



Trends in racial/ethnic and income disparities in foods and beverages consumed and purchased from stores among US households with children, 2000–2013^{1,2}

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ABSTRACT

Background: It is unclear whether racial/ethnic and income differences in foods and beverages obtained from stores contribute to disparities in caloric intake over time.

Objective: We sought to determine whether there are disparities in calories obtained from store-bought consumer packaged goods (CPGs), whether brands (name brands compared with private labels) matter, and if disparities have changed over time.

Design: We used NHANES individual dietary intake data among households with children along with the Nielsen Homescan data on CPG purchases among households with children. With NHANES, we compared survey-weighted energy intakes for 2003–2006 and 2009–2012 from store and nonstore sources by race/ethnicity [non-Hispanic whites (NHWs), non-Hispanic blacks (NHBs), and Hispanic Mexican-Americans) and income [$\leq 185\%$ federal poverty line (FPL), 186–400% FPL, and $>400\%$ FPL]. With the Nielsen data, we compared 2000–2013 trends in calories purchased from CPGs (obtained from stores) across brands by race/ethnicity (NHW, NHB, and Hispanic) and income. We conducted random-effect models to derive adjusted trends and differences in calories purchased (708,175 observations from 64,709 unique households) and tested whether trends were heterogeneous by race/ethnicity or income.

Results: Store-bought foods and beverages represented the largest component of dietary intake, with greater decreases in energy intakes in nonstore sources for foods and in store sources for beverages. Beverages from stores consistently decreased in all subpopulations. However, in adjusted models, reductions in CPG calories purchased in 2009–2012 were slower for NHB and low-income households than for NHW and high-income households, respectively. The decline in calories from name-brand food purchases was slower among NHB, Hispanic, and lowest-income households. NHW and high-income households had the highest absolute calories purchased in 2000.

Conclusions: Across 2 large data sources, we found decreases in intake and purchases of beverages from stores across racial/ethnic and income groups. However, potentially beneficial reductions in calories purchased were more pronounced in some subgroups over others. *Am J Clin Nutr* 2016;104:750–9.

Keywords: calories purchased, children, disparities, energy intake, socio-economic

INTRODUCTION

Since the early 2000s, per capita intake and purchases of food and beverage calories have declined with greater relative declines in beverage calories than food calories, particularly among households with children (1–3). Examination of potential racial/ethnic differences in energy intake among US children has found that the differences are not consistently significant (3). However, other studies have described racial/ethnic or income disparities in consumption of food away from home (FAFH)³ (4, 5). In particular, being black and having lower education have been associated with higher intake of fast food, which may contribute to diet-related health disparities (4–7). Nonetheless, energy intake from FAFH locations has decreased since 2003 across all racial/ethnic and income subpopulations (5, 8, 9).

Besides FAFH, store-bought foods are the main contributor of energy. Earlier studies show that energy intake from stores fell between 2003 and 2010 among US children (1, 9). Yet it remains unknown whether racial/ethnic or income differences in store-bought foods and beverages also contribute to disparities in energy intake. One study found no differences in intake in foods obtained from stores among US adults across racial/ethnic groups, but the use of pooled data from 2003 to 2008 to obtain sufficient sample sizes for the racial/ethnic groups may mask important trend differences (6).

Meanwhile, past investigations into caloric contributions from store purchases have focused on the consumer packaged goods (CPGs) segment. These include evaluations of the Healthy Weight Commitment Foundation (HWCF) marketplace pledge

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² Supplemental Data Sources, Supplemental Figures 1–7, and Supplemental Tables 1–4 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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³ Abbreviations used: CPG, consumer packaged goods (foods and beverages sector); FAFH, food away from home; FPL, federal poverty line; HWCF, Healthy Weight Commitment Foundation; NB, name brand; NHB, non-Hispanic black; NHW, non-Hispanic white; PL, private label.

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made by a group of 16 major global food companies (10, 11), which found differential reductions by brand and food or beverage categories. Another analysis of dietary intake and food purchase data until 2010 and 2011, respectively, suggests that there is a plateauing of the calories purchased, especially among black and Hispanic households with children, even after controlling for economic factors (1). Concurrently, research shows shifts in consumer demand toward private-label (PL) products and that the promotion/marketing, and hence popularity of PLs, can vary depending on store type and demographic makeup of customers (12). Nutritionally, there is little evidence of significant or consistent differences in macronutrient profiles of PLs compared with name brands (NBs), at least from studies outside of the United States (13–17). However, there has yet been a study to elucidate whether and how CPG purchases across brands may vary by racial/ethnic or income subgroups over time.

This article seeks to assess the trends in racial/ethnic and income disparities in calories consumed and purchased in US households with children by using data sources on dietary intake and household purchases. It investigates the roles of source (store/home compared with nonstore/away-from-home, hence store compared with nonstore) and whether changes in one source are being offset by another and by brands (HWCF NB, non-HWCF NB, and PL) among CPG purchases from stores. Our focus is to determine whether there are statistically and meaningfully significant differences by racial/ethnic and income subgroups and whether these differences (if any) are widening or narrowing. The findings can shed light on whether improvements are limited to specific subpopulations.

METHODS

We used a combination of both individual dietary intake data from 24-h recalls broken down by the location from which food and beverage items were obtained (store compared with nonstore), and household purchase data for CPG food and beverage purchases from stores. To maximize comparability, the samples used are representative of individuals living in households with any child in both data sources. **Table 1** describes the differences

across the 2 data sources in terms of sample representativeness, data captured, and potential sources of measurement error.

