Published in final edited form as:

Am J Prev Med. 2016 February ; 50(2): 180–190. doi:10.1016/j.amepre.2015.07.025.

The nutrient content of US household food purchases by store types

Dalia Stern, BS, **Shu Wen Ng, PhD**, and **Barry M Popkin, PhD**

Department of Nutrition, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC (DS, SWN, BMP). Carolina Population Center, University of North Carolina at Chapel Hill, Chapel Hill, NC (SWN, BMP). Duke-UNC Center for Behavioral Economics and Healthy Food Choice Research (SWN)

Abstract

Introduction—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.

Methods—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.

Results—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.

Corresponding author information: Barry M. Popkin, W. R. Kenan, Jr. Distinguished Professor of Nutrition, Carolina Population Center, University of North Carolina at Chapel Hill, 137 E Franklin St Room 6305, Chapel Hill, NC 27514, Phone: 919-962-6139, Fax: 919-966-9159, popkin@unc.edu.

Authors' contributions: DS and BMP participated in the project conception and development of the research plan; DS conducted statistical analysis; DS drafted the manuscript; SWN and BMP provided critical intellectual input on methods and analyses and feedback on manuscript development; and DS, SWN, BMP had primary responsibility for final content.

Preliminary findings were presented at The Obesity Society 2014 Annual Meeting.

None of the authors have conflict of interests of any type with respect to this manuscript.

Conflict of interest statement: Funding for this study comes from the Robert Wood Johnson Foundation (Grants 67506, 68793, 70017, 71837), NIH (R01DK098072) and the CPC (5 R24 HD050924). DS is supported by the Mexican Council "Consejo Nacional para la Ciencia y Tecnologia" (CONACyT) scholarship 309902. Study sponsors had no role in study design; collection, analysis, and interpretation of data; writing the report; and the decision to submit the report for publication. None of the authors have conflict of interests of any type with respect to this manuscript.

Conclusions—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 [1–4] 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. [5] 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. [6] 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. [7–10] Studies on where people shop for food rely on the presence of stores located within people's residential food environment [11, 12] or the location of people's principal food store source.[13, 14] 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.[15] Additionally, these studies fail to capture all the possible stores where people may shop. The few food purchase studies use small samples [16–18] and have focused on specific food groups, ignoring the entire set of purchases made at the store. [19, 20] Moreover, studies have collected data on a limited number of days of purchases, [21] failing to capture usual shopping habits.

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. [22] 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. [23] 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. [24] 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. [25, 26] 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 (Appendix 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 analysis

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.[27]

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 Appendix 2, and sample characteristics by store-type are shown in Appendix 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 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 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 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 Appendix 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%) (Appendix 5.)

DISCUSSION

There has been a rapid transformation of the food retail sector. [28] 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. [29] 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, [30, 31] 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. [32] 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. [33] 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. [34–36] 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. [37]

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 [38–41] along with individual food preferences, [5] transportation, and time. [42, 43] 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. [44] 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. [45] Moreover, elsewhere we showed that trends in Homescan purchase data mirror trends in NHANES food intake from stores. [46]

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.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

We thank Dr. Donna Miles and Dr. Kuo-Ping Li for exception assistance with the data management, Ms. Frances L. Dancy for administrative assistance, Mr. Tom Swasey for graphics support, and Dr. David K. Guilkey, Dr. Penny Gordon-Larsen and Stephanie Mazzucca for their contributions to reviewing and improving this work. We also wish to thank the Robert Wood Johnson Foundation (Grants 67506, 68793, 70017, 71837) and the National Institutes of Health (R01DK098072 and CPC 5 R24 HD050924) for financial support. DS is supported by the Mexican Council “Consejo Nacional para la Ciencia y Tecnologia” (CONACyT) scholarship 309902. Study sponsors had no role in study design; collection, analysis, and interpretation of data; writing the report; and the decision to submit the report for publication.

