Where people shop is not associated with the nutrient quality of packaged foods for any racial-ethnic group in the United States[1,2]

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ABSTRACT

Background: In the literature, it has been suggested that there are race-ethnic disparities in what Americans eat. In addition, some studies have shown that residents of African American and low-income neighborhoods have less access to grocery stores and supermarkets, which tend to stock healthier foods. However, it is unclear whether differences in food shopping patterns contribute to the poorer nutrient profile of food purchases made by racial-ethnic minorities.

Objectives: We examined whether the mix of food stores where people shop (i.e., food-shopping patterns) was associated with the nutrient profile of packaged food purchases (PFPs) and the types of foods and beverages purchased, and we determined whether these associations differ across racial-ethnic groups.

Design: We used PFPs by US households (Nielsen National Consumer Panel) from 2007 to 2012 and implemented a cluster analysis to categorize households according to their food-shopping patterns. Longitudinal random-effects linear regression models were used to examine the association between food shopping patterns and the nutrient qualities and types of packaged foods and beverages purchased by race-ethnicity in US households.

Results: Shopping primarily at grocery chains was not associated with a better nutrient profile of household PFPs or the food and beverages that households purchased than was shopping primarily at mass merchandisers (value-oriented stores that sell merchandise lines in multiple departments) or at a combination of large and small stores. These results were consistent across racial-ethnic groups. Regardless of where households shopped, non-Hispanic African American households purchased foods with higher energy, total sugar, and sodium densities than did non-Hispanic white and Hispanic households.

Conclusion: 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. *Am J Clin Nutr* 2016;103:1125–34.

Keywords: disparities, food purchases, store type, US, food environment

INTRODUCTION

The literature has suggested that there are race-ethnic disparities in what Americans eat (1). In US adults, non-Hispanic African Americans have a poorer dietary quality than do non-Hispanic whites and Mexican Americans (2). The literature has also shown that residents of non-Hispanic African American and low-income neighborhoods have less physical access to food stores that sell healthy foods (i.e., grocery stores or supermarkets) and more physical access to convenience or small stores (3–6). On the basis of these findings, it has been suggested that the type of stores at which people shop for food influences what people eat (7, 8).

With the assumption that differential food access might underlie nutritional disparities, programs and policies at state and national levels (9–12) have focused on building grocery stores or supermarkets in food deserts or areas with poor access to healthy foods to improve dietary quality and reduce health disparities. These strategies have relied on the assumption that people who shop at larger retail stores (e.g., grocery stores) purchase foods with a better nutrient profile because grocery stores sell a greater variety of foods with a higher nutritional quality at lower prices than in other stores (e.g., convenience stores), and larger stores have more capacity to handle perishables (13). However, improving the retail food infrastructure of neighborhoods (14–17) may not produce the desired changes in food purchasing and consumption patterns.

Most studies that have looked at the food environment and its association to diet and health have focused on the physical access to food stores (5, 18–20) but have not collected data on where people shopped for food and what they actually purchased and have not examined the nutrient profiles of these purchases (3, 4, 21). Therefore, it is unclear whether shopping at grocery stores is associated with a better nutrient profile of food purchases than is shopping at other types of stores and whether there are

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[2] Supplemental Materials 1 and 2 and Supplemental Tables 1–3 are available from the "Online Supporting Material" link in the online posting of the article and from the same link in the online table of contents at http://ajcn.nutrition.org.

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differences by race-ethnicity. Moreover, evidence has suggested that people shop for food outside their residential neighborhoods (22, 23). In addition, food-environment studies have made inferences about the types of stores where people shop for food and associations with diet without directly linking the foods and beverages consumed to the stores where the foods and beverages were purchased (24). Another gap is that policy strategies that aimed to address food disparities were informed by studies that focused primarily on shopping at a single store rather than looking at the combination of stores where people shop for food. 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 packaged food purchases (PFPs) and the types of foods and beverages purchased and to determine whether these associations differ across race-ethnicity. We hypothesized that households who primarily shop at chain grocery stores will have a better nutrient profile and a healthier mix of food and beverage purchases than if they shopped at other stores.

METHODS

Study design and population

We used PFP (i.e., all foods and beverages with barcode and nutrition information) data from the US National Consumer Panel data set from 2007 to 2012 (25), which was a longitudinal national survey of US households. Participating households were given barcode scanners, and household members were instructed to scan the barcodes on all purchased items on returning home after every shopping trip. Scanning occurred continuously through the year and included products purchased from the following types of stores: warehouse clubs, mass merchandisers, supermarkets and groceries, convenience stores, drug stores, and dollar stores. The names of the stores were reported by participants.

The National Consumer Panel uses an open-cohort study design; households were allowed to exit the study at any time, and new households were enrolled to replace dropouts and rebalance the panel to match demographic and geographic targets and maintain national representativeness (26). For a household to be included in the panel, the household needed to report purchases for ≥10 mo. Demographic characteristics and household sizes were collected with the use of a questionnaire. From 2007 to 2012, the length of follow-up ranged from 10 mo to 6 y (mean: 3.1 y). Households were sampled from 76 markets, which were defined as 52 metropolitan and 24 nonmetropolitan geographical areas.

