%), households purchased about a third of beverage calories from regular soft drinks and fruit drinks/juices at convenience-stores and mass-merchandisers, respectively in all years. Overall, all other types of stores had fresh milk as the dominant beverage.

Overall, this first aim showed that grocery-chains account for the majority of household PFP. However, growing volume trends of household PFP from types of stores with poorer nutrient density (more energy, total sugar, sodium and saturated fat-dense), such as warehouse-club, mass-merchandisers, and convenience-stores, could pose a potential US public health concern. Nevertheless, less healthy food and beverage groups such as grain-based desserts, salty

snacks, fruit/vegetable drinks and regular soft-drinks were top calorie contributors to household purchases across all types of stores.

Trends and recent sociodemographic predictors of food shopping patterns among US households from 2000-2012

Using cluster analysis we identified three distinct food shopping patterns in each year: primary-grocery, primary-mass-merchandise and combination cluster (mixture of large and small stores). The primary-grocery cluster was characterized by households purchasing the majority of their packaged foods and beverages at grocery-chains (e.g., Kroger, Safeway). The primary-mass-merchandiser cluster was characterized by households purchasing the majority of their packaged foods and beverages at mass-merchandisers (e.g., Walmart, Super Target). The combination cluster was characterized by households purchasing their packaged foods and beverages at a combination of types of stores such as warehouse-club, ethnic-specialty stores, non-chain grocery, grocery-chains, and mass-merchandisers. Overall, from 2000-2012, 50-60% of households were grouped into the primary-grocery cluster, regardless of the year. However, over time, there has been a shift towards fewer households being categorized in the primary-grocery cluster (63.9% in 2000 to 50.2% in 2012) and more households categorized in the primary-mass-merchandise cluster (16.5% in 2003 to 22.5% in 2012). We also observed that over this 13-year period, 24.5-27.3% of households used a combination of types of stores to shop for food.

In 2012, for every income/race-ethnic group, the majority of households shopped at the primary-grocery cluster. Among low-income households, for the primary-grocery cluster, no differences were observed by race-ethnicity. For the primary mass-merchandise cluster, non-

Hispanic blacks (19.2%, 95% CI 16.3-22.0%) and Hispanics (18.2%, 95% CI 14.7-21.7%) had a significantly lower probability of being categorized at the primary mass-merchandise cluster compared to non-Hispanic whites (27.1%, 95% CI 25.8-28.4%). For the combination cluster, only Hispanics (35.4%, 95% CI 31.0-39.8%) had a significantly higher probability of being categorized at the combination cluster compared to non-Hispanic whites (23.7%, 95% CI 22.5-24.9%). Comparable to low-income households, we observed similar associations at the primary grocery- and mass-merchandise cluster among middle-income households. Among middle- and high-income households, for the combination cluster, Hispanics and non-Hispanic blacks were more likely to be in the combination cluster compared to non-Hispanic whites. Among high-income households, for the primary mass-merchandiser cluster, no differences were observed by race-ethnicity.

Overall, this second aim showed that while grocery-chains accounted for the majority of the total volume of food purchases by US households, our cluster analysis revealed that for some households, purchases were not made primarily at grocery-chains but at mass-merchandisers, especially in recent years. In addition, in some cases, shopping for food involved visiting multiple types of stores, including a mixture of large and small stores. Regardless of income and race-ethnicity group, households predominantly shopped primarily at grocery stores. Regardless of income level, we observed that racial minority households were more likely to shop at a combination of large and small stores compared to non-Hispanic white households. These varied shopping patterns and race-ethnic/income differences must be considered in future policy initiatives and interventions.