References

1. Executive Office of the President of the United States. [Accessed September 29, 2014] White House Task Force on Childhood Obesity. Solving the problem of childhood obesity in a generation: report to the president. http://www.letsmove.gov/sites/letsmove.gov/files/TaskForce_on_Childhood_Obesity_May2010_FullReport.pdf. Published 2010
2. The White House. Office of the First Lady. [Accessed Septhember 29, 2014] First Lady Michelle Obama Announces Nationwide Commitments to Provide Millions of People Access to Healthy, Affordable Food in Underserved Communities. http://www.whitehouse.gov/the-press-office/2011/07/20/first-lady-michelle-obama-announces-nationwide-commitments-provide-milli. Published 2011
3. Food Policy Task Force by the New York City Departments of Health and City Planning and the New York City Economic Development Corporation. [Accessed September 29, 2014] Food Retail

Expansion to Support Health (FRESH) program. http://www.nyc.gov/html/misc/pdf/going_to_market.pdf. Published 2013

4. The Healthy Food Financing Initiative (HFFI). [Accessed September 29, 2014] An Innovative Public-Private Partnership Sparking Economic Development and Improving Health. http://www.healthyfoodaccess.org/sites/default/files/updated-hffi-fact-sheet.pdf. Published 2014
5. Walker RE, Keane CR, Burke JG. Disparities and access to healthy food in the United States: A review of food deserts literature. Health Place. 2010; 16(5):876–884. [PubMed: 20462784]
6. Zenk SN, Schulz AJ, Hollis-Neely T, et al. Fruit and vegetable intake in African Americans income and store characteristics. Am J Prev Med. 2005; 29(1):1–9. [PubMed: 15958245]
7. Morland K, Wing S, Diez Roux A, Poole C. Neighborhood characteristics associated with the location of food stores and food service places. Am J Prev Med. 2002; 22(1):23–29. [PubMed: 11777675]
8. Powell LM, Slater S, Mirtcheva D, Bao Y, Chaloupka FJ. Food store availability and neighborhood characteristics in the United States. Prev Med. 2007; 44(3):189–195. [PubMed: 16997358]
9. Morland K, Diez Roux AV, Wing S. Supermarkets, other food stores, and obesity: the atherosclerosis risk in communities study. Am J Prev Med. 2006; 30(4):333–339. [PubMed: 16530621]
10. Elbel B, Moran A, Dixon LB, et al. Assessment of a government-subsidized supermarket in a high-need area on household food availability and children's dietary intakes. Public Health Nutr. 2015:1–10.
11. Morland K, Wing S, Diez Roux A. The contextual effect of the local food environment on residents' diets: the atherosclerosis risk in communities study. Am J Public Health. 2002; 92(11): 1761–1767. [PubMed: 12406805]
12. Moore LV, Diez Roux AV. Associations of neighborhood characteristics with the location and type of food stores. Am J Public Health. 2006; 96(2):325–331. [PubMed: 16380567]
13. Drewnowski A, Aggarwal A, Hurvitz PM, Monsivais P, Moudon AV. Obesity and supermarket access: proximity or price? Am J Public Health. 2012; 102(8):e74–e80. [PubMed: 22698052]
14. Jiao J, Moudon AV, Ulmer J, Hurvitz PM, Drewnowski A. How to identify food deserts: measuring physical and economic access to supermarkets in King County, Washington. Am J Public Health. 2012; 102(10):e32–e39. [PubMed: 22897554]
15. Franco M, Diez-Roux AV, Nettleton JA, et al. Availability of healthy foods and dietary patterns: the Multi-Ethnic Study of Atherosclerosis. Am J Clin Nutr. 2009; 89(3):897–904. [PubMed: 19144728]
16. Yoo S, Baranowski T, Missaghian M, et al. Food-purchasing patterns for home: a grocery store-intercept survey. Public Health Nutr. 2006; 9(3):384–393. [PubMed: 16684391]
17. Cullen K, Baranowski T, Watson K, et al. Food category purchases vary by household education and race/ethnicity: results from grocery receipts. J Am Diet Assoc. 2007; 107(10):1747–1752. [PubMed: 17904935]
18. French SA, Wall M, Mitchell NR. Household income differences in food sources and food items purchased. Int J Behav Nutr Phys Act. 2010; 7:77. [PubMed: 20977738]
19. Rose D, Richards R. Food store access and household fruit and vegetable use among participants in the US Food Stamp Program. Public Health Nutr. 2004; 7(08):1081–1088. [PubMed: 15548347]
20. Turrell G, Blakely T, Patterson C, Oldenburg B. A multilevel analysis of socioeconomic (small area) differences in household food purchasing behaviour. J Epidemiol Community Health. 2004; 58(3):208–215. [PubMed: 14966233]
21. Gustafson A, Christian JW, Lewis S, Moore K, Jilcott S. Food venue choice, consumer food environment, but not food venue availability within daily travel patterns are associated with dietary intake among adults, Lexington Kentucky 2011. Nutr J. 2013; 12:17. [PubMed: 23360547]
22. Slining MM, Ng SW, Popkin BM. Food companies' calorie-reduction pledges to improve U.S. diet. Am J Prev Med. 2013; 44(2):174–184. [PubMed: 23332336]
23. The Nielsen Co. [Accessed September 29th 2014] Nielsen Consumer Panel and Retail Measurement. http://www.nielsen.com/content/corporate/us/en/solutions/measurement/retail-measurement.html. Published

