American Journal of
Preventive Medicine

RESEARCH ARTICLE

Trends in Store-Level Sales of Sugary Beverages and Water in the U.S., 2006–2015

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Introduction: Previous research on sugar-sweetened beverage trends has focused on self-reported consumption from surveys. Few studies used objective store sales or explored differences by area-level demographics and store type.

Methods: The average volume of beverages sold per store per 3-digit zoning improvement plan code from 2006 to 2015 was calculated using national Nielsen Retail Scanner point-of-sale data from 24,240 stores. A multilevel regression model analyzed annual trends, with random intercepts for state and separate models for beverage type (regular soda, no/low-calorie soda, other sugary drinks, 100% fruit juice, bottled water). Differences by store type (convenience, supermarkets, drug stores, mass merchandisers) and area-level demographics (categorized as tertiles) were examined. Data were analyzed in 2019.

Results: The model-based estimates indicated that sales of regular soda (−11.8%), no/low-calorie soda (−19.8%), and 100% fruit juice (−31.9%) decreased over time, whereas sales of bottled water (+34.4%) increased and sales of other sugary drinks remained stable (+2.4%). Decreases in sugar-sweetened beverage sales were largely concentrated in supermarkets and larger in areas with high income and education levels and a high percentage of black and Hispanic people. There were also relatively larger increases in bottled water sales in states located in the South and Midwest.

Conclusions: The finding that sales of sugar-sweetened beverages decreased over time, whereas sales of bottled water increased is encouraging because sugar-sweetened beverage consumption is linked to obesity and other chronic conditions. This study provides a novel, rigorous assessment of U.S. beverage sales trends and differences by community and store characteristics.

Am J Prev Med 2020;59(4):522–529. *© 2020 American Journal of Preventive Medicine. Published by Elsevier Inc. All rights reserved.*

INTRODUCTION

Excess consumption of sugar-sweetened beverages (SSBs) and potentially 100% fruit juice[1] is a major risk factor for weight gain and obesity.[2,3] Research also suggests that the substitution of SSBs with low-calorie beverages is linked to lower energy intake and lower weight gain.[4] Therefore, reducing SSB consumption and increasing consumption of water have been targets of several policy efforts and public health campaigns in the past decade.[5–9] To support ongoing and future efforts designed to curb SSB consumption and increase water intake, it is important to track changes in objective sales of SSBs and low-calorie beverages across the U.S.

Though recent work suggests that self-reported consumption of all beverages declined significantly from 2003 to 2014, the percentage of children and adults

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0749-3797/$36.00
https://doi.org/10.1016/j.amepre.2020.04.022

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consuming SSBs on a given day remains high.[10] Previous studies also show that low-income, black, and Hispanic consumers and people with less than a high school education are more likely to consume SSBs[11,12] and that these groups have a disproportionally high prevalence of obesity and other chronic diseases.[13,14] Previous studies also indicate that SSB sales patterns differ by retail location. Data from the National Health and Nutrition Examination Survey show that grocery stores and supermarkets were the largest sources of self-reported SSB purchases among U.S. adults in 2011–2012 (~52%) compared with convenience stores (~11%).[15] To identify where to focus future policy efforts, it is critical to surveil SSB sales by community and store characteristics.

The majority of the current research on beverage trends in the U.S. has focused on self-reported individual consumption levels instead of objective store sales, which are vulnerable to response bias and challenging to measure.[16–23] Objective store sales data can be used to complement self-reported intake data by providing precise estimates of change for far less cost to researchers than measuring dietary intake. Few studies have used objective data, and those that did, predate recent SSB policy and intervention activity[24–26] or lack sales data broken down by beverage type.[27] Furthermore, to the authors' knowledge, no studies have examined the differences in SSB sales by community characteristics or food store type. To fill this gap, national trends in beverage sales are analyzed using weekly objective sales data from major chain retailers at the Universal Product Code (UPC) level from 2006 to 2015. Differences in trends by area-level income, education, and race/ethnicity, Census region, and food store type are also examined.