Food shopping patterns were not associated with the nutrient quality of households PFP or the foods and beverages they purchased

Overall, we found no meaningful differences in the energy, sugar, saturated fat, and sodium densities of total packaged food purchases across food shopping patterns. Additionally, within race-ethnic groups, we did not find differences in the relationship between shopping patterns and the nutritional profiles of total foods purchased. Similar results were observed for the nutrient profile of total beverages purchased. Moreover, we found that shopping patterns were not associated with differences in the proportion of calories purchased from key food and beverage groups across race-ethnic groups. In other words, each race-ethnic group purchased a similar distribution of products regardless of where they shopped. Some of these products included: salty snacks, grain-based-desserts, breads and tortillas, candy and sweet snacks, SSB, fruit juices and plain milk, among others. However, across the different food shopping patterns, non-Hispanic black households purchased packaged foods with higher energy, sugar, and sodium density, compared to non-Hispanic white and Hispanic households. In terms of beverages purchased, across food shopping patterns, non-Hispanic black households purchased beverages with higher sugar but lower sodium densities, compared to non-Hispanic white and Hispanic households. Additionally, the contribution of calories from SSB and fruit juices to total beverages calories across shopping patterns was higher for non-Hispanic black households, compared to non-Hispanic white and Hispanic households. Non-Hispanic black households also purchased a lower proportion of calories from plain milk (i.e., unsweetened/unflavored whole and low fat milk) across shopping patterns, compared to non-Hispanic white and Hispanic households.

This last aim showed that in the Homescan sample, following a primary-grocery

shopping pattern was not associated with a lower energy, total sugar, saturated fat or sodium densities of household PFP or the food and beverage groups they purchased, compared to shopping at a primary-mass-merchandiser or employing a combination shopping pattern. Additionally, salty snacks, grain-based-desserts, breads and tortillas, candy and sweet snacks, SSB and fruit juices were some of the main food and beverage groups purchased across shopping patterns. These findings were consistent across race-ethnic groups. However, even after accounting for different shopping patterns, there were race-ethnic differences in the nutritional profiles of packaged food purchases. Specifically, non-Hispanic blacks purchased foods with a higher content of energy, sugar and sodium, and also purchased a higher proportion of calories from SSB and fruit juices, compared to non-Hispanic whites and Hispanics. The ubiquity of unhealthy packaged foods and beverages that are high in sugars, sodium and fat regardless of the type of store were people shop may thwart efforts to improve eating habits. Additionally, policy initiatives that focus on increasing physical access to stores or helping stores sell healthier products to encourage healthier purchases may be ineffective because other factors may be more important determinants of food and beverage purchases than where people shop or what is available in the store.

Limitations

Analytical limitations

A key limitation is that where individuals choose to shop for food is also a result of individual choice and is a complex decision affected by many factors, both observable and unobservable, that overlap with the purchase decision. The four P's of marketing, product, price, promotion, and placement, influence food purchasing decisions [76-79] along with individual food

preferences, [1] transportation, and time. [45, 80] This is known as self-selection, [114] and although these are all different types of selection mechanism, at the end, the choice of where consumers shop for food (i.e., type of store) and what foods/beverages they purchase is non-random. Our results were a reflection of where households choose to shop, what was available to purchase at the stores where they shopped, and what they chose to purchase. In Aim 1, we could not control for selection into types of stores. Therefore, we cannot determine how much of the differences in the nutrient profile of purchases and the foods and beverages purchased were due to type of store factors versus individual preferences. In Aim 3, we expected an upward bias in the association between the primary-grocery shopping pattern and the nutrient profile of PFP. In other words, individuals that were highly motivated to eat a healthy diet may also be more likely to shop at a higher quality store and purchase "healthier" foods and beverages once they get there. However, even with this hypothesized upward bias, we still did not observe meaningful differences in the nutrient profile of PFP and what foods and beverages people purchased by shopping patterns. Future studies should correct for self-selection regarding the types of stores where households shop for food. One methodological approach to correct for self-selection would be to use instrumental variables. [116] The two major challenges are 1) to have the necessary data/variables and 2) to find instrumental variables that are both, theoretically and statistically valid. [117] In this study, we attempted to use store-specific food and beverage price indices as instrumental variables; however, they were not statistically valid instrumental variables.

