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Types and amounts of non-nutritive sweeteners purchased by US households: a comparison of 2002 and 2018 Nielsen Homescan purchases

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Abstract

Background: Purchases of foods containing non-nutritive sweetener (NNS) alone or in combination with caloric sweeteners (CS) has increased in recent years in the US. At the same time clinical evidence is emerging of different cardiometabolic effects of each NNS type.

Objective: To examine the prevalence and volume purchased of commonly-consumed types of NNS in packaged food and beverage products comparing 2002 and 2018 using data from nationally representative samples of US households.

Participants/Setting: Nielsen Homescan Consumer Panels; 2002 and 2018.

Main outcome measures: Prevalence and volume of foods and beverages purchased containing CS, NNS, both CS and NNS, or neither CS nor NNS, as well as prevalence and volume of products containing specific NNS types.

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Statistical analyses performed: Differences examined using Students *t*-test, p-value of <0.05 considered significant.

Results: Volume of products purchased containing CS decreased comparing 2002 and 2018 (436.6±1.6g/d to 362.4±1.3g/d; p<0.05), yet increased for products containing both CS and NNS (10.8g/d to 36.2g/d; p<0.05). Regarding specific types of NNS, changes were noted in the prevalence of households purchasing products containing saccharin (1.3% to 1.1%; p<0.05), aspartame (60.0% to 49.4%; p<0.05), rebaudioside-A (0.1% to 25.9%) and sucralose (38.7% to 71.0%). Non-Hispanic whites purchased twice the volume of products containing NNS compared to Hispanics and non-Hispanic blacks in both years. Beverages were predominantly responsible for larger volume per capita purchases of products containing only NNS as well as both CS and NNS.

Conclusions: A decline in purchases of products containing CS occurred in tandem with an increase in purchases of products containing both CS and NNS, along with a large shift in the specific types of NNS being purchased by US households. New NNS types enter the market regularly, and it is important to monitor changes in the amount of NNS and products containing NNS that consumers purchase.

Keywords

caloric sweetener; non-nutritive sweetener; packaged foods; food supply

Introduction

The United States (US) has one of the highest intakes of sugar globally[1] and a significant proportion of packaged barcoded foods in the US contain some type of caloric sweetener (CS).[2,3] Alongside this, interest from consumers and the food industry in reducing sugar consumption (and pressure from health-related bodies such as the World Health Organization) have led to an increase in intake of non-nutritive sweeteners (NNS; also termed artificial, low calorie or non-sugar sweeteners)[4–6] and wider availability of food products containing NNS.[7] Prevention policies such as sugar-sweetened beverage taxes and front-of- package labels may also be incentivizing companies to utilize NNS as a way of reducing CS.[1,8] In 2012, >40% of American adults and >20% of American children reported consuming NNS on a daily basis compared to 30% in 2008.[9] Based on sales data, purchases of foods containing either NNS alone or in combination with CS has increased dramatically over the past decade in the US.[10] Moreover, a growing number of different types of NNS have become available in the US food supply, with new variants of NNS appearing on the market each year.

While the intake of added sugars, and sugar-sweetened beverages in particular, is commonly associated with poor health outcomes,[11,12] the association between NNS consumption and adverse health outcomes has remained relatively controversial in the academic literature.[13,14] A number of cohort studies have linked NNS consumption to increased body weight, type 2 diabetes and other adverse cardio-metabolic outcomes while literature with the same cohorts has found the opposite effect once controlling for many measurement and causality issues linked with NNS used.[12,15–17] Additionally, results from randomized controlled trials

(RCTs) have failed to demonstrate a relationship between NNS and energy intake or increased consumption of sweet foods.[18,19] However, previous RCTs and meta-analyses have generally categorized all NNS together and have not examined differences in the effect of specific types of NNS on health outcomes, energy intake or body weight while the RCT of Higgins and Mattes noted below suggests heterogeneity in health impacts of different NNS types.[20]

Both research and policy recommendations generally group all NNS together, suggesting that each type of NNS has the same effect on appetite, energy intake and body weight.[20] However, not only does each NNS have its own unique chemical structure and therefore sensory properties (e.g., sweetener intensities, mouth feel), a recent RCT that examined the effects of four commonly-consumed NNS in the US on body weight found differential responses between NNS types, indicating that consumption likely has effects beyond the contribution of sweetness to food and beverage products.[20] In particular, saccharin was found to significantly increase body weight, while aspartame, rebaudioside A (reb-A, which is predominantly found in Stevia®), and sucralose (often known by one trademark-Splenda) resulted in greater weight loss.