24. Poti JM, Mendez MA, Ng SW, Popkin BM. Is the degree of food processing and convenience linked with the nutritional quality of foods purchased by US households? Am J Clin Nutr. 2015
25. Ng SW, Popkin BM. Monitoring foods and nutrients sold and consumed in the United States: dynamics and challenges. J Acad Nutr Diet. 2012; 112(1):41–45. e44. [PubMed: 22389873]
26. Ng SW, Slining MM, Popkin BM. Use of caloric and noncaloric sweeteners in US consumer packaged foods, 2005–2009. J Acad Nutr Diet. 2012; 112(11):1828–1834. e1821–1826. [PubMed: 23102182]
27. Angeles G, Guilkey DK, Mroz TA. The Impact of Community-Level Variables on Individual-Level Outcomes Theoretical Results and Applications. Sociol Methods Res. 2005; 34(1):76–121.
28. White M. Food access and obesity. Obes Rev. 2007; 8 (Suppl 1):99–107. [PubMed: 17316311]
29. Euromonitor International. Trends in US grocery retailing. 2014.
30. Vernarelli JA, Mitchell DC, Rolls BJ, Hartman TJ. Dietary energy density is associated with obesity and other biomarkers of chronic disease in US adults. Eur J Nutr. 2015; 54(1):59–65. [PubMed: 24664188]
31. Mendoza JA, Drewnowski A, Christakis DA. Dietary energy density is associated with obesity and the metabolic syndrome in U.S. adults. Diabetes Care. 2007; 30(4):974–979. [PubMed: 17229942]
32. Buzby JC, Hyman J. Total and per capita value of food loss in the United States. Food Policy. 2012; 37(5):561–570.
33. Institute of Medicine and National Research Council. The public health effects of food deserts: workshop summary. Washington, DC: 2009.
34. Bleich SN, Wolfson JA. Trends in SSBs and snack consumption among children by age, body weight, and race/ethnicity. Obesity (Silver Spring). 2015; 23(5):1039–1046. [PubMed: 25919923]
35. O'Neil CE, Nicklas TA, Keast DR, Fulgoni VL. Ethnic disparities among food sources of energy and nutrients of public health concern and nutrients to limit in adults in the United States: NHANES 2003–2006. Food Nutr Res. 2014; 58:15784. [PubMed: 25413643]
36. O'Neil CE, Keast DR, Fulgoni VL, Nicklas TA. Food sources of energy and nutrients among adults in the US: NHANES 2003–2006. Nutrients. 2012; 4(12):2097–2120. [PubMed: 23363999]
37. Ghosh-Dastidar B, Cohen D, Hunter G, et al. Distance to store, food prices, and obesity in urban food deserts. Am J Prev Med. 2014; 47(5):587–595. [PubMed: 25217097]
38. Cheadle A, Psaty BM, Curry S, et al. Community-level comparisons between the grocery store environment and individual dietary practices. Prev Med. 1991; 20(2):250–261. [PubMed: 2057471]
39. Andreyeva T, Long MW, Brownell KD. The impact of food prices on consumption: a systematic review of research on the price elasticity of demand for food. Am J Public Health. 2010; 100(2): 216–222. [PubMed: 20019319]
40. Childs NM. In-Store Marketing to Children: US Food Retailer Practices Abating Childhood Obesity. Portuguese Journal of Marketing. 2012; 27:78.
41. Nestle M. Food marketing and childhood obesity—a matter of policy. N Engl J Med. 2006; 354(24):2527–2529. [PubMed: 16775233]
42. Hirsch JA, Hillier A. Exploring the role of the food environment on food shopping patterns in Philadelphia, PA, USA: a semiquantitative comparison of two matched neighborhood groups. Int J Environ Res Public Health. 2013; 10(1):295–313. [PubMed: 23343984]
43. Krukowski RA, Sparks C, DiCarlo M, McSweeney J, West DS. There's more to food store choice than proximity: a questionnaire development study. BMC Public Health. 2013; 13:586. [PubMed: 23773428]
44. Lusk JL, Brooks K. Who Participates in Household Scanning Panels? Am J Agric Econ. 2011; 93(1):226–240.
45. Zhen C, Taylor JL, Muth MK, Leibtag E. Understanding Differences in Self-Reported Expenditures between Household Scanner Data and Diary Survey Data: A Comparison of Homescan and Consumer Expenditure Survey. Review of Agricultural Economics. 2009; 31(3): 470–492.