Dietary intake by US children and adults from households with children

We used nationally representative surveys of children and adults residing in households with any child with complete data on age, race/ethnicity, and household income from What We Eat In America, the dietary intake interview section of NHANES 2003–2004 and 2005–2006 ($n = 6943$ children and 3610 adults), and 2009–2010 and 2011–2012 ($n = 5557$ children and 3985 adults).

The surveys were multistage, stratified-area probability samples of the US civilian noninstitutionalized population. A complete description of the complex sampling design and data collection methodology is available elsewhere (18). Briefly, cross-sectional surveys are conducted in 2-y cycles and include individual and family-level interviews. Survey cycles were combined (2003–2004 with 2005–2006 and 2009–2010 with 2011–2012) to increase sample size within racial/ethnic and income subgroups and thereby produce estimates with greater statistical reliability, as recommended by survey administrators, as well as to ensure balanced periods of data for comparison over time. Our study included children aged 2–18 y and adults residing in households with children aged <18 y. In 2011–2012, we identified adults from households with children directly from demographic information about the number of children in the household reported during the family interview. Because this detailed household composition was not reported in the demographic information for 2003–2004 through 2009–2010, we included adults from households with children as identified by NHANES when determining eligibility to complete the food security questionnaire for households with children.

Two 24-h dietary recalls were collected by using the USDA's Automated Multiple-Pass Method by trained interviewers, the first conducted in person and the second 3–10 d later by phone. Recalls for children aged <6 y were completed by a proxy respondent, and recalls for children aged 6–11 y were proxy-assisted. Nutrient information for each reported food or beverage

TABLE 1

Description of differences between What We Eat in America–NHANES and the Homescan panel¹

	What We Eat in America, diet component of NHANES	Nielsen Homescan Panel
Years of data used	2003–2006 2009–2012	2000–2013
Sample representation	Nationally representative sample of US residents aged >2 y	Large panel of US households from 48 contiguous states across 76 metropolitan and nonmetropolitan areas
Levels of measurement	Individual Dietary intake on foods and beverages consumed One 24-h recall	Household Purchases of CPGs Every reported shopping episode
Nutrient information linked to	Year or wave-specific USDA Food and Nutrient Database for Dietary Surveys	Year-specific Nutrition Facts Label information from various sources
Potential source of underreporting or missing data	Social desirability (underreporting of less-healthy consumption) Forgotten foods Portion size estimation	Nonpackaged foods (e.g., random-weight meats, store-prepared ready-to-eat or ready-to-eat foods, loose fruits or vegetables) On-the-go packaged foods that are unreported because of quick consumption Social desirability (underreporting of less-healthy purchases)
Potential source of overreporting	Social desirability (overreporting of healthier consumption) Portion size estimation	Food waste Spoilage

¹CPG, consumer packaged goods (food and beverages sector).

was determined from the USDA's Food and Nutrition Database for Dietary Studies versions 2.0 (2003–2004), 3.0 (2005–2006), 5.0 (2009–2010), and 2011–2012. As recommended by NHANES analytic guidelines, we used only the first day of recall to generate group mean intake (19).

For each recalled food or beverage, respondents reported the location from which the item was obtained; for items that came from the participant's home food supply and were originally purchased from a retail food store, the location of purchase was recorded as store. We classified each item by source as store or nonstore to more appropriately compare dietary intake with the CPG purchase data for retail food stores. Foods and beverages that came from a store were obtained from grocery stores, supermarkets, convenience stores, or drug stores and were prepared either at the store or in the home. Foods and beverages obtained from fast food, restaurants, schools, vending machines, food/ice cream trucks, at someone else's home, from other people, and from all other miscellaneous sources were termed *nonstore*. Individuals were excluded if they were missing information on food source for any calorie-containing item ($n = 240$) or missing information about the presence of children in the household ($n = 143$ adults).

Mean daily energy intake from foods and from beverages were estimated for the pooled 2003–2006 and 2009–2012 samples. Nationally representative estimates were obtained by using survey commands within Stata (StataCorp LP) to take into account complex survey design and dietary sample weights, which account for differential probabilities of selection, nonresponse, and noncoverage. For food intake and beverage intake (kcal/d) from all sources, from stores, and from nonstore sources, differences were examined by race/ethnicity [non-Hispanic whites (NHWs), non-Hispanic blacks (NHBs), and Mexican Americans] and by household income [categorized on the basis of the gross federal poverty level (FPL) as $\leq 185\%$ FPL (low income), 186–400% FPL (middle income), and $>400\%$ FPL (high income)]. Intake by Mexican Americans, rather than all Hispanics, was analyzed because What We Eat In America–NHANES first adequately surveyed all Hispanics in 2007–2010 (20). Differences across subpopulations within a given year and changes across time (comparing 2009–2012 with 2003–2006) within each subpopulation were compared by using 2-sided paired t tests with $P < 0.05$ after Bonferroni correction for multiple comparisons considered significant.

Food and beverage purchases by US households with children

Although the dietary intake data provide useful information about individual level intakes by race/ethnicity and household income for those aged ≥ 2 y, the need to combine 2 waves (4 y) of NHANES because of small sample sizes within subpopulations limits our ability to understand trends. In addition, the NHANES data are limited in their ability to distinguish the contribution of NBs compared with PL products to US diets and how they may have changed over time by the various subgroups.

To handle these issues, we used the 2000–2013 Nielsen Homescan purchase data (21) to measure changes in CPG food and beverage purchases from stores. These data miss information about the purchases of items without barcodes, such as loose fruit and vegetables, cut-to-order meats or cheeses, and

bulk grains or nuts. A detailed review of these data sources is provided elsewhere (11, 22) and under **Supplemental Data Sources, Supplemental Table 1**, and **Supplemental Figure 1**. Identification of HWCF products was based on information in 2013 on the brand and manufacturer of each barcode provided by Nielsen Homescan following the approach described in an earlier evaluation (11). The CPGs were hence mutually exclusively categorized as HWCF NB, non-HWCF NB, and PL.