METHODS

Study Sample

Nielsen Retail Scanner data from the James M. Kilts Center for Marketing in the Booth School of Business at the University of Chicago, Illinois, were used to quantify national trends in beverage sales.[28] The Nielsen Retail Scanner data capture weekly price, dollar sales, and units sold per individual product at the UPC level in the participating food stores. These data were collected from >30,000 chain food stores with estimated total annual sales >$2 million. On the basis of the North American Industry Classification System (NAICS), participating food stores included grocery stores (NAICS 4,451, 4,452); gasoline stations (NAICS 4,471); pharmacies and drug stores (NAICS 4,461); department stores and other general merchandise stores (NAICS 4,521, 4,529); and beer, wine, and liquor stores (NAICS 4,453).[29] According to Nielsen, the data represented approximately 53% of grocery store and supermarket, 55% of drug store, 32% of mass merchandiser, 2% of convenience store, and 1% of liquor store total annual sales volume at the end of 2011. All stores in a retail chain are included in the data, although a small number may be excluded because a retailer may consider a subset confidential.

The data were delivered as point-of-sale transactions per week per store at the 3-digit zoning improvement plan (ZIP) code level and were not linked to individuals. The stores in the Nielsen Retail Scanner data set were followed for as long as they remained Nielsen clients, and stores may have changed ownership over time. Store-level data for each week between 2006 and 2015 were obtained, including 42,079 unique store locations. To characterize trends in beverage sales, only data from stores that sold beverages in each year from 2006 to 2015 were used (n=24,260) and liquor stores were excluded (n=20). Thus, the analytic sample represents 24,240 unique stores per year from 869 unique 3-digit ZIP codes. The latter represents 98.2% of all the 3-digit ZIP codes in the U.S. and approximately 99.5% of the total U.S. population.

Measures

A total of 5 beverage categories were analyzed: regular soda, no/low-calorie soda, other sugary drinks, 100% fruit juice, and bottled water. To create these categories, this study used the brand descriptions provided by Nielsen, which assigns UPCs to predefined product groups on the basis of UPC and brand descriptions. The category of regular soda included carbonated soft drinks with added sugars or flavoring and that companies marketed as regular soda. No/low-calorie soda included carbonated soft drinks with artificial sweeteners and marketed as diet soda. Other sugary drinks included fruit drinks and sports and energy drinks with added sugars or artificial sweeteners (or both), and the category of 100% fruit juice included fruit juice products with no added sugars or artificial sweeteners. The bottled water category was made up of products advertised as water, sparkling water, and flavored water, including products with added sugars or other sweeteners. On the basis of a manual search for UPCs, the presence of non-water and caloric beverages in the bottled water category was minimal, and the presence of beverages with added sugars in the 100% fruit juice category was negligible (details are provided in Appendix File 1, available online).

To characterize area-level demographics, county-level data from the American Community Survey were used, including median household income; the percentage of the population with a high school degree; the percentage of the population that is black, non-Hispanic; the percentage of the population that is Hispanic; and the percentage of the population that is white, non-Hispanic. To minimize missing data, 5-year estimates from 2005 to 2009 were used as proxies for baseline values. Using the Tabulate Intersect tool in ArcMap, version 10.6.1, the percentage of each county within a given 3-digit ZIP code was calculated, and these percentages were applied to proportionally weight estimates.

The primary outcome was the total volume (fluid ounces) of each beverage type sold per year averaged over all stores in a given 3-digit ZIP code. When beverages were sold in packs, the total volume was calculated by multiplying the number of units sold by the numeric quantity of the beverage in individual packs (e.g., 12-ounce can) and by how many of those beverages appear in a given pack (e.g., 6-pack of cans). The data were then aggregated by year and by 3-digit ZIP code and then divided by the number of stores per 3-digit ZIP code. Thus, the outcome represents the per-store average volume of beverages sold per year per 3-digit ZIP code, which accounts for the different number of stores in each 3-digit

ZIP code. The outcome was also calculated by area-level demographics, categorized as tertiles (i.e., areas with low, medium, and high values) and Census region (Midwest, Northeast, South, and West). In addition, the data were aggregated by food store type and then divided by the number of stores of the same type per 3-digit ZIP code.