46. Ng SW, Slining MM, Popkin BM. Turning point for US diets? Recessionary effects or behavioral shifts in foods purchased and consumed. Am J Clin Nutr. 2014; 99(3):609–616. [PubMed: 24429538]

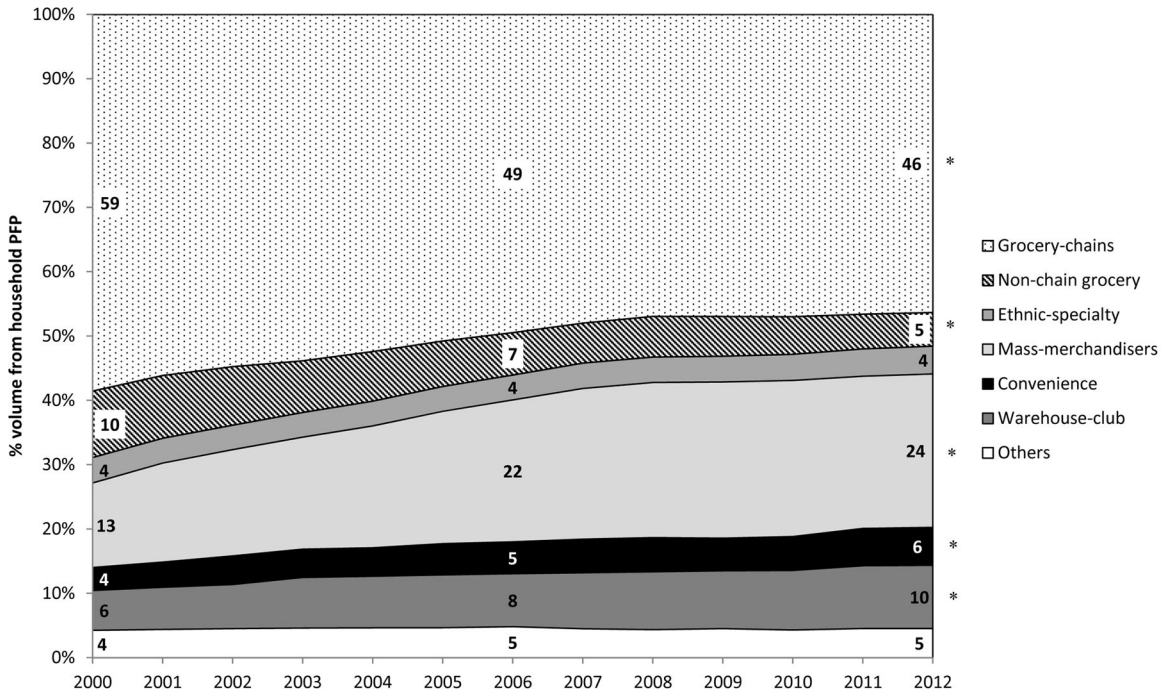

Figure 1. Trends in the proportion of annual volume from household PFP by store-type, Homescan 2000–2012

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. *University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for* the *2000–2012 periods, for* the *U.S. market. Copyright © 2014, The Nielsen Company*.