Household food and beverage CPG purchase statistical analyses

The 2000–2013 Nielsen Homescan household CPG food and beverage purchase data were used to estimate trends in calories purchased per capita per day among US households with children (64,709 unique households). Using household sampling weights, we present the crude weighted but unadjusted 2000–2013 trends in calories purchased from CPGs by racial/ethnic and household income groups. The outcomes of interest were calories from CPG foods and from CPG beverages purchased per capita per day and purchases by brand category (CPG calories purchased from HWCF NB products, from non-HWCF NB products, and from PL products per capita per day).

Because of the panel nature of these data and the longer period of time reflected, models adjusted for changes in the US socio-demographic composition, market-level unemployment rates (as a measure of macroeconomic condition), and food prices were used to estimate the number of calories purchased in the absence of changes in these factors over the 14-y period. Maximum likelihood random-effect models (a form of multilevel modeling) with clustering at the household level were used to derive the model-adjusted trends in CPG calories purchased by the sample of households with children aged 2–18 y in 2000–2013, (708,175 household-quarter observations from 64,709 unique households). Details on the variables and modeling specifications are available under “Household CPG food and beverage purchase modeling” in the Supplemental Data Sources. Briefly, the models adjust for household-level variables, such as the number of household members in each sex and age group category, the educational attainment of the head of household, race/ethnicity of the head of household, and household income (based on FPL). We also controlled for market- and quarter-specific unemployment rates in which a household resides and market- and quarter-specific real prices (using the value of a US dollar in the first quarter of 2000 in Los Angeles as the base) of products across food or beverage categories. Market dummies were included to control for time invariant endogeneity because of unobservables at the market level that affect both market- and individual-level decisions, quarter dummies addressed seasonality in purchases, and year dummies captured secular trends.

Because we were interested in determining whether the trends in calories purchased were heterogeneous by race/ethnicity (NHW, NHB, and Hispanic) or household income (low, medium, and high), we interacted these measures with the year dummies. We then predicted the adjusted outcomes for each year for the racial/ethnic groups relative to NHW households in 2000, and household income groups relative to households with high income, using margins in Stata (23), which is able to compute predicted means and Δ -method SEs (23). We were also interested in examining whether changes over time were consistent.

We did this by deriving changes in calories purchased per capita per day over the 2003–2006 period compared with the 2009–2012 period assuming linear trends. We broke this down by racial/ethnic groups and by income groups for foods and beverages from each brand category.

All analyses for both data sources were conducted in 2015 by using Stata, version 14 (23).

RESULTS

Unadjusted calories consumed from store compared with nonstore sources among Americans residing in households with children

Energy intake from store-bought foods did not significantly change between 2003–2006 and 2009–2012 for any racial/ethnic group (Figure 1); however, per capita intake from nonstore sources decreased slightly among NHBs (-37 kcal/d, $P = 0.3$) and significantly for NHWs (-76 kcal/d, $P = 0.01$). Meanwhile, per capita energy intake from store-bought beverages significantly decreased across time for all racial/ethnic groups, particularly among Mexican Americans (-72 kcal/d, $P < 0.001$); no significant changes occurred in beverage intake from nonstore sources. In 2009–2012, there were no significant differences in energy intake from store-bought foods or beverages across racial/ethnic groups.

Differences in energy intake from foods between 2003–2006 and 2009–2012 were not statistically significant for any income groups regardless of the source (Figure 2). Consistent with patterns across racial/ethnic groups, per capita energy intake from store-bought beverages significantly decreased during this time span for all income groups (low income: -49 kcal/d, $P < 0.001$; middle income: -54 kcal/d, $P = 0.001$; high income: -42 kcal/d, $P = 0.004$), with no changes in beverages from nonstore sources. At both time points, participants from low-income households had significantly greater energy intake from store-bought beverages than other income groups. In Supplemental Figures 2–5, we present the results among US children aged 2–18 y and among US adults aged ≥ 19 y from households with children to show how reductions from store-obtained beverages among children are the most notable and occurred across all racial/ethnic groups and incomes.

Unadjusted trends in calories purchased by brand categories

The contribution of each of the 3 brand categories for CPG food and beverage calories purchased over time are shown in Table 2. We found that in general the caloric share of HWCF foods and beverages fell over time, particularly in more recent years, while the caloric share of PLs rose over time. Unadjusted trends (see Supplemental Figures 6 and 7) and between-group