Data limitations

While knowing the type of store where households shop for food is one of the biggest strengths of this study, it is not without limitations. Our store-type categorization was based on Nielsen's store categorization. Nielsen's store categorization uses store size, annual

sales/revenue and proportion of grocery items in stock to classify stores. Consequently, some of the categories represent a very heterogeneous group of stores. Therefore, we used the name of the store and Internet searches to further classify the grocery sector into corporate-owned grocery-chains; non-chain grocery; ethnic-stores; and specialty-stores. Nevertheless, heterogeneity within store-type categories may still exist, and pooling them together may obscure differences on the nutrient profile of household PFP or in the sociodemoghraphic characteristics of the people that purchase foods at those store-types. Moreover, our store categorization assumes that stores under the same chain name are equivalent. However, studies have shown that even the same store offers different products depending on the geographic location of the store. [118] For example, predominantly black and lower-income neighborhoods have differential offerings of healthy foods compared to similar stores located in white and higher-income neighborhoods. [119] Our study cannot measure neighborhood characteristics, since we do not know the location of where people live or the location of the stores where they shopped, therefore, we do not know the direction or magnitude of these differences.

Another key limitation of the Homescan data is that it does not fully capture all food store purchases. Non-packaged foods (e.g. products without barcodes or nutrition labels), such as random-weight produce, cut-to-order deli meats and cheeses, bakery products, and store-prepared foods are not captured in our dataset. While we do not have nutrient data, we have information on household expenditures on non-packaged foods and for broad non-packaged foods groups, such as "meats," "produce," "cheese," "prepared food," etc. for a subsample of Homescan from 2007-2011. We estimated 1) the proportion of household expenditures on non-packaged vs. packaged foods by types of store among the total sample, and 2) the proportion of household expenditures by non-packaged food groups by types of store among non-packaged

food consumers. At each type of store, dollars spent on non-packaged foods/non-packaged foods groups remained stable over time. However, we observed differences in non-packaged food expenditures between types of stores. These differences may reflect availability of these types of food at the different types of store as well as individual preferences. Differences in non-packaged foods between types of store may influence the nutrient profile of total purchases, especially if non-packaged foods purchased are of better nutrient quality at certain types of store. It is important to recognize that not all non-packaged food purchases are produce or "healthy." Many of the non-packaged food purchases are deli meats, cheeses or prepared food, but no nutrient data are available for these items.

Homescan does not capture away-from-home purchases, and therefore our findings pertain only to purchases of packaged foods and beverages from retail stores and may not be generalizable to total food and beverage purchases (i.e. fast-food and full-service restaurants). A recent study suggests that energy intake from fast food and full-service restaurants decreased from 2003 to 2008. However, fast food and full-service restaurants remained prevalent and constitutes an important source of energy intake. [29]

Another limitation of the Homescan data is that even if we observe a households shopping in a given store, we only have data for the products they actually purchased, not the full variety of products offered at the store. [111]

With these data, we cannot verify whether a household scanned all the foods and beverages purchased from all shopping trips or types of store. While scanning, relative to dietary assessment methods, is a more objective measure that captures what people are actually purchasing, it is still self-reported and subject to measurement error. In other words, it is possible that households do not scan all their purchases. This will be a problem if there is systematic

underreporting of purchases from certain types of stores. Households may be less likely to scan purchases that occurred "on the go" and never made it home. Some of the "on-the-go" purchases are more likely to happen at convenience/drug stores. Specifically, in Aim 1, systematic underreporting of household PFP from specific types of stores could affect the ranking of foods and beverages purchased as well as the nutrient profile of household PFP. However, we found that purchases from convenience-stores already had one of the "worst" nutrient profiles; therefore, our results could be interpreted as a lower-bound or underestimate of the nutrient profile of purchases from convenience-stores. Underreporting of convenience-store shopping trips may also impact the food shopping patterns derived in Aim 2 and then used in Aim 3, especially if there is differential underreporting by race-ethnicity and income groups. However, validation studies found the accuracy of the Homescan data at measuring purchases at the national level was comparable to other widely used economic datasets. [82] Moreover, elsewhere we showed that trends in Homescan purchase data mirror trends in NHANES food intake from stores. [83]