In this context, comprehensive nutrient databases capable of capturing newly introduced or reformulated products in the US food and beverage supply are critical in order to capture changes to both the amount and type of NNS to which consumers are exposed.[21] The level of NNS is not required to be displayed on nutrition labels in the US, so obtaining accurate and direct measures of the concentration of different types of NNS in the food supply is problematic.[10] Alongside this, the USDA food composition tables are not updated frequently enough to capture the ongoing rapidly occurring changes in the food supply. Studies using data from the National Health and Nutrition Examination Surveys (NHANES) can only capture consumption of about 7,600 unique foods from over 85,000 products with unique formulations that US consumers purchase each year.[7,22] As a consequence, studies examining consumption of NNS generally rely on non-ingredient specific keywords, such as “low calorie”, to identify foods containing NNS. To the knowledge of the authors, no studies to date have examined the extent to which individual types of NNS are purchased and consumed by the US population.

In this study, the prevalence and volume purchased of commonly-consumed types of NNS in packaged food and beverage products is examined using data from a nationally representative sample of US households. Comparisons between 2002 and 2018 among the types and volume of each NNS purchased by US consumers are analysed to examine trends of NNS use over time. Generalizations of added sweetener categories are also examined to determine whether there have been changes in the prevalence of foods and beverages purchased containing CS, NNS, both CS and NNS, or neither CS nor NNS.

Subjects and Methods

Study design and population

The Nielsen Homescan Consumer Panels from 2002 and 2018 were used to examine food purchase data for the US population. This panel is an ongoing nationally representative

longitudinal survey of between 35,000 and 60,000 households each year and contains information on purchases of packaged food and beverage items at the Universal Product Code (UPC) level (with close to 3 million barcoded products included over this time period). Participating households are given handheld scanners with which they record yearly food purchases from grocery, drug, mass merchandise and convenience stores. Households also report sociodemographic and household information including gender, income, education and race/ethnicity of the head of the household. Households included in Homescan are sampled and weighted to be nationally representative. The Homescan dataset is used frequently by researchers to examine food consumption and purchasing patterns.[23–25] The Institution Review Board of UNC noted this was secondary data with no direct contacts and the data was exempt from any review.

Linkage of barcodes food products with nutrition facts panel data

Each uniquely barcoded product captured in Homescan was linked with Nutrition Facts Panel (NFP) data and ingredient information using commercial nutrition databases (i.e., Gladson, Label Insight, Product Launch Analytics and Mintel). These commercial databases contain national brands and private label items at the UPC level and data are generally updated regularly as new products enter the market. Further details regarding matching these commercial datasets at the UPC level, and other methodological facts have been published previously.[2,26] Products were classified as containing NNS in Homescan 2002 and 2018 in order to examine whether changes have occurred over time. Keyword searches were performed on ingredient lists provided for each UPC purchased by participating households. A detailed list of key terms is available in Supplementary Table 1, but in brief, keyword searches were performed for the four most commonly-consumed NNS (saccharin, aspartame, sucralose and reb-A),[20] as well as all other known NNS used by US food and beverage manufacturers. The ingredient lists were also examined for CSs in order to determine whether NNSs were used alone, or in combination with CSs. Estimates of total purchases per year were calculated to estimate total volume purchased per day (mL/day for beverages; g/day for foods) by a household. Then, the total purchases of each household were divided by the number of people in the household to calculate a per capita estimate of purchases. The percent of households purchasing foods and beverages by sweetener type was determined. To define a consumer in a meaningful way and exclude unusual or one-time purchases, the total purchases per year was divided by pre-defined portions: 100 for beverages and 50 for foods. For the purpose of this research, a household was considered a consumer in Homescan if purchases totalled at least 52 portions per year, or one portion per week.