This study included households in the data set from 2007 to 2012 (n = 368,934 household-year observations). To ensure that we captured usual purchases, we excluded household-quarter observations that were deemed unreliable (i.e., <$135 worth of PFPs in a 4-wk period for ≥2-member households and <$45 for single-member households) and household-year observations including more than one unreliable quarter, which resulted in the exclusion of 3.34% of household-year observations. The final analytic sample included 356,611 household-year observations.

Store-type categorization

For every shopping occasion made in a year, all households reported the names of the stores where they shopped for food. We defined the store type as the different types of stores where each household reported purchasing food for each shopping occasion made in a year. We developed our own classification to categorize store types into 7 mutually exclusive categories as follows: *1*) warehouse club (e.g., Costco and Sam's); *2*) mass merchandisers and supercenters [hereafter referred to as mass merchandisers (e.g., Walmart and Super Target)]; *3*) grocery chains (≥10 units; e.g., Kroger and Safeway); *4*) nonchain grocery stores (<10 units); *5*) convenience, drug, or dollar stores [hereafter referred to as convenience stores (e.g., 7-Eleven, CVS, Dollar General, and gas stations]; 6) ethnic and specialty stores (e.g., Compare Foods and Whole Foods Market); and *7*) others stores (e.g., department stores and book stores) (27).

Nutrient information and food and beverage groups

To determine the nutritional content of household PFPs, each barcoded product captured in the National Consumer Panel was linked with Nutrition Facts Panel data. The methodology for this process has been described elsewhere (28, 29). Nonpackaged foods (i.e., foods without barcodes or without nutrition information) were not included. Examples include loose produce, meats sold by weight, bakery items, and prepared foods. However, produce and meats that were packaged were included (e.g., a bag of apples, a bagged salad, and frozen meats). Information on ingredient lists and product attributes for each barcoded product were used to categorize all foods and beverages purchased in the National Consumer Panel into 52 food and 14 beverage groups (26) (**Supplemental Table 1**).

Food-shopping patterns

We used a 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 on the basis of the amount of PFPs by store type (30, 31). We ran a cluster analysis with the use of the volume of household PFPs by store type for every year. We entered the volume of PFPs as a percentage of the volume from each store type relative to the total volume of PFPs to account for the different amounts purchased at different store types (30). We performed a cluster analysis with the use of the SAS FASTCLUST procedure (SAS version 9.3; SAS Institute Inc.). This k-means procedure used Euclidean distances, which were computed from input variables, to assign a cluster membership by minimizing the distance in members in a cluster while maximizing the distance between clusters in an iterative process with the use of 1000 replications and randomly selected seeds (32). Iterations that produced the largest R^2 values indicated the best fit for the data and maximized the intercluster-to-intracluster variability ratio (32, 33). To determine the most appropriate number of clusters, we examined the pseudo–F statistic (34) for each number of cluster solutions, with increases from 2 to 5 clusters. A higher pseudo–F-statistic value indicated better intracluster homogeneity and intercluster 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 (35).

In our previous cluster analysis of these data, we identified the following 3 distinct food-shopping patterns (36): *1*) a primary grocery cluster, which was characterized by households who

purchased the majority of their packaged foods and beverages at grocery chains (e.g., Kroger and Safeway); *2*) a primary mass-merchandiser cluster, which was characterized by households who purchased the majority of their packaged foods and beverages at mass merchandisers (e.g., Walmart and Super Target); and *3*) a combination cluster, which was characterized by households who purchased their packaged foods and beverages at a combination of store types such as a warehouse club, an ethnic or specialty store, a nonchain grocery, a grocery chains, and a mass merchandiser (**Table 1**).

Covariates

The self-reported race-ethnicity of the household head was categorized as non-Hispanic white, Hispanic, non-Hispanic African American, or other non-Hispanic. Because other non-Hispanic represented a very heterogeneous group, results were not focused on this group. The ratio of the family income to the poverty threshold was calculated from the self-reported household income and was used to categorize households according to the percentage of the Federal Poverty Level as low (≤185%), middle (>185% to <400%), or high (≥400%). The self-reported highest educational attainment of the male or female head of the household was categorized as less than high school, completed high school, some college, graduated from college, or postcollege graduate. We created household-composition variables with the use of the number of males and females by the following age categories: 2–5, 6–12, 13–18, 19–29, 30–39, 40–49, 50–59, 60–69, and ≥70 y. We created market year–level, store type–specific food and beverage price indexes to control for the fact that some store types may have offered the same products at lower prices (**Supplemental Material 1**). Considering foods and beverages separately, we identified a standard basket of packaged foods and beverages that were sold across store types, markets, and years. With the use of information on prices paid by participant households, we created store type–market year–level food and beverage price indexes. The year and market were entered as a set of indicator variables.

Statistical analysis

All analyses were performed with the use of Stata 14 software (StataCorp LP). For descriptive analyses, we used survey commands to account for the study design and weighting to generate nationally representative results. We calculated univariate descriptive statistics for the total sample and by food shopping patterns from 2007 to 2012.