Homescan measures household purchases, not consumption. Additionally, purchases are recorded at the household-level, and participant households do not report whether some foods or beverages are consumed by select household members only; thus, we cannot extrapolate our household-level findings to make inferences about individual-level intake. While energy-dense diets have been associated with obesity, elevated insulin levels and metabolic syndrome in US adults, [68, 69] our results are on purchases, not diets. Relating household PFP to individual intake is challenging considering consumer-level food waste associated with households PFP and the fact that purchases are recorded at the household-level. [70] This issue is more complex when considering the fact that there might be differential consumer-level food waste household SES

characteristics. Future studies should determine whether differences or lack of differences in nutrient densities by types of stores or food shopping patterns translate to higher total energy intake, poor dietary quality, or weight gain at the individual level.

Although the use of NFP data in Aims 1 and 3 was important for providing nutrient information of household PFP, it was also a limitation. First, our study was limited to the nutrients that are required to be reported on NFP. For example, added sugar content is not required on NFP; therefore we used total sugar content. A previous study examined the substitution of total sugars for added sugars in nutrient profiling and concluded that this approach was reasonable.[120] Additionally, NFP reports total content of saturated fat. Recent studies suggest that only specific types of saturated fatty acids are associated with diabetes and cardiovascular diseases.[121-123] Our study only explored caloric, total sugar, saturated fat and sodium density. The caloric and these three nutrient densities do not necessarily capture all nutrients that impact dietary quality or health outcomes, such as refined carbohydrate content, fiber or whole grains, micronutrients, and other components that were not sufficiently available in our data. Because of these limitations, conclusions about the nutrient quality of purchases by type of store or food shopping patterns pertain only to the caloric and nutrients examined here.

Participating households are selected to match the US population in terms of selected demographic characteristics. However, selection bias may occur, because households that volunteer to participate in the panel might have certain characteristics that are associated with purchasing behaviors.[124] Therefore, our results might not be generalizable to all US households. In Aims 1 and 2, estimates were weighted to be nationally representative, however, households participating in Homescan might differ from the US population or the "shoppers population" in unobservable characteristics that were not incorporated into the sampling weights.[124]

Finally, an important limitation of this study is that we lack information on weigh, height and health outcomes. Therefore, we could not examine whether food shopping patterns were associated with obesity or nutrition-related non-communicable diseases.

Strengths

For every shopping occasion made over a year, each household reported the name of the store where they shopped for food. Using this information, we were able to classify household purchases by types of store. Contrary to other studies looking at the food environment, with Homescan we know at which type of stores households shopped for food. Moreover, Homescan includes store purchases from both, traditional and non-traditional grocery-stores such as mass-merchandisers, warehouse-club, pharmacies, gas stations, and other retail stores whose primary business is not food. [105]

Another key advantage of this study is that we know what foods and beverages households purchased at the different types of store. Additionally, Homescan was linked to information from the NFP, which allowed us to examine the actual nutrient profile of purchases by types of store. This ability to examine the foods and beverages purchased and their nutrient quality by types of store is a key advantage over other studies looking at where people shop for food. The majority of the studies mostly rely on the presence of stores located within people's residential food environment [15, 16] or the location of people's principal food store source [17, 18], failing to capture all the possible stores where people may shop for food. Most studies also rely on dietary assessment methods to measure dietary intake as a proxy for store purchases, but do not capture food purchases themselves. These studies make inferences about the types of stores where people shop for food and associations with diet without directly linking foods consumed

to the stores where the foods were purchased. [52] Studies that do measure food purchases from a given store-type have focused on specific food groups, ignoring the entire set of purchases made at the store. [26, 59] Homescan enable us to study all household packaged foods and beverages purchased from a given type of store.