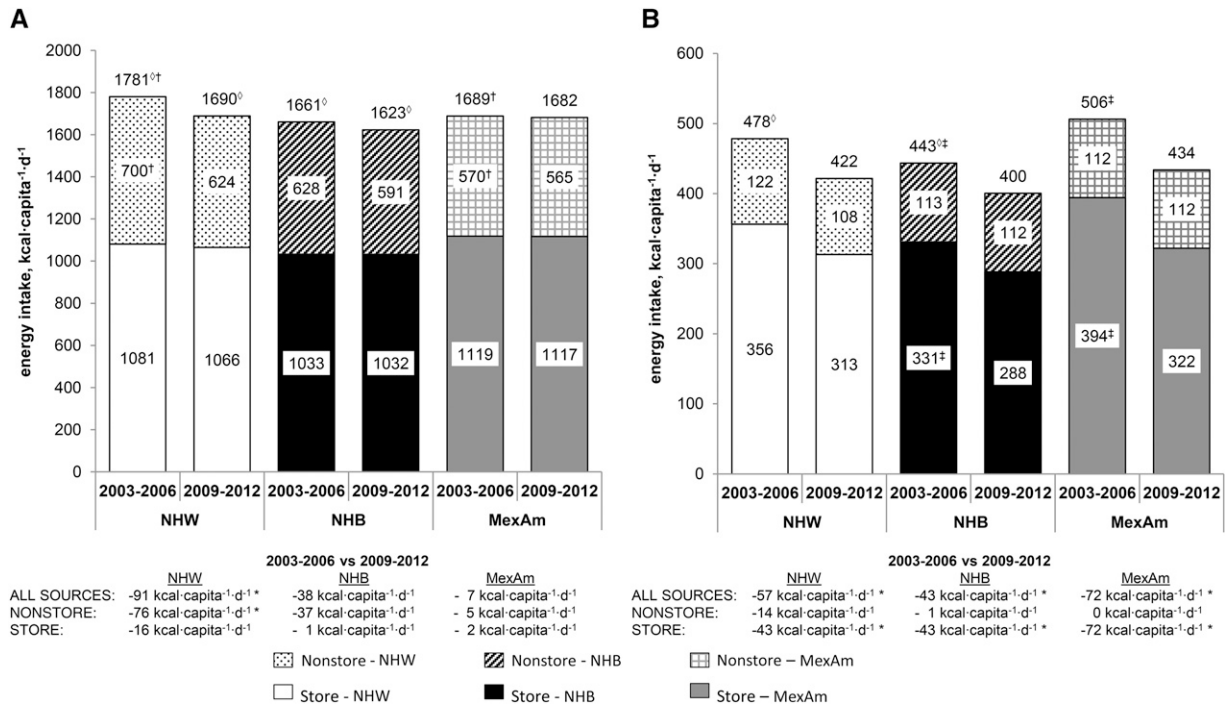


FIGURE 1 Daily energy intake from stores and nonstore sources of foods (A) and beverages (B) by race/ethnicity among US children and adults from households with children. Data are from 20,095 children and adults from households with children aged < 18 y participating in NHANES 2003–2006 and 2009–2012. Values are mean per capita energy intake from stores and from nonstore sources (fast food, restaurant food, schools, vending machines, etc.) reported on the first day of 24-h dietary recall. All values are weighted to be nationally representative and account for complex survey design. Results not shown for participants reporting other races or Hispanic origin other than Mexican. \diamond , \dagger , \ddagger Mean total energy intake, intake from stores, and intake from nonstore sources were compared across racial/ethnic groups for the specified survey year by using pairwise t tests with $P < 0.05$ after Bonferroni correction for multiple comparisons considered statistically significant. \diamond NHW and NHB are significantly different. \dagger NHW and MexAm are significantly different. \ddagger NHB and MexAm are significantly different. *Mean total energy intake, intake from stores, or intake from nonstore sources was significantly different in 2009–2012 compared with 2003–2006 for the specified racial/ethnic group, $P < 0.05$. SEs are found in Supplemental Table 3. MexAm, Mexican American; NHB, non-Hispanic black; NHW, non-Hispanic white.