Outcome specification

As primary outcomes, we used continuous measures of the nutrient profile of household PFPs from foods and beverages separately as follows: energy density and nutrient density (g total sugars, mg Na, and g saturated fat) per 1000 g. As secondary outcomes, with foods and beverages considered 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 food shopping patterns derived from the cluster analysis and included primary grocery, primary mass-merchandise, and combination clusters.

Model specification

We used longitudinal random-effects models (**Supplemental Material 2**) to investigate the association between food shopping patterns and the nutrient profile of total household PFPs and food and beverage groups purchased over the period studied. We used longitudinal random-effects models to account for the fact that we had multiple year observations per household. We estimated separate models for foods and beverages. To assess whether the association between food shopping patterns and the nutrient profile of household PFPs and food and beverage groups purchased differed by race-ethnicity or by income, we conducted Wald chunk tests for the joint significance of the income–food shopping pattern interaction terms and for the race-ethnicity–food shopping pattern interaction terms with $P < 0.05$ considered significant. All models were adjusted for the maximum level of education, income, household composition, store type–specific food and beverage price indexes, year, and market. To aid interpretability, we used the margins command in Stata to predict the mean ± SE energy and nutrient densities of PFPs and the mean ± SE proportions of calories from key food and beverage groups for each food shopping pattern by race-ethnic group. These predictions were based on the model coefficients of the main exposures plus additional adjustments performed in the model. Within each race-ethnicity group, we used the primary grocery cluster as the referent food shopping pattern. We tested for significant differences with the use of Student's *t* tests. A 2-sided $P = 0.001$ was set to denote significance to account for multiple comparisons and a large sample size.

RESULTS

Sociodemographic characteristics

From 2007 to 2012, households from the National Consumer Panel were predominantly non-Hispanic white, highly educated, and in the middle- and upper-income categories. The average household size was <3 individuals, and the majority of households were composed of only adults. The primary grocery cluster was the largest, whereas the other clusters each represented approximately one-quarter of the population. Sociodemographic characteristics of the food shopping patterns varied by household income, race-ethnicity, and household education. Compared with the primary grocery cluster and the combination cluster, the shoppers in the primary mass-merchandiser cluster were more likely to have a low income and a lower educational distribution. Compared with the primary grocery cluster and the primary mass-merchandiser cluster, combination-cluster shoppers were less likely to be non-Hispanic whites with a greater representation of Hispanics, non-Hispanic African Americans, and others (Table 1).

On average, households purchased 2341 g PFPs/d (1035 g foods/d and 1306 g beverages/d). We showed a significant interaction between food shopping patterns and race-ethnicity in our random-effects longitudinal model with the use of the

TABLE 1
Volume by store type and sociodemographic characteristics by food shopping patterns of US households participating in the 2007–2012 National Consumer Panel[1]

	Primary grocery	Primary mass merchandiser	Combination	Total
Total households, *n* (%)	182,345 (51.1)	80,855 (22.7)	93,411 (26.2)	356,611
Volume of household PFPs[2] by store type,[3] %				
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
Nonchain grocery	2.3	3.3	15.2	5.9
Others	2.6	2.3	9.2	4.3
Household income,[4] *n* (%)				
Low	33,215 (18.2)	18,405 (22.8)	16,196 (17.3)	67,816 (19.0)
Middle	76,839 (42.1)	37,900 (46.9)	38,468 (41.2)	153,207 (43.0)
High	72,291 (39.7)	24,550 (30.3)	38,747 (41.5)	135,588 (38.0)
Household race-ethnicity,[5] *n* (%)				
Non-Hispanic white	151,231 (82.9)	68,874 (85.2)	71,656 (76.7)	291,761 (81.8)
Hispanic	8898 (4.9)	3107 (3.8)	6083 (6.5)	18,088 (5.1)
Non-Hispanic African American	14,868 (8.2)	6214 (7.7)	9907 (10.6)	30,984 (8.7)
Non-Hispanic other	7348 (4.0)	2660 (3.3)	5765 (6.2)	15,773 (4.2)
Household education,[6] *n* (%)				
Less than high school	2231 (1.2)	1181 (1.5)	1137 (1.2)	4549 (1.9)
Graduated from high school	31,233 (17.1)	16,864 (20.9)	13,871 (14.9)	61,968 (17.38)
Some college	52,406 (28.7)	26,086 (32.3)	27,086 (29.0)	105,578 (29.6)
Graduated from college	64,502 (35.4)	26,646 (33.0)	33,287 (35.6)	124,435 (34.9)
Postcollege graduate	31,973 (17.5)	10,078 (12.5)	18,030 (19.3)	60,081 (16.85)
Household type,[7] *n* (%)				
Single	50,571 (27.7)	18,503 (22.9)	23,713 (25.4)	92,787 (26.0)
Adults, no kids	89,376 (49.0)	40,783 (50.4)	48,909 (52.4)	179,068 (50.2)
Adult(s) and kid(s)	42,398 (23.3)	21,569 (26.7)	20,789 (22.3)	84,756 (23.8)
Household size,[8] *n*	2.3	2.4	2.3	2.4

[1]Data are from the 2007–2012 National Consumer Panel of household PFPs. The volume of household PFPs by store type for the total sample and by food-shopping patterns is presented as the proportion of PFPs from a given store type relative to the total household PFPs over the period studied. The proportion of the number of households by food-shopping patterns is presented as row percentages. Household socioeconomic values for the total sample and by food-shopping patterns are presented as counts and column percentages, and the household size is presented as means. Calculations based in part on data reported by Nielsen through its Homescan Services (The Nielsen Company) for the food and beverage categories.