The Homescan dataset provides other advantages as well. For each household we used purchase data for at least a year, reflecting usual shopping habits. Moreover, the large sample size allowed us to explore predictors of food shopping patterns by income and race-ethnic subpopulations in Aim 2 and race-ethnic differences in the association between food shopping patterns and nutrient quality of PFP in Aim 3.

Significance and Public Health Impact

Obesity and nutrition-related chronic diseases remain a public health concern in the US. [125, 126] Associated with the increased prevalence of overweight and obesity there have been changes in our food environment. Unhealthy food environments foster unhealthy diets [127] which in turn may have an impact in the obesity epidemic. Many scholars suggest that less access to supermarkets or grocery-stores and higher access to convenience-stores are one of the multiple environmental drivers of the obesity epidemic. [84, 128] Because of this, policymakers have advocated for improvements in local access to food by building new supermarkets or grocery-stores in disadvantaged areas as one way to improve diet quality and reduced health disparities. [3-6] The underlying assumption is that people will purchase "healthier foods" from grocery-stores because grocery-stores usually stock more "healthy foods" and have more capacity to handle perishables and produce in safe and efficient ways, compared to smaller retail stores. Our study provides empirical evidence showing that "less healthy" food and beverage groups such as grain-

based desserts, salty snacks, fruit/vegetable drinks and regular soft-drinks are top calorie contributors to US household purchases from all types of stores, including grocery-stores. In other words, the same food and beverage groups were purchased at any type of store. While grocery-stores may in fact stock more "healthy foods", they also offer a large variety of processed and unhealthy foods, as do convenience-stores, mass-merchandisers and warehouse-clubs. Therefore, regardless of the type of store where people shop for food, the ubiquity of unhealthy packaged foods and beverages that are high in sugars, sodium and fat and the may thwart efforts to improve eating habits.

While grocery-chains account for the majority of household PFP in 2012, purchases from warehouse-club, mass-merchandisers, and convenience-stores increased over time. Additionally, the nutrient profile of household purchases by type of store also suggest that US households may be buying relatively more unhealthy food products at selected types of stores, such as warehouse-club, mass-merchandisers, and convenience-stores. Together, this findings indicate that growing volume trends of household PFP from types of stores with poorer nutrient density (more energy, total sugar, sodium and saturated fat-dense), such as warehouse-club, mass-merchandisers, and convenience-stores, could pose a potential US public health concern. However, this study was not able to control for individual selection into the different types of store and so, it cannot determine how much of the differences in the nutrient quality of household PFP is due to type of store. Future research is needed to disentangle the role of the store where people shop from individual preferences and food choices.

Research on the field of neighborhood food access has focused on disparities between income and race-ethnic groups in their access to retail food outlets, especially supermarkets or grocery-stores. Most of the research involves enumerating food stores within a given geographic

unit of analysis, such as census tract or zip code area. [129] However, these studies do not collect information on where people actually shopped for food, making ecological associations between neighborhood SES characteristics and type of store availability. The studies that do collect data on where people shop for food usually focus on a single type of store, and do not consider all the types of stores where people shop for food. Our study was unique since we did not only have information on the type of store where people actually shopped for food, but we also considered their food shopping patterns. We defined food shopping patterns as the mix of food stores US households use to shop. We showed that the majority of US households follow a shopping pattern characterized by purchasing food primarily at grocery-chains. However, a growing proportion of US households follow a shopping pattern characterized by purchasing food primarily at mass-merchandisers. Additionally, an important proportion of US households shopped at a combination of stores including a mixture of small and big retail stores. We also show that regardless of income and race-ethnicity group, households predominantly follow a primary grocery-store shopping pattern. Therefore, it is possible that in our sample, racial minorities and economically disadvantaged households overcome barriers to shop at grocery-stores. Additionally, among low- and middle-income households, Hispanic and non-Hispanic black households were less likely to follow a primarily at mass-merchandisers shopping pattern. These findings may reflect regional differences. Racial minorities may be more likely to live in large metropolitan areas, while mass-merchandise stores are usually located in suburban areas. [130] Moreover, across all income levels, Hispanic households were more likely to follow a combination shopping pattern. It is hard to determine whether those differences reflect true shopping pattern differences, or whether there is differential patterning by race-ethnicity captured in our combination cluster. However, it is also likely that Hispanic households shop for