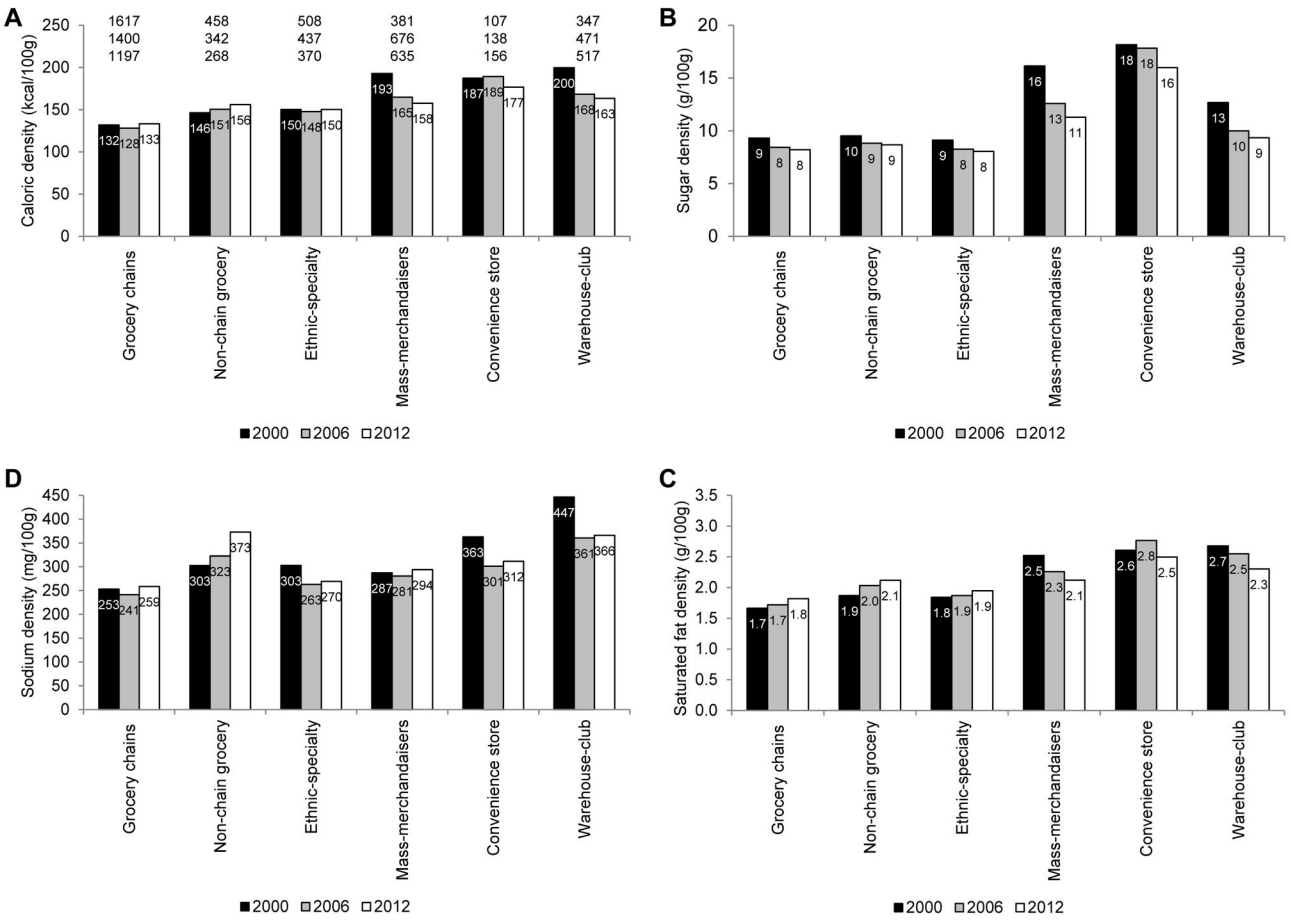

Figure 2. Caloric, total sugar, sodium and saturated fat densities from household PFP by store-type, Homescan 2000, 2006, and 2012

(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. *University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for* the *2000–2012 periods, for* the *U.S. market. Copyright © 2014, The Nielsen Company.*

Table 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-store (n=28,604)			Warehouse-club (n=17,014)		
		Food group	**% kcal**	**mean (s.e.)**	**Food group**	**% kcal**	**mean (s.e.)**	**Food group**	**% kcal**	**mean (s.e.)**	**Food group**	**% kcal**	**mean (s.e.)**	**Food group**	**% kcal**	**mean (s.e.)**	**Food group**	**% kcal**	**mean (s.e.)**
	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)
Top packaged foods	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)
	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)
Top packaged beverages	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-store (n=50,462)			Warehouse-club (n=29,956)		
		Food group	**% kcal**	**mean (s.e.)**	**Food group**	**% kcal**	**mean (s.e.)**	**Food group**	**% kcal**	**mean (s.e.)**	**Food group**	**% kcal**	**mean (s.e.)**	**Food group**	**% kcal**	**mean (s.e.)**	**Food group**	**% kcal**	**mean (s.e.)**
	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)
Top packaged foods	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)
	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)
Top packaged beverages	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)

		<---2006--->															
		Grocery chains (n=57,712)			Non-chain grocery (n=29,477)			Ethnic-specialty (n=13,385)			Mass-merchandisers (n=54,476)			Convenience-store (n=50,462)			Warehouse-club (n=29,956)		
		Food group	% kcal	mean (s.e.)	Food group	% kcal	mean (s.e.)	Food group	% kcal	mean (s.e.)	Food group	% kcal	mean (s.e.)	Food group	% kcal	mean (s.e.)	Food group	% kcal	mean (s.e.)
		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--->																	
		Grocery chains (n=55,880)			Non-chain grocery (n=26,417)			Ethnic-specialty (n=15,449)			Mass-merchandisers (n=53,482)			Convenience store (n=47,703)			Warehouse-club (n=30,257)		
		Food group	% kcal	mean (s.e.)	Food group	% kcal	mean (s.e.)	Food group	% kcal	mean (s.e.)	Food group	% kcal	mean (s.e.)	Food group	% kcal	mean (s.e.)	Food 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)
Top packaged foods	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)
	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)
Top packaged beverages	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 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, we could not statistically compare across store-types due to different samples for each store-type.

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).