Statistical Analysis

To characterize trends in beverage sales, a multilevel regression model was used, with year modeled continuously and random intercepts for state (i.e., hierarchical model with 2 levels, including 3-digit ZIP code and state). To account for the varying number of stores per 3-digit ZIP code, the authors weighted the primary outcome by the inverse of its variance. Separate models were run for each beverage type. To test for the differences in beverage sales by tertiles of area-level demographics and Census region, an interaction term for year and the covariate of interest were added. In stratified models, the differences in sales by food store type were also examined. To descriptively characterize changes within Census regions, the change in sales between 2006 and 2015 by state was calculated (but not examined in regression models). In a supplementary analysis, trends in national sales of milk were also examined. Stata, version 15, was used for all analyses[30] with the margins postestimation command to obtain estimated marginal means at each year and by tertiles of area-level demographics, Census region, and food store type (Appendix Tables 1–8, available online). All data were analyzed in 2019.

RESULTS

The model-based estimates indicated that sales by volume of regular soda (7.6 million fluid ounces) and bottled water (7.8 million fluid ounces) were approximately equal in 2006 across the U.S., whereas sales of bottled water (10.4 million fluid ounces) were larger in 2015 than those of other beverage types (Figure 1). Between 2006 and 2015, regular soda decreased by 11.8% ($p<0.001$), low-calorie soda decreased by 19.8% ($p<0.001$), and 100% fruit juice decreased by 31.9% ($p<0.001$), whereas sales of bottled water increased by 34.4% ($p<0.001$) and other sugary drinks remained stable (+2.4%, $p=0.55$). Sales by volume of milk also remained stable over time (2.9%, $p=0.77$) (Appendix Table 9, available online).

Sales by volume of all beverage types in 2006 were larger in high-income than in low-income areas (Appendix Figure 1, available online). Higher-income areas had greater declines in sales of regular soda (−21.1%) than lower-income areas (−9.5%, $p=0.01$). This was also true for other sugary drinks (−11.3% vs +9.7%, $p<0.001$) and 100% fruit juice (−35.7% vs −29.6%, $p<0.001$) but not for no/low-calorie soda sales (−22.8% vs −22.3%, $p=0.10$). By contrast, the increase in bottled water sales was larger in low-income areas (43.1% vs 18.2%), but the difference was not significant ($p=0.42$). Trends in sales in areas with a higher (vs lower) education level were similar to trends in higher- (vs lower-) income areas (Appendix Figure 2, available online).

Decreases in sales by volume of other sugary drinks (−10.6% vs +17.3%, $p<0.001$) and 100% fruit juice (−37.5% vs −20.7%, $p<0.001$) were significantly larger in areas with a higher percentage of black population than in those with a lower percentage (Appendix Figure 3, available online). The differences in changes in sales of regular soda (−18.6% vs −5.0%, $p=0.09$), no/low-calorie soda (−26.9% vs −15.8%, $p=0.15$), and bottled water (+23.2% vs +66.0%, $p=0.49$) by percentage of black population were large but not statistically significant. Similar patterns were observed for no/low-calorie soda (−25.5% vs −14.7%, $p=0.49$), other sugary drinks (−10.6% vs +20.5%, $p=0.002$), and 100% fruit juice (−35.1% vs −23.7%, $p=0.001$) in areas with a higher (vs lower) percentage of Hispanic population. However, these areas had statistically significantly larger decreases in sales of regular soda (−17.5% vs −1.9%, $p=0.01$) and smaller increases in sales of bottled water (22.5% vs 100.6%, $p=0.01$) (Appendix Figure 4, available online). Conversely, changes in sales of other sugary drinks (+9.6% vs −10.7%, $p<0.001$) and 100% fruit juice (−25.7% vs −36.6%, $p<0.001$) were smaller in areas with a higher percentage of white population than in those with a lower percentage (Appendix Figure 5, available online). Sales of regular soda (−12.1% vs −16.3%, $p=0.33$) and no/low-calorie soda (−17.1% vs −27.4%, $p=0.17$) did not statistically differ by percentage white population, but the increase in sales of bottled water was larger (+25.4% vs +22.0%, $p=0.001$) in areas with a higher percentage of white population than in those with a lower percentage.