food at a variety of stores, where they can find foods that are in line with their cultural and dietary preferences. These varied shopping patterns and race-ethnic/income differences must be considered in future studies and policy initiatives. Further, it is important to continuing to study the complex rationale for people's food shopping patterns.

As other scholars have pointed out, [10, 118] programs and policies focusing on addressing the obesogenic features of the neighborhood environment make intuitive sense: people make choices to eat foods to the extent that their circumstances allow them to do so. And even when people can make healthy choices and intend to do so, research suggests that environmental cues influence people's behavior. However, simply building new retail stores may not be sufficient to promote behavioral change related to diet. While our study does not measure access, we do have information on the types of stores where people shopped for food and what they actually purchased. When we look at the relationship between food shopping patterns and total PFP, our results add to the body of literature suggesting that the mix of food stores where people shop for food it is not necessarily associated with the nutrient quality of purchases or the types of foods and beverages purchased. These findings were true across race-ethnic groups. In other words, across shopping patterns, non-Hispanic whites, Hispanics and non-Hispanic blacks are purchasing packaged foods with similar nutrient profile and are purchasing similar foods and beverages. However, regardless of food shopping patterns, non-Hispanic black households purchased foods with higher caloric and poorer nutrient densities (higher in total sugar and sodium), compared to non-Hispanic white and Hispanic households.

The results of our study lead to an important policy question: should policy initiatives rely on increasing physical access to stores and helping stores sell "healthy food" groups to encourage healthier purchases, or are those efforts negated by people choosing to purchase foods

that are in line with their culture, socioeconomic characteristics and dietary preferences? Since the nutrient profile of purchases from the different food shopping patterns did not differ, then better access to certain types of stores, such as supermarket or grocery-stores, may not guarantee improved nutritional quality of household purchases. While access to healthy foods is a necessary condition, studies suggest that it is insufficient to change dietary behaviors. Therefore interventions and policies should consider moving beyond access alone, and implement complementary interventions and policies that will lead to behavioral changes to achieve healthier diets. This is especially true for non-Hispanic black households, as we show that overall they purchase foods with poorer nutrient quality. Some of these strategies may include: shopping and cooking skills programs, price promotions, and increasing in-store stocking of foods that promote a healthy diet while decreasing in-store stocking of foods that promote and unhealthy diet.

Overall, the substantial contribution of "less healthy" packaged foods to total household purchases suggests that the food industry and food retailers play an important role in impacting the nutritional quality of the foods and beverages Americans purchase. Thus, this work could be seen as a motivator for the food industry to improve the sugar, sodium and saturated fat content of their products and for the food retailers to implement strategies that will promote consumers make healthier choices when purchasing their food. As other scholars have noted, the food industry has the ability to shape the food and environments we live in. Through marketing and other strategies, the food industry also alters people's perceptions, desires, and accepted norms. Therefore, active support from the food industry is needed to reduce obesogenic environments and to potentially improve people's diets.[131]

Future Directions

While our research contributes with empirical evidence to the understanding of the types of stores where US households shop for food, the foods and beverages they purchase and the nutrient quality of those purchases, there are still gaps on our understanding about the role of the food environment on diet. Our analysis only looked at changes in certain nutrients and key food and beverage groups. However, people do not consume nutrients or foods in isolation, but rather as part of an overall diet or pattern. [132] Thus, one question to address in the future is whether certain food shopping patterns are associated with healthier food purchasing patterns and whether that translates to healthier diets.