[2]PFP, packaged food purchase.

[3]We defined food shopping patterns as the combinations of store types that US households use to shop for food on the basis of the volume from PFPs by store type. We found 3 food-shopping patterns or clusters as follows: *1*) a primary grocery cluster, which was characterized by households purchasing the majority (~80%) of their packaged foods and beverages at grocery chains (e.g., Kroger and Safeway); *2*) a primary mass-merchandiser cluster, which was characterized by households purchasing the majority (~70%) of their packaged foods and beverages at mass merchandisers (e.g., Walmart and Super Target); and *3*) a combination cluster, which was characterized by households purchasing their packaged foods and beverages at a combination of store types such as grocery chains, mass merchandisers, warehouse clubs (e.g., Costco and Sam's), and convenience stores (e.g., 7-Eleven and Walgreens).

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

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

[6]Household self-reported highest educational attainment.

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

[8]All values are means of the number of people living in the household.

energy density of foods as the outcome (*P*-interaction = 0.002) in our fully adjusted model. We did not find a significant interaction between food shopping patterns and income in our fully adjusted model. Predicted probabilities of the adjusted model were similar to the unadjusted results; therefore, we only present adjusted model results. Because we were studying many nutrient outcomes (i.e., energy and nutrient densities and percentages of kilocalories from food and beverage groups), to be consistent across models, we included the main effect for race-ethnicity and an interaction term between race-ethnicity and food shopping-pattern exposures in all models (**Supplemental Tables 2 and 3**).

Associations between food shopping patterns and household PFPs

With foods and beverages considered separately, **Figure 1** shows the nutrient profile of packaged foods by food shopping patterns across racial-ethnic groups. After adjustment for confounders, we showed no nutritionally meaningful differences in energy, sugar, saturated fat, and sodium densities in food-shopping patterns overall despite some statistically significant differences. In addition, within racial-ethnic groups, we did not show differences in the relation between food shopping patterns and the nutritional profiles of foods purchased. Similar results were seen for the nutrient profiles of packaged beverages (**Figure 2**). **Table 2** shows the mean proportion of calories purchased from key food and beverage groups by food shopping patterns across racial-ethnic groups. Overall, after adjustment for confounders, we showed that food shopping patterns were not associated with differences in the proportion of calories purchased from key food and beverage groups across racial-ethnic groups. In other words, each racial-ethnic group purchased similar distributions of products regardless of where they shopped.

Racial-ethnic differences in the associations between food shopping patterns and household PFPs

Across the different food-shopping patterns, non-Hispanic African American households purchased packaged foods with higher energy, sugar, and sodium densities than did non-Hispanic white and Hispanic households. The saturated fat content of