Decreases in sales by volume of regular soda were significantly larger in the Northeast (−31.4%) than in the South (−10.4%, $p<0.001$) and Midwest (−1.9%, $p=0.01$) but not in the West (−16.5%, $p=0.55$) (Appendix Figure 6, available online). Similar findings for other sugary drinks and 100% fruit juice were observed. The decline in sales of no/low-calorie soda was lower in the Midwest (−12.6%) than in the Northeast (−32.7%, $p=0.001$) but not in the South (−20.6%, $p=0.90$) or the West (−27.2%, $p=0.08$). No significant differences in the increase in sales of bottled water by region were observed; however, the increase in sales was larger in several states located in the Midwest and South than in those located in the Northeast and West (Appendix Table 10, available online).

In the analytic sample, sales in grocery stores and supermarkets accounted for 81.8% of total sales by volume of beverages, followed by mass merchandisers (9.6%), drug stores (5.9%), and convenience stores (2.7%). Sales of regular soda decreased in all store types,

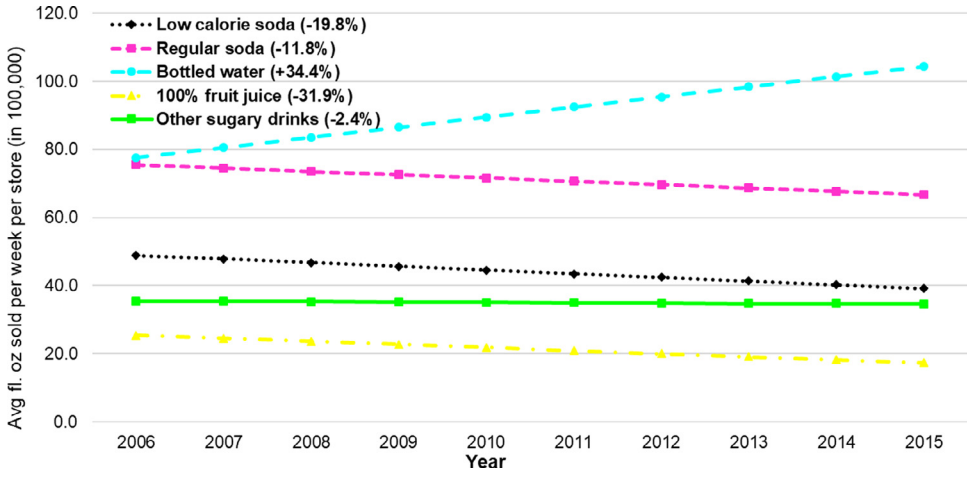

Figure 1. Trends in sales by volume of beverages and low-calorie beverages in the U.S., 2006–2015.
Note: The analytic sample represents 24,240 unique store locations per year from 869 unique 3-digit ZIP codes, including chain food stores with estimated total annual sales greater than $2 million. The category of regular soda included carbonated soft drinks with added sugars or flavoring marketed as soda; low-calorie soda included carbonated soft drinks with artificial sweeteners and marketed as diet soda; bottled water included products advertised as water, sparkling water, and flavored water; and other sugary drinks included 100% fruit juice, fruit juice with added natural or artificial sweeteners, sports drinks, and energy drinks (and excluded products marketed as water, sparkling water, and flavored water). Sales were calculated as the total volume (fluid ounces) of each beverage type sold per year, averaged over all stores in a given 3-digit ZIP code.
Avg, average; fl., fluid; oz, ounce; ZIP, zoning improvement plan.