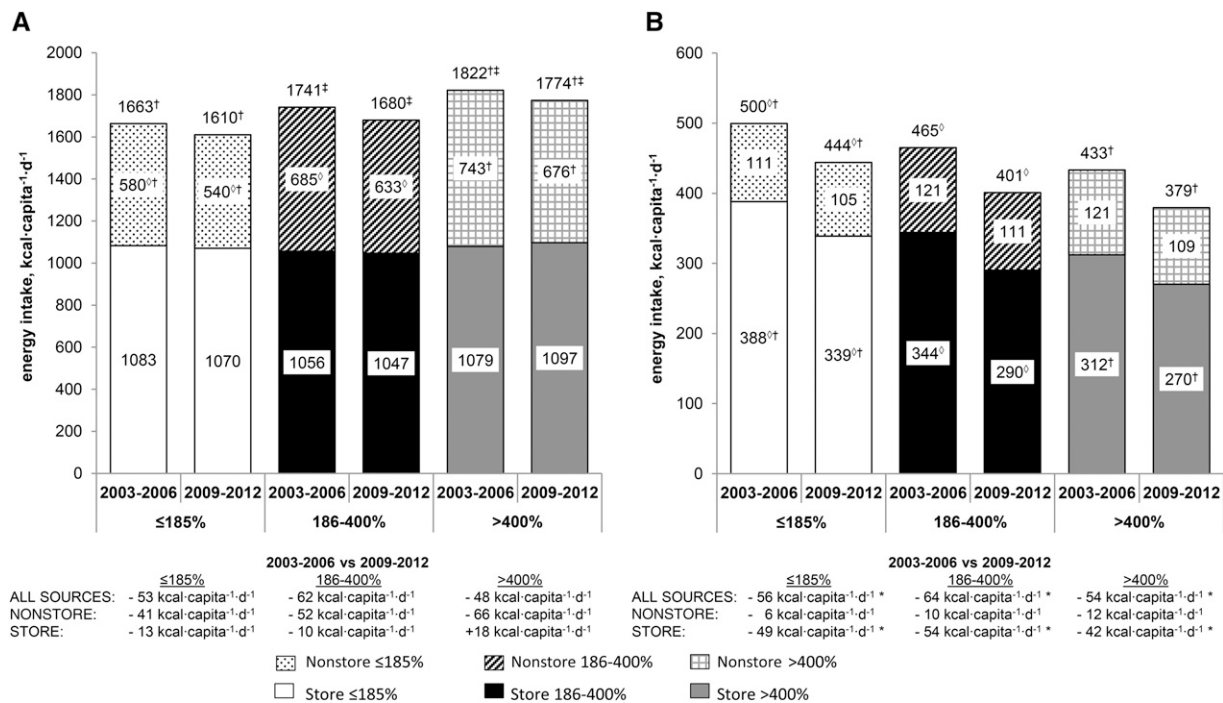


FIGURE 2 Daily energy intake from stores and nonstore sources of foods (A) and beverages (B) by household income among US children and adults from households with children. Data are from 20,095 children and adults from households with children aged <18 y participating in NHANES 2003–2006 and 2009–2012. Values are mean per capita energy intake from stores and from all nonstore sources (fast food, restaurant food, schools, vending machines, etc.) reported on the first day of 24-h dietary recall. All values are weighted to be nationally representative and account for complex survey design. Income groups were defined based on family income expressed as a percentage of the FPL. ◊, †, ‡ Mean total energy intake, intake from stores, and intake from nonstore sources were compared across income groups for the specified survey year by using pairwise *t* tests with $P < 0.05$ after Bonferroni correction for multiple comparisons considered statistically significant. ◊ ≤185% FPL and 186–400% FPL are significantly different. † ≤185% FPL and >400% FPL are significantly different. ‡ 186–400% FPL and >400% FPL are significantly different. *Mean total energy intake, intake from stores, or intake from nonstore sources was significantly different in 2009–2012 compared with 2003–2006 for the specified income group, $P < 0.05$. SEs are found in Supplemental Table 3. FPL, federal poverty level.

differences were generally consistent for the unadjusted and adjusted results, so we focused on the modeled estimates.

Model-adjusted trends in calories purchased by brand categories

The estimates from the maximum likelihood random-effect models for total CPG calories are shown in **Supplemental Table 2**. To aid with interpretability, we predicted the adjusted outcomes for each year for the racial/ethnic groups (**Figure 3**) relative to NHW households in 2000 and household income groups (**Figure 4**) relative to high-income households at >400% FPL.

Across all racial/ethnic groups and holding all else constant, CPG purchases were lower than they were for NHW households in 2000. However, among CPG food purchases, the rate of decline varied by race/ethnicity and over time. NHB and Hispanic households had a higher rate of decline than NHW households did in 2003–2006. However, this accelerated in 2009–2012 for both NHW and Hispanic households but did not change significantly for NHB households. Moreover, in 2009–2012, the absolute decline in total food calories purchased was significantly lower for NHB than for NHW households.

When looking at brand categories of CPG foods purchased, we see that HWCF foods in particular had larger absolute declines in 2009–2012 than in 2003–2006 across all racial/ethnic groups, but NHB and Hispanic households had significantly lower rates

of decline in 2009–2012 than NHW households did. The declines in non-HWCF NB foods were consistent over time and not significantly different by race/ethnicity. Meanwhile, PL foods had higher declines in 2009–2012 among NHW and Hispanic households but little change among NHB households compared with 2003–2006.

Among CPG beverages, the decline in calories purchased by NHB households stalled in 2009–2012 relative to 2003–2006 and became significantly less than the continued reductions by NHW households. For each brand, the reductions in calories purchased over time by racial/ethnic groups were generally not statistically different.

In model-adjusted comparison of changes in CPG purchases by income and holding all else constant, packaged food and beverage purchases by high-income households appeared to be the highest throughout 2000–2013. Reductions in CPG food purchases were greater in 2009–2012 than in 2003–2006, but low-income households fell the least, whereas the high-income households had the highest reductions in 2009–2012. This acceleration in 2009–2012 was largely driven by reductions in food calories purchased from HWCF brands for all income groups. Meanwhile, low-income households had the highest absolute calories from PLs in 2000, and the largest decline in PL foods compared with the other income groups over time. Low-income households also had the lowest absolute calories from HWCF foods in 2000 and the lowest decline for HWCF and non-HWCF NB foods in 2009–2012. Also of note is that low-income households had the lowest

TABLE 2

Proportion of weighted-unadjusted calories purchased from brand categories among households with children by race/ethnicity and income for select years¹

Subpopulation	CPG food calories by brand, %			CPG beverage calories by brand, %		
	HWCF	non-HWCF	PL	HWCF	non-HWCF	PL
Non-Hispanic white						
2000	43.8	32.8	23.4	32.2	32.8	35.0
2003	42.0	33.1	24.9	33.3	32.2	34.5
2006	41.3	32.5	26.2‡	31.0	31.2	37.8‡
2009	39.1‡	32.0	28.9‡	28.5‡	32.5	39.0‡
2012	36.6‡	34.8‡	28.6‡	27.0‡	32.8	40.2‡
Hispanic						
2000	41.2	36.8*	22.0	29.3*	36.6*	34.1
2003	39.5	37.0*	23.4	31.7‡	33.2	35.2
2006	39.1	36.0	24.9‡	31.0	32.3‡	36.7‡
2009	37.2‡	36.1*	26.7‡	27.3	33.9	38.8‡
2012	35.2‡	38.5	26.4‡	26.5‡	36.6*	37.0*‡
Non-Hispanic black						
2000	40.7*	34.9	24.4	33.7	34.4	32.0
2003	38.8*	35.0	26.3	34.1	34.0	31.9*
2006	40.1	33.7	26.1	33.4*	35.1*	31.4*
2009	37.9‡	35.1	27.0‡	29.7‡	36.9*‡	33.4*
2012	36.0‡	36.9	27.0‡	30.5*‡	38.1*‡	31.4*
≤185% FPL						
2000	38.8*	32.8	28.3*	30.8	31.5*	37.6*
2003	35.9*	33.6	30.5*‡	31.7	31.6*	36.8*
2006	36.7*	32.3	31.0*‡	31.3	30.5*	38.2*
2009	35.6*‡	32.1	32.3*‡	29.4	30.9*	39.7*‡
2012	34.5*‡	35.2‡	30.3*	29.0*	32.8*	38.1
186–400% FPL						
2000	43.5	33.5	22.9*	32.3	33.2	34.5
2003	41.5	33.8	24.7*	33.6	31.9	34.5
2006	41.3	33.3	25.4*‡	31.6	31.5	37.0*‡
2009	39.3‡	32.9	27.8*‡	27.9‡	32.7*	39.3*‡
2012	36.8‡	35.6‡	27.6*‡	26.2‡	34.4‡	39.4‡
>400% FPL						
2000	47.3	34.6	18.1	32.5	36.3	31.1
2003	45.2	34.7	20.0	33.8	34.6	31.6
2006	44.9‡	34.5	20.6‡	31.3	34.9	33.8‡
2009	41.7‡	35.2	23.1‡	27.9‡	38.5‡	33.5‡
2012	38.1‡	37.5‡	24.4‡	26.0‡	36.4	37.6‡