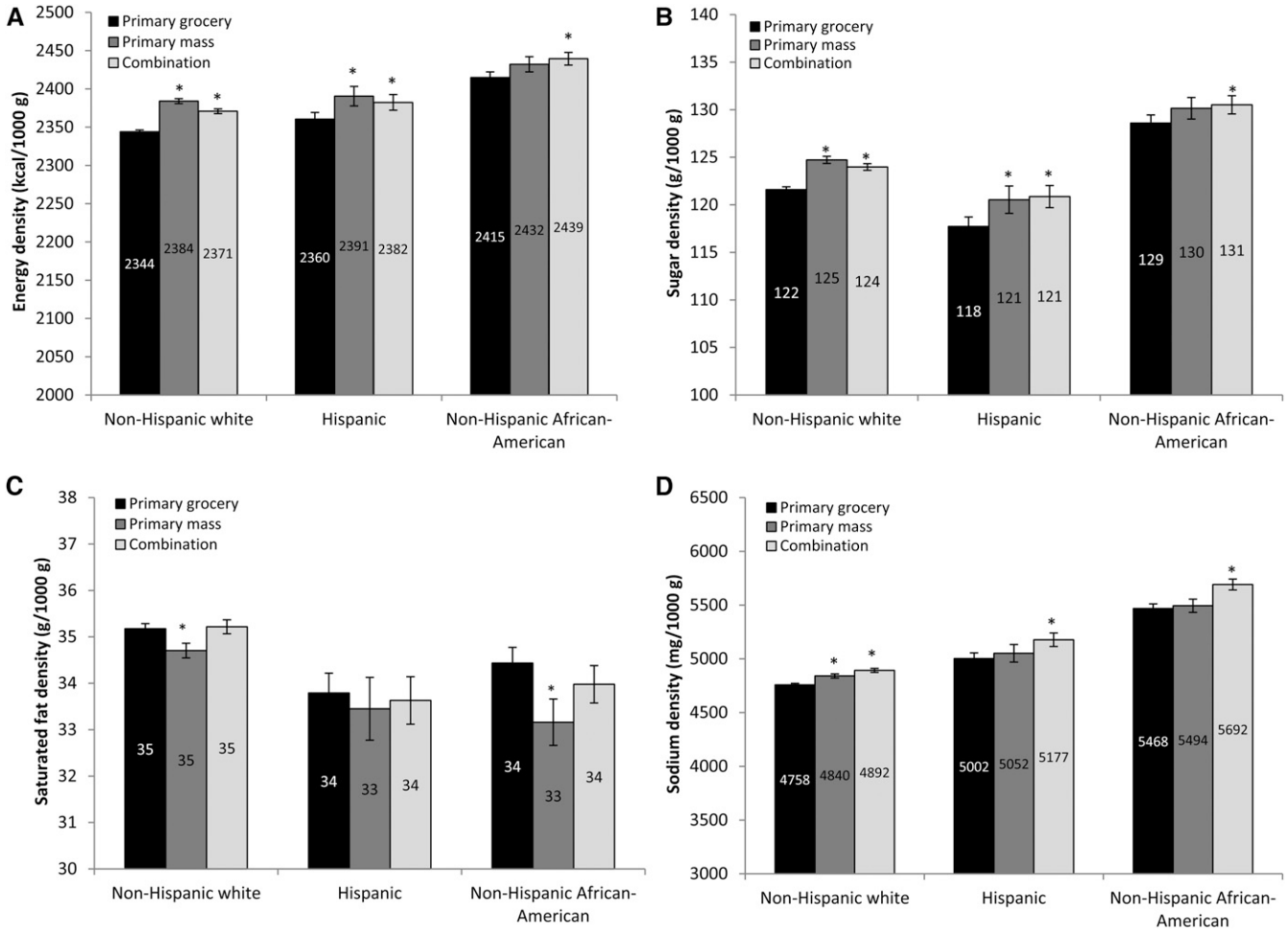

FIGURE 1 Mean ± SE energy and nutrient densities of packaged foods by food shopping patterns across racial-ethnic groups: the National Consumer Panel 2007–2012. (A) Energy density (kcal/1000 g). (B) Sugar density (g/1000 g). (C) Saturated fat density (g/1000 g). (D) Sodium density (mg/1000 g). Values 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 indexes, year, and market. We defined food shopping patterns as the combinations of store types that US households use to shop for food on the basis of the volume from packaged food purchases by store type. We found 3 food-shopping patterns or clusters as follows: *1*) a primary grocery cluster, which was characterized by households purchasing the majority (~80%) of their packaged foods and beverages at grocery chains (e.g., Kroger and Safeway); *2*) a primary mass-merchandiser cluster, which was characterized by households purchasing the majority (~70%) of their packaged foods and beverages at mass merchandisers (e.g., Walmart and Super Target); and *3*) a combination cluster, which was characterized by households purchasing their packaged foods and beverages at a combination of store types such as grocery chains, mass merchandisers, warehouse clubs (e.g., Costco and Sam's), and convenience stores (e.g., 7-Eleven and Walgreens). Racial-ethnic groups were created on the basis of the self-reported race-ethnicity of the household head. Within each race-ethnicity group, we used the primary grocery cluster as the referent food shopping pattern. We tested for significant differences with the use of Student's *t* tests. *A 2-sided $P = 0.001$ was set to denote significance to account for multiple comparisons and a large sample size. Data come from the 2007–2012 Nielsen National Consumer Panel of household packaged food purchases ($n = 356{,}611$ household-year observations). Calculations based in part on data reported by Nielsen through its Homescan Services (The Nielsen Company) for the food and beverage categories.