with the largest declines in convenience stores (−23.6%) and grocery stores/supermarkets (−12.1%) (Figure 2). The decrease in sales of no/low-calorie soda was similar in all store types. Sales of other sugary drinks decreased slightly in grocery stores and supermarkets (−3.6%); however, sales increased in convenience stores (50.5%), drug stores (9.0%), and mass merchandisers (5.3%). Sales of 100% fruit juice decreased in all food store types, though the decline was negligible in mass merchandisers (−0.7%). The sales of bottled water nearly doubled in drug stores (90.0%) yet decreased in convenience stores (−15.7%).

DISCUSSION

Using weekly, store-level sales data from 24,240 retailers, this study examined trends in the average total volume of SSBs and low-calorie beverages sold in the U.S. from 2006 to 2015. The sales of regular soda, no/low-calorie soda, and 100% fruit juice decreased over time, whereas the sales of bottled water increased and other sugary drinks remained stable. These results corroborate recent studies showing a decline in self-reported consumption of SSBs and 100% fruit juice and a concomitant increase in water-based alternatives in the past decade,[10,27] potentially due in part to public health efforts targeting SSB consumption.[5–9] Trend differences by area-level demographics, region, and food store type were also observed, indicating that the sales of SSBs and low-calorie beverages did not change equally across the U.S.

Similar to survey data,[10] the results indicated that absolute sales of SSBs were higher in areas with a higher percentage of black and Hispanic people and that the decreases in SSBs sales were notably larger in counties with relatively higher income and education levels. Yet, decreases in SSB sales were relatively larger in areas with a higher percentage of black and Hispanic people. Taken together, these findings suggest that the shift toward healthier beverage purchases is greater in stores located in high-SES areas but also in areas with a high percentage of racial/ethnic minorities. The latter was unexpected, given how black and Hispanic individuals disproportionately inhabit high-poverty neighborhoods[31] and how previous work shows smaller declines in self-reported SSB consumption among low-income consumers and minorities.[10,32] These results may reflect true relationships, but because only area-level data were used, they may be due to the ecologic fallacy, wherein purchases in the stores located in areas with a high percentage of racial/ethnic minorities may not reflect purchases by black and Hispanic individuals. Previous research indicates that neighborhoods with a high percentage of black people have the fewest supermarkets,[33] and the data in this study reflect only a small percentage of sales from other store types. Therefore, the data may not adequately represent the individual shopping behaviors of black and Hispanic consumers.

The results extend previous research by showing that the absolute decline in SSB sales was largely concentrated in supermarkets, which was not surprising, given