¹The 2000–2013 Nielsen sample size = 708,175 household-quarter observations representing 2,146,375,933 household-quarters and University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services (21) for food and beverage categories in the 2000–2013 periods for the US market. *Difference in calories purchased compared with non-Hispanic white or >400%-FPL households with children during the same year, $P < 0.01$. ‡Difference in change in calories purchased compared with 2000, $P < 0.01$. CPG, consumer packaged goods; FPL, federal poverty line; HWCF, Healthy Weight Commitment Foundation's 16 companies; NB, name brand; PL, private label.

absolute calories from beverages, with significantly lower reductions in beverage purchases than high-income households had in 2009–2012, although the differences were small in magnitude.

DISCUSSION

Disparities in calories from foods and beverages among households with children are nuanced, source- and brand-specific, and evolving over time. Across 2 large-scale data sources, we consistently found substantial decreases in intake and purchases of beverages from stores among all racial/ethnic and income groups. Moreover, we found that these decreases in calorie intake from store-bought beverages were not offset by increases in nonstore intake between 2003 and 2012, confirming

that stores may be contributing to overall declines in energy intake. In addition, model-adjusted comparisons of changes in CPG purchases by race/ethnicity and income reveal evidence of disparities in calories purchased, because NHW and high-income households had the steepest declines in both food and beverage purchases over time. Our results suggest that potentially beneficial reductions in calories purchased, particularly between 2009 and 2012, were slower for NHB and low-income households than for NHW and high-income households, respectively.

The finding that NHW and high-income households had higher caloric purchases are not consistent with the NHANES findings on intake, but this may be due to food waste (24), which might vary across subpopulations, and it is possible that NHB, Hispanic, and