In addition, this study only captures food and beverage purchases from food retailers, and within these retailers, it only captures packaged foods. We need to better understand how purchases from non-retailers (i.e., fast-foods, sit-down restaurants, farmers markets, etc.) together with purchases from food retailers are associated with total food and beverage purchases. In other words, people purchase and consume foods from a combination of food retailers and food non-retailers. While fast food consumption has been associated with consumption of diets with higher energy, fat, saturated fat, sodium and SSB intake, it is likely that people who are usual fast food consumers may also purchases less healthy foods across the different types of retail stores where they shop, compared to non-fast food consumers. In fact, a study in children using NHANES data suggests that outside the fast food, children that are fast food consumers ate Western diets. [92] We hypothesize that the location or source where foods are obtained may not be as important as the nutritional quality of foods purchased. Therefore, in order to study the nutrient quality of purchases from all the food establishments where people may shop for food, studies should try to collect data to link individuals in real time and space

with all the food establishments they visit, what they purchase and then consume.

Moreover, future studies should also collect information on non-packaged foods to try to better understand how purchases of non-packaged foods relate to total food purchases and diet quality. Non-packaged foods not only include random-weight or loose produce; they also include meats sold by weight, cheeses, bakery items and ready-to-eat meals. Especially, ready-to-eat meals have become more prevalent at different retail store formats. The nutrient content of these products has not been measured yet. These will represent a big challenge for future work.

As we disused previously, people may shop for food in settings that are outside their residential neighborhood, such as their workplace neighborhoods or the travel corridor between home and work. [133] The use of the Nielsen Homescan dataset allowed us to describe the relationship between type of store and PFP without restricting the analyses to food retailers located in households residential neighborhoods. However, as we previously discussed, people may choose to shop at a particular retailer for a variety of reasons, such as culture, individual SES characteristics, personal preferences, prices, products offered, proximity, etc. This could be especially true for some race-ethnic and income groups. However, in our study, we found no meaningful differences in the nutrient profile of purchased packaged foods and beverages and the food and beverage groups purchased by food shopping patterns. These null findings were consistent across race-ethnic groups. Nevertheless, we found that non-Hispanic blacks purchased foods with a poorer nutrient quality compared to non-Hispanic whites and Hispanics. Other scholars have also shown that SES disparities in the nutrient quality of food purchases persist, even when looking across households shopping in the same store. [111] Therefore, in order to have targeted interventions, influence dietary behaviors and reduce disparities, more research needs to be done to better understand *why* people choose to shop for food where they shop, *why* they

purchase the foods and beverages they purchase and to identify which factors are most important in explaining why food demand varies across race-ethnicity and SES groups.

A very important question still remains: do unhealthy foods proliferate because the demand for healthier food is low, or do unhealthy foods/environments encourage poor dietary behaviors? Environments by themselves may not cause poor diets; instead, environments may have evolved to accommodate the eating, exercising, and other demands of their inhabitants. Future work should consider the dynamic interrelationship of neighborhoods characteristics, food resources, individual characteristics, and supply and demand to better understand the relationship between the food environment and individual dietary behaviors. [133] Specifically, a challenging area of future work will be to identify strategies to limit and discourage consumption of unhealthy foods, especially in small store interventions. [134] Future research should also try to understand how individual preferences for healthy or unhealthy life-styles as well as placement of stores across different social and geographic spaces influence dietary behaviors. A big challenge for nutrition and public health policies will be to make sure that availability of healthy foods will positively alter people's behaviors. In other words, researchers will need to focus on increasing consumers demand for programs that increase availability of healthy foods to be successful.

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