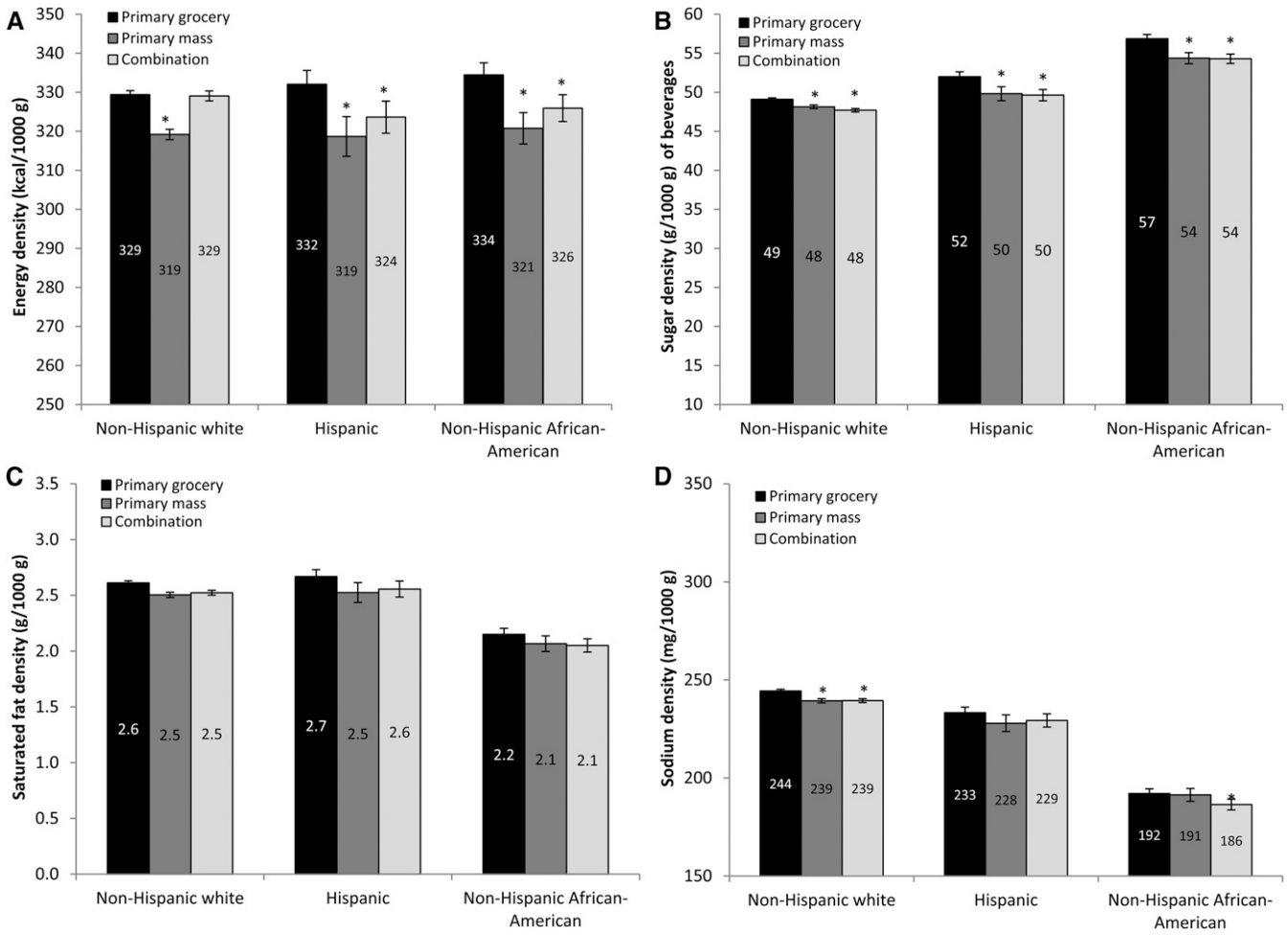

FIGURE 2 Mean ± SE energy and nutrient densities of packaged beverages by food shopping patterns across racial-ethnic groups: National Consumer Panel 2007–2012. (A) Energy density (kcal/1000 g). (B) Sugar density (g/1000 g). (C) Saturated fat density (g/1000 g). (D) Sodium density (mg/1000 g). Values 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 indexes, year, and market. We defined food shopping patterns as the combinations of store types that US households use to shop for food on the basis of the volume from packaged food purchases by store type. We found 3 food-shopping patterns or clusters as follows: *1*) a primary grocery cluster, which was characterized by households purchasing the majority (~80%) of their packaged foods and beverages at grocery chains (e.g., Kroger and Safeway); *2*) a primary mass-merchandiser cluster, which was characterized by households purchasing the majority (~70%) of their packaged foods and beverages at mass merchandisers (e.g., Walmart and Super Target); and *3*) a combination cluster, which was characterized by households purchasing their packaged foods and beverages at a combination of store types such as grocery chains, mass merchandisers, warehouse clubs (e.g., Costco and Sam's), and convenience stores (e.g., 7-Eleven and Walgreens). Racial-ethnic groups were created on the basis of self-reported race-ethnicity of the household head. Within each race-ethnicity group, we used the primary grocery cluster as the referent food shopping pattern. We tested for significant differences with the use of Student's *t* tests. *A 2-sided $P = 0.001$ was set to denote significance to account for multiple comparisons and a large sample size. Data come from the 2007–2012 Nielsen National Consumer Panel of household packaged food purchases ($n = 356{,}611$ household-year observations). Calculations based in part on data reported by Nielsen through its Homescan Services (The Nielsen Company) for the food and beverage categories.

packaged foods purchases did not appear to be higher in non-Hispanic African Americans than in non-Hispanic white and Hispanic households (Figure 1). In terms of beverage purchases, across the different food-shopping patterns, non-Hispanic African American households purchased packaged beverages with a higher sugar density and lower sodium density than did non-Hispanic white and Hispanic households (Figure 2). The different racial-ethnic groups purchased similar proportions of calories from food groups across the different food-shopping patterns. However, for beverage groups, the contribution of calories from sugar-sweetened beverages (SSBs) and fruit juices to total calories from beverages purchased across food shopping patterns was higher for non-Hispanic African American households than for non-Hispanic white and Hispanic households. Non-Hispanic African American households also purchased a lower proportion of calories from plain milk (i.e., unsweetened and unflavored whole and low-fat milk) across food shopping patterns than did non-Hispanic white and Hispanic households (Table 2).