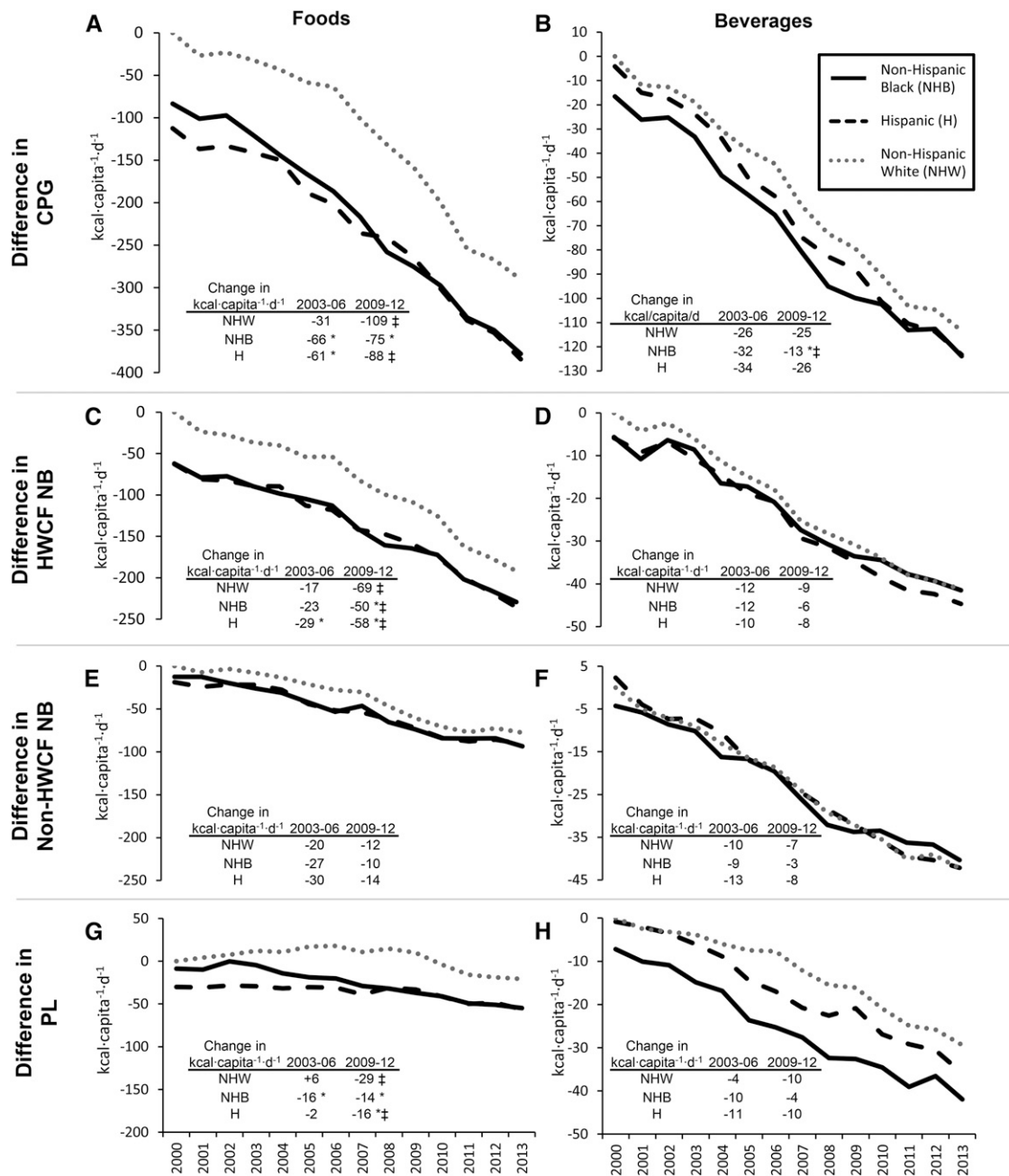


FIGURE 3 Model-adjusted differences in calories purchased from CPG foods (A), CPG beverages (B), HWCF foods (C), HWCF beverages (D), non-HWCF foods (E), non-HWCF beverages (F), PL foods (G), and PL beverages (H) relative to NHW households with children in 2000. Model adjusts for household composition, race/ethnicity, income level, educational attainment of the head of household, household head's employment status, year, market-level unemployment rates, and market-level food prices. Data are from 708,175 household-quarter observations from 64,709 unique households and the University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services (21) for food and beverage categories in the 2000–2013 periods for the US market. *Assuming linearity, difference in change in calories purchased compared with NHW households, $P < 0.01$. ‡Assuming linearity, difference in change in calories purchased compared with 2003–2006, $P < 0.01$. SEs are found in **Supplemental Table 4**. CPG, consumer packaged goods; H, Hispanic; HWCF, Healthy Weight Commitment Foundation's 16 companies; NB, name brand; NHB, non-Hispanic black; NHW, non-Hispanic white; PL, private label.

low-income households waste less food than NHW and higher-income households do. However, there have been no studies on racial/ethnic- or income-specific food wastage to date (25, 26).

Meanwhile, studies on food marketing toward children suggest that the food industry may be marketing certain NB products more heavily toward NHB and lower-income areas (27–30) or marketing nutritionally poor food products toward Spanish-speaking children (31), affecting their food culture (32). This

might encourage brand loyalty and could explain the slower decline among NHB, Hispanic, and lowest-income households over time for HWCF and other NB foods. Concurrently, although CPG manufacturers and retailers purport to be reformulating their products to be “better-for-you” (33), these products tend to be more expensive (34, 35), less marketed toward lower income households, and thus less purchased by these households. It is also unclear if reformulations are necessarily