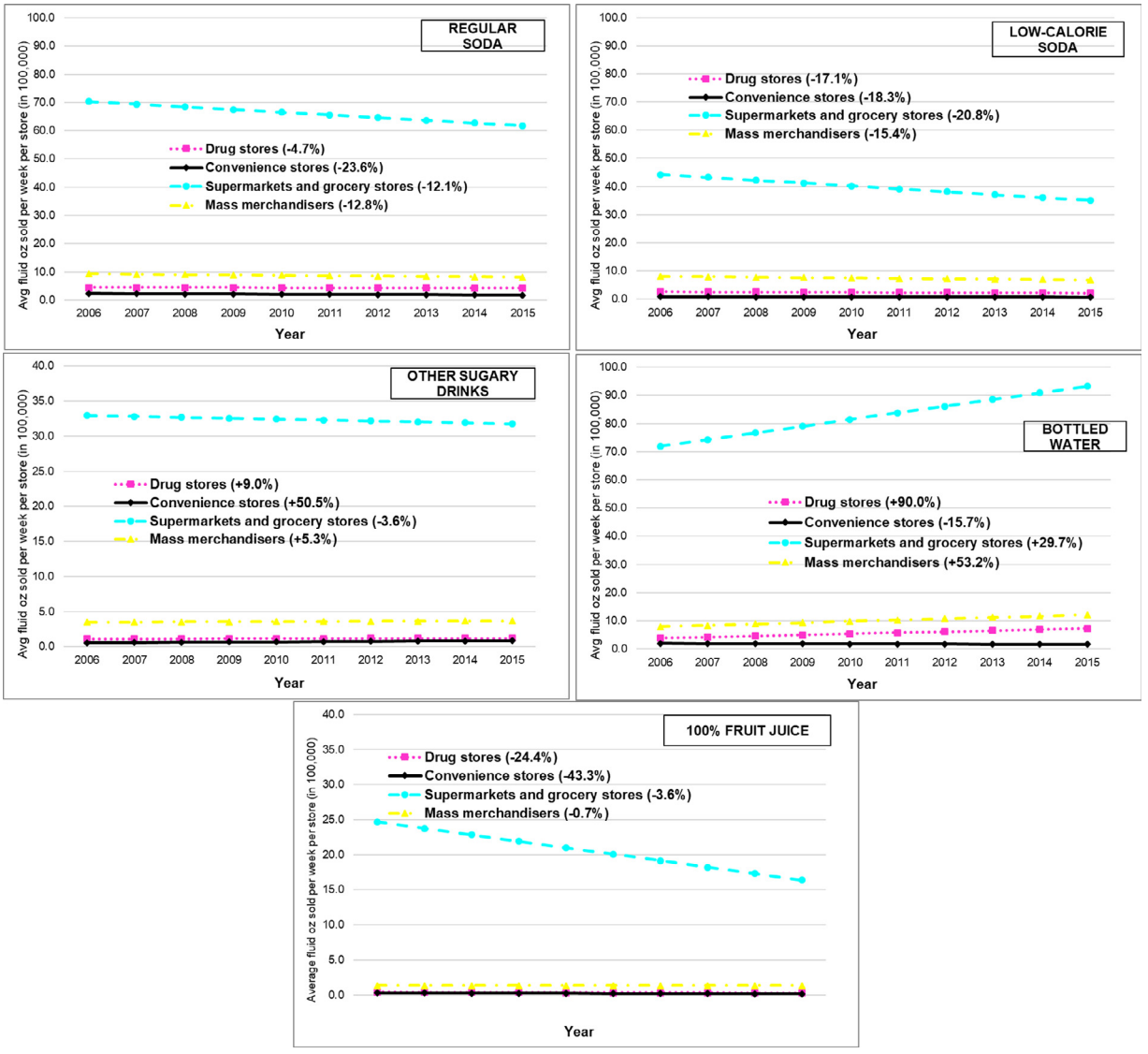

Figure 2. Trends in sales by volume by store type, 2006–2015.

Note: To facilitate interpretation of trends, the scale of the y axes differs by beverage type. The analytic sample represents 24,240 unique store locations per year from 869 unique 3-digit ZIP codes, including chain food stores with estimated total annual sales greater than $2 million. The store types include drug stores, convenience stores, food stores (e.g., grocery stores and supermarkets), and mass merchandisers. The category of regular soda included carbonated soft drinks with added sugars or flavoring marketed as soda; low-calorie soda included carbonated soft drinks with artificial sweeteners and marketed as diet soda; bottled water included products advertised as water, sparkling water, and flavored water; and other sugary drinks included 100% fruit juice, fruit juice with added natural or artificial sweeteners, sports drinks, and energy drinks (and excluded products marketed as water, sparkling water, and flavored water). Sales were calculated as the total volume (fluid ounces) of each beverage type sold per year, averaged over all stores in a given 3-digit ZIP code.