DISCUSSION

Our results suggest that, in the National Consumer Panel sample, shopping primarily at grocery chains was not associated with a better nutrient profile of household PFPs or food and beverage groups purchased than was shopping primarily at a mass merchandiser or a combination of small and large stores. From the perspective of the supply side, one study suggested that the

TABLE 2
Predicted adjusted proportion of calories purchased from key food and beverage groups by food shopping pattern across racial-ethnic groups: the National Consumer Panel 2007–2012[1]

	Non-Hispanic white			Hispanic			Non-Hispanic African American		
	Primary grocery	Primary mass merchandiser	Combination	Primary grocery	Primary mass merchandiser	Combination	Primary grocery	Primary mass merchandiser	Combination
Food									
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
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
Beverage									
SSBs	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

[1]All values are predicted means ± SEs. Data are from the 2007–2012 National Consumer Panel of household packaged food purchases (n = 356,611 household-year observations). Values 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 indexes, year, and market. Within each race-ethnicity group (defined as the self-reported race-ethnicity of the household head), we used the primary grocery cluster as the referent food shopping pattern. We defined food shopping patterns as the combinations of store types that US households use to shop for food on the basis of the volume from PFPs by store type. We found 3 food-shopping patterns or clusters as follows: *1*) a primary grocery cluster, which was characterized by households purchasing the majority (~80%) of their packaged foods and beverages at grocery chains (e.g., Kroger and Safeway); *2*) a primary mass-merchandiser cluster, which was characterized by households purchasing the majority (~70%) of their packaged foods and beverages at mass merchandisers (e.g., Walmart and Super Target); and *3*) a combination cluster, which was characterized by households purchasing their packaged foods and beverages at a combination of store types such as grocery chains, mass merchandisers, warehouse clubs (e.g., Costco and Sam's), and convenience stores (e.g., 7-Eleven and Walgreens). Information on ingredient lists and product attributes were used to categorize all foods and beverages purchased in the National Consumer Panel into 52 food groups and 14 beverage groups at the barcode level. With foods and beverages considered 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 included, e.g., potato chips, crackers, corn chips, pretzels, tortilla chips, popcorn, sandwich crackers, rice cakes, and snack mixes with crackers. Breads and tortillas included, e.g., bread, rolls, hot dog or hamburger buns, sandwich rolls, sandwich wraps, bagels, tortillas, and taco shells. Grain-based desserts included, e.g., ready-to-eat, ready-to-bake, and baking mixes for cookies, brownies, cake, pie, sweet rolls, snack cakes, muffins, doughnuts, granola bars, and other snack bars. Candy and sweet snacks included, e.g., candy, chocolate, candy bars, fruit snacks, gum, mints, popsicles, and candy-coated nuts or seeds. Cheese included regular and processed cheeses. Processed meats included, e.g., refrigerated, frozen, or canned (or shelf-stable) processed meat such as bacon, sausage, hot dogs, ham, smoked or cured meats, and lunchmeat. Vegetables, both unsweetened and unflavored, included fresh or refrigerated vegetables, such as bagged or packaged lettuce and salad blends, fresh baby carrots, carrot sticks, whole carrots, celery, heads of lettuce, tomatoes, or mushrooms; frozen vegetables, such as, e.g., broccoli, carrots, green beans, spinach, and vegetable mixtures; and dried vegetables. Vegetables, canned, included, e.g., canned green beans, tomatoes, spinach, greens, carrots, and mushrooms. Nuts and nut butters, both sweetened and flavored, included, e.g., raw, blanched, dry-roasted, or oil-roasted nuts or seeds (salted, flavored, frosted, or honey roasted); nut mixtures; nut-based trail mix; peanut butter; other nut butters. Ready-to-eat cereal included cold breakfast cereals and granola. SSBs included, e.g., 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. Plain milk included fresh or shelf-stable plain milk (both whole milk and low-fat milk). Fruit juices included, e.g., 100% or <100% juice, not from-concentrate or from-concentrate juice, sweetened juice, frozen fruit-juice concentrate, sparkling fruit juice, and cider. We tested for significant differences with the use of Student's t tests. A 2-sided $P = 0.001$ was set to denote significance to account for multiple comparisons and a large sample size. All comparisons were significant at $P < 0.001$. Calculations based in part on data reported by Nielsen through its Homescan Services (The Nielsen Company) for the food and beverage categories. PSP, packaged food purchase; SSB, sugar-sweetened beverage.

poor diets of many racial-ethnic groups are attributable to limited access to stores that sell healthy foods, especially grocery stores or supermarkets (37). Our study allowed us to examine a metric that reflected both the availability and demand. We showed that, no matter what food shopping pattern different racial-ethnic groups used, 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, e.g., salty snacks, grain-based desserts, candy, processed meat, and SSBs regardless of where they shopped. As other authors have pointed out, the availability (38) and in-store marketing strategies (39) of less-healthy foods might be a stronger determinant of what is purchased rather than the availability of healthy foods.