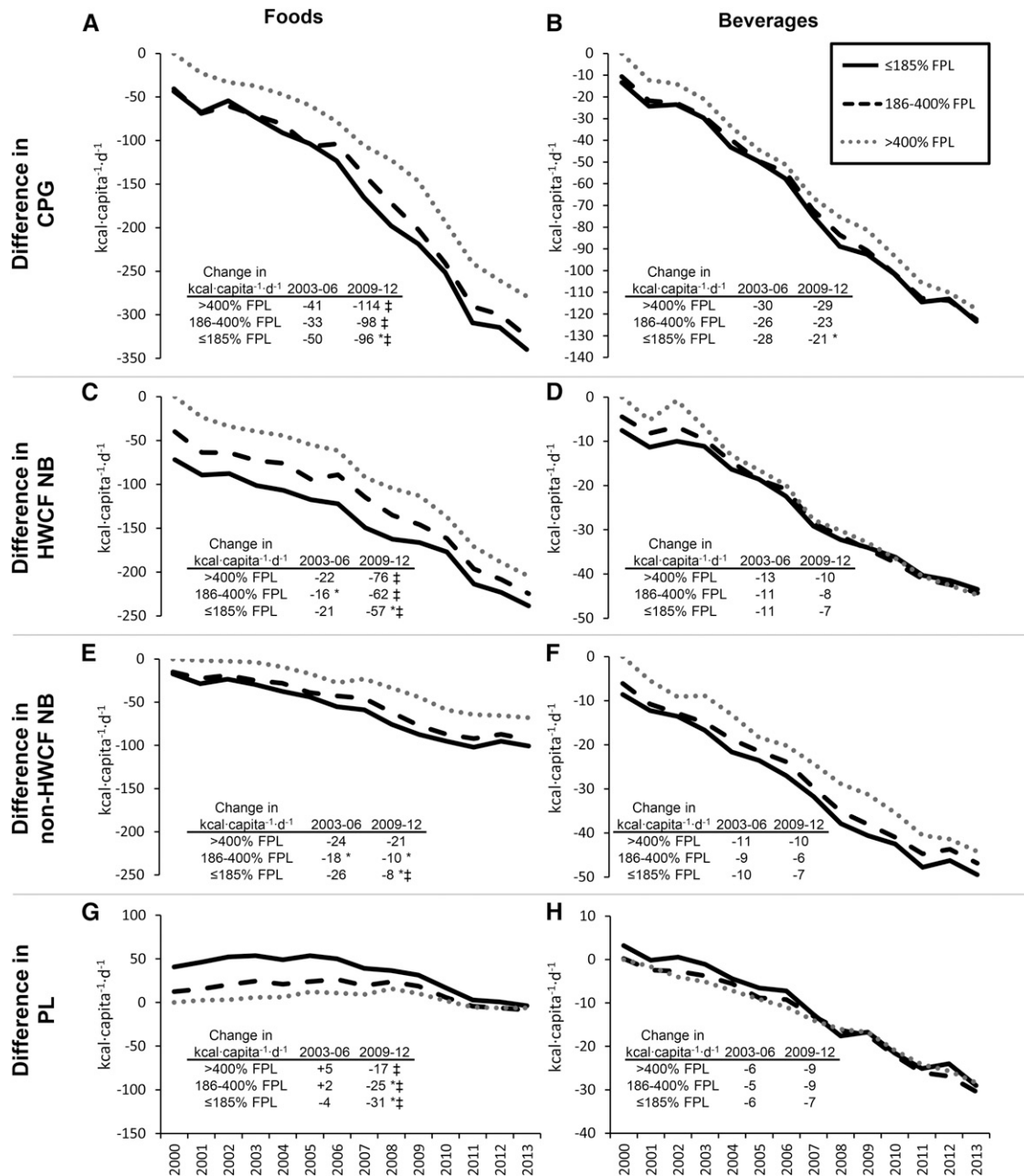


FIGURE 4 Model-adjusted differences in calories purchased from CPG foods (A), CPG beverages (B), HWCF foods (C), HWCF beverages (D), non-HWCF foods (E), non-HWCF beverages (F), PL foods (G), and PL beverages (H) relative to >400%-FPL households with children in 2000. Model adjusts for household composition, race/ethnicity, income level, educational attainment of the head of household, household head's employment status, year, market-level unemployment rates, and market-level food prices. Data are from 708,175 household-quarter observations from 64,709 unique households and the University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services (21) for food and beverage categories in the 2000–2013 periods for the US market. *Assuming linearity, difference in calories purchased compared with >400%-FPL households with children, $P < 0.01$. ‡Assuming linearity, difference in change in calories purchased compared with 2003–2006, $P < 0.01$. SEs are found in Supplemental Table 4. CPG, consumer packaged goods; FPL, federal poverty line; HWCF, Healthy Weight Commitment Foundation's 16 companies; NB, name brand; PL, private label.

occurring in the most important categories of CPG foods. Among grain-based desserts, a major contributor to energy intake for children (36), research has showed no noticeable reformulation between 2005 and 2012 (37). Meanwhile, among sugar-sweetened beverages there is some evidence of growth in the lower-calorie options (38, 39), which is also evident in the caloric reductions from beverages found in this study. However, what is still unknown and requires additional analysis is to what

extent these reductions in beverage calories are due to consumers' behavioral change, reformulations by beverage manufacturers, and/or retailers stocking lower-calorie beverages.

There are multiple pathways that can lead to disparities in food purchases, diet, and health, ranging from broader contextual forces to individual-level behavioral choices (40). Although parents or caregivers are the primary purchasers of foods for households, children's preferences can drive purchasing decisions

and shopping behavior (41, 42). Children's food preferences have been found to be highly susceptible to branding and marketing strategies (43, 44) and are highly associated with dietary preferences and health outcomes later in life (45). Consequently, efforts to limit disparities in diet and health need to begin in childhood.

A main limitation of our analysis of dietary intake is the use of self-reported data, because systematic misreporting of energy intake has been consistently shown and may be associated with race/ethnicity and income (46, 47). Because NHANES does not consistently collect detailed information about brands of products consumed by respondents, it is not possible to determine how changes in purchases for different brand categories across various subpopulations relate to diet and health outcomes. NHANES also does not capture many of the product reformulations ongoing in the CPG sector (48). However, this article shows that store-bought foods and beverages are large contributors of calories consumed. We are in the process of completing linkage of the barcodes for every CPG food and beverage available since 2007 with the USDA data used in NHANES from 2007–2008 through 2011–2012 (48). Among other important research questions, this will allow us to assess the associations between the food industry and retailer pledges and their widely varying reformulations with measured changes in US diets, particularly those of children in lower-income and racial/ethnic populations at greatest risk of childhood obesity.

A second critical issue is that of food waste as mentioned earlier (24), which suggests that reductions in calories consumed may not be as large as found in the reductions in calories sold or purchased (49).

Last, this study focuses on calories because of their direct relation with obesity and does not look at other nutrients of concern, particularly excess consumption of solid fats, added sugars, refined carbohydrates, and sodium (9, 50). Nonetheless, the overall improvements in terms of calories found in this article are in line much of the research that has documented a plateauing of obesity prevalence across most age, racial/ethnic, and socioeconomic subpopulations (51, 52). Future work needs to explore the role of CPGs and brand categories in contributing to the various nutrient intakes and health status of children and vulnerable subpopulations.

As we and others have shown, energy intakes across all racial/ethnic groups have declined over the past 14 y. These declines were greater in nonstore sources for food and greater in store-sources for beverages. For store purchases, NHW and high-income households started with the highest absolute calories purchased in 2000 and had the greatest reduction in CPG calories purchased from 2000 to 2013. There was also a slower decline among NHB, Hispanic, and lowest-income households over time for HWCF and other branded foods than in NHW and high-income households, respectively. Jointly, these results suggest overall improvements but greater improvements in diet for NHW and higher-income households. The health implications of these dietary shifts remain unexplored except for the presumed plateauing of obesity among most age, gender, and racial/ethnic subpopulations.

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