Avg, average; oz, ounce; ZIP, zoning improvement plan.

that supermarkets are the largest source of SSB purchases.[15] However, unlike overall trends, large increases in sales of other sugary drinks were observed in convenience stores. It is possible that some SSB consumers may have shifted their purchases of other sugary drinks from supermarkets to these retailers potentially because of lower prices.[34] The results of this study support the need for policies like beverage taxes that apply to all store types, and targeting SSB purchases at supermarkets remains a priority. However, specific efforts to curtail sales of other sugary drinks may be successful if targeted at convenience stores, especially in areas with a high percentage of black and Hispanic consumers.

Although survey data suggest that self-reported consumption of no/low-calorie SSBs did not change from 2003 to 2014,[10] a decline in sales of no/low-calorie soda was observed, which is consistent with industry reports.[35] The results also indicate that sales of bottled

water increased over time, corroborating recent work documenting trends in self-reported water consumption.[10] Absolute sales of bottled water were higher in areas with a lower percentage of white, non-Hispanic people, which may reflect racial disparities in access, perceptions about the safety and taste of tap water, or the impacts of climate change.[36–38] Increases in sales of bottled water were larger in states located in the South and Midwest where the occurrence of repeated drinking water quality violations was high[39] and where rising temperatures may be more impactful. For example, those who live in states with frequent drinking water quality violations are more likely to report drinking bottled water because of taste and safety concerns.[40] Although consumers' reasons for purchasing bottled water during this time period are not known, increases in sales may contribute to lower calorie consumption and lower obesity risk.

Limitations

The 10 years of weekly sales data from more than 24,000 food stores across the U.S. are a major strength of this study. However, the data are limited to stores with estimated total annual sales greater than $2 million and do not include data from smaller, nonchain stores or other vendors (e.g., restaurants, vending machines). Owing to the large size of the data set, the authors aggregated the sales data to the 3-digit ZIP code level, which may have impacted estimates of variance and marginal means and thus the statistical inferences. However, they weighted the primary outcome by the inverse of its variance to provide more nationally representative estimates. Although it was not possible to also weight analytic data by the national distribution of sales data by retail location, self-reported data from the National Health and Nutrition Examination Survey indicate that the distribution of SSBs by purchase location is consistent with the objective data used in this study.[15] This study did not include individual-level data on beverage purchases or intake, which limited the ability to draw inferences about geographic disparities in SSB trends because of ecologic fallacy. In the future, it will be important to investigate the reasons for differential trends in beverage sales by area-level demographics with individual-level data. Finally, pre-existing categories of beverages provided by Nielsen were used, which likely attenuated the magnitude of the findings. For example, some products classified as SSBs included beverages without added sugars and vice versa for no/low-calorie beverages and 100% fruit juice.

CONCLUSIONS

The finding that sales of SSBs decreased over time, whereas sales of bottled water increased, is encouraging because the consumption of SSBs and potentially 100% fruit juice is linked to obesity and other chronic conditions.[41] The exact reasons for these shifts in sales are unknown, but they may be due in part to public health efforts designed to curb SSB consumption.[5,7] Such efforts have received wide media attention, which may have also shaped public opinions and increased awareness about the risks of SSB consumption.[42] The results also suggest that factors influencing beverage purchases may differ by area-level demographic characteristics and might require tailored attention when developing sugary drink reduction campaigns. In addition, this study provides a novel and rigorous assessment of U.S. trends in SSB sales at the store level and the differences in sales by community and store characteristics using a large source of objective sales data.

ACKNOWLEDGMENTS

Researcher(s)' own analyses calculated (or derived) based in part on data from The Nielsen Company (U.S.), LLC and marketing databases provided through the Nielsen Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business.

The conclusions drawn from the Nielsen data are those of the researcher(s) and do not reflect the views of Nielsen. Nielsen is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

Information about the data and access are available at research.chicagobooth.edu/nielsen/.

No financial disclosures were reported by the authors of this paper.

SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at https://doi.org/10.1016/j.amepre.2020.04.022.

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