Studies have suggested that, within a given store type, stores located in predominantly African American and lower-income neighborhoods have less availability of healthy foods (24) or a lower relative availability of healthier food alternatives (40) than do similar stores located in predominantly white and higher-income neighborhoods. However, a recent study (41) showed that, even when looking at purchases from the same store, low-income

households purchased foods that were less healthful than those purchased by high-income households. The relation between the food environment and people's diet quality is complex and likely to be bidirectional. In addition, food preferences, budget constraints, differences in price sensitivities, car ownership, and food marketing likely 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 a lack of safety at stores (42).

One of our key findings is that, even after different food shopping patterns are accounted for, there are race-ethnic differences in the nutritional profiles of PFPs. Specifically, across the 3 food shopping patterns, non-Hispanic African American households purchased foods with higher energy, total sugar, and sodium densities than did non-Hispanic white and Hispanic households. Non-Hispanic African American households also purchased a higher proportion of beverage calories from SSBs and juice drinks and fewer calories from plain milk. In terms of food groups, we showed no differences. The heterogeneity within food groups is a possible explanation for the observed differences in the nutrient profile of foods purchased but not in the food groups purchased by non-Hispanic African American households compared with other race-ethnic groups. It is possible that different racial-ethnic groups purchased foods with better nutrient profiles (e.g., regular- compared with low-sodium canned vegetables) or purchased different types of products within the same food group (e.g., potato chips compared with pretzels). Overall, our race-ethnic findings suggest that cultural factors, taste preferences, and economic and time constraints might be more influential to the nutrient profile of purchases and what foods and beverages people purchase than are shopping patterns. Therefore, additional actions need to be considered to improve the quality and types of foods and beverages purchased regardless of the store type, especially for non-Hispanic African Americans.

A major strength of our study is that it measured where households actually shopped for food as well as the foods and beverages purchased there. In addition, the study links PFPs to high-quality nutritional information. Moreover, the large samples of racial-ethnic minorities allowed us to study racial-ethnic differences regarding where households shopped for food and what they purchased. In addition, our analysis was focused at the household level, which is the primary unit at which food purchases are directed. Finally, we collected data for household PFPs during the course of an entire year, which reflected the usual purchases of households.

A key limitation of our study is that the location where individuals choose to shop for food is a result of an individual choice and is a complex decision affected by many factors, both observable and unobservable, that overlap with the purchase decision. For example, product, price, promotion, and placement influence food-purchasing decisions (43–47) along with individual food preferences (48), transportation, and time (49, 50). These factors are known as self-selection (51), and although these are different types of selection mechanisms, at the end, the choice of where consumers shop for food (i.e., the type of store) and what foods and beverages they purchase are nonrandom. Because of these self-selection mechanisms, we expected an upward bias in the association between the primary grocery-shopping pattern and the nutrient profile of PFPs. In other words, individuals who are highly motivated to eat a healthy diet may also be more likely to go to a store where they can purchase healthier foods and beverages. However, even with this hypothesized upward bias, we did not observe meaningful differences in the nutrient profiles of PFPs and what foods and beverages people purchased by food shopping patterns.

Our analysis focused on the calories, total sugars, saturated fat, and sodium of PFPs and not on consumption. In addition, these components did not capture all aspects of foods and beverages that affect dietary quality or health. Another limitation was our lack of food-purchase data for foods without barcodes or those that were not required to have Nutrition Facts Panel information. If differences in the nutrient profile of purchases across store types are due only to differences in purchases of fresh produce and other nonpackaged foods, these items that were missing from our study might explain the lack of association between food shopping patterns and the nutrient profile of purchases observed in our study.

Households who participated in the National Consumer Panel were required to scan all groceries at home. The process of recording might have been time consuming, which could have resulted in an underreporting of data. This outcome would have been a problem if households systematically and differently underreported PFPs from a specific store type or if misreporting differed by sociodemographic characteristics. In addition, we had access only to data for the products actually purchased by each household in a given store, and not the full variety of products offered at the store (41).

The National Consumer Panel sample does not perfectly match the US population on the basis of demographic characteristics. Despite the large sample size, households with low education and low income who were willing to participate in the panel may have shopped at stores with a greater availability of healthy foods and may have had greater access to higher-quality stores than did low-income households in the United States in general. Therefore, these results may not be generalizable to the US population.

In conclusion, we observed no meaningful differences in the nutrient profiles of purchased packaged foods and beverages and the food and beverage groups purchased by food shopping patterns. These null findings were consistent across racial-ethnic groups. However, non-Hispanic African Americans had a lower nutrient quality of foods purchased than did non-Hispanic whites and Hispanic households. Overall, the ubiquity of unhealthy packaged foods and beverages that are high in sugars, sodium, and fat, regardless of the store type, may thwart efforts to improve eating habits. In addition, 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.

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feedback on the manuscript development; and all authors: had primary responsibility for the final content of the manuscript. None of the authors reported a conflict of interest related to the study.

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