Food Grouping

Packaged products in the data are not grouped in a manner which lends themselves to nutrition-related analyses. Our UNC team of trained MPH/RDs created a food grouping system and worked through the major beverage and food groupings to create nutritionally meaningful food groups. Supplemental Table 2 provides a description of the beverage and food groupings. Based on these groupings, we ranked the top ten food and beverage groups based on the volume per capita per day of products purchased within these groups containing any non-nutritive sweetener.

Statistical analysis

All analyses were performed using SAS v9.4. Results are presented overall and by demographic subgroup in both 2002 and 2018. Results are reported for households both with and without children, three race-ethnic groups (Hispanic, non-Hispanic White and non-Hispanic black), three income groups (<185%, 185–350% and >350% of the Federal Poverty Level) and three head of household education groups (less than high school, high school diploma, and more than high school). Significant changes between 2002 and 2018 in prevalence of intake were examined using chi squared tests. Results for volume per capita per day are reported mean (±SE), and differences examined using Students *t*-test. A p-value of <0.05 was considered significant for all reporting.

Results

In 2002, 39,300 households were included in analysis and 61,101 in 2018 (Supplementary Table 3). The Homescan data in general had a higher proportion of households without children and non-Hispanic whites (Supplementary Table 3).

Household purchases of products containing CS

In 2002, 100% of households purchased products containing CS, which reduced slightly but significantly to 99.9% in 2018 (Figure 1). The volume of products purchased containing only CS also decreased significantly, from 436.6±1.6g/d to 362.4±1.3g/d ($p<0.05$; Figure 2), although the decrease was due to a large decrease in purchases of beverages containing only CS, as food purchases slightly increased over the study period (227.8±0.7g/d to 231.0±0.7g/d; Figure 2). All demographic subgroups showed a decrease in volume of foods and beverage purchases overall containing only CS ($p<0.05$ for all; Supplementary Table 4. Despite almost 100% of both households with and without children purchasing products containing CS in 2018, households with children purchased a considerably lower volume of products containing only CS (259.0±1.5g/d) than households without children (412.2±1.7g/d; Supplementary Table 4.

Household purchases of products containing both CS and NNS

The opposite trend to purchases containing only CS was seen for household purchases of products containing both CS and NNS together. The proportion of households purchasing products containing both CS and NNS increased almost 30% between 2002 and 2018 ($p<0.05$; Figure 1), with the increase driven mainly by beverages which showed an increase from 15.9% in 2002 to 49.4% in 2018 ($p<0.05$; Figure 1). All demographic subgroups showed an increase in both the proportion of households (Supplementary Table 5) and per capita volume purchased of products containing both CS and NNS (Supplementary Table 4). In 2018, non-Hispanic whites purchased the highest volume of food products containing both CS and NNS (9.6g/d versus 6.4g/d for Hispanics and 5.9g/d for non-Hispanic blacks; Supplementary Table 6) and non-Hispanic blacks purchased the highest volume of beverage products (32.2g/d versus 22.7g/d for Hispanics and 28.4g/d for non-Hispanic whites; Supplementary Table 7). In fact, non-Hispanic black households showed a 42% increase in the prevalence of households purchasing beverage products containing both CS and NNS between 2002 (21.8%) and 2018 (56.6%) (Supplementary Table 8. Interestingly, despite a

larger proportion of households with children in 2018 purchasing products containing both CS and NNS (83.6%) than households without children (68.6%), households without children had a much higher volume purchased (40.9g/d versus 26.3gd; Supplementary Table 4).

Household purchases of products containing neither CS nor NNS

Almost 100% of households purchased products that contained neither CS nor NNS in both 2002 and 2018 (Figure 1). The volume purchased by households of products containing neither CS nor NNS increased between 2002 and 2018 (355.4g/d to 415.0g/d; $p<0.05$) (Figure 2) and this was driven by both an increase in food and beverage purchases. Interestingly, in 2002, US households purchased a higher volume of food and beverage products containing only CS (436.6g/d) than neither CS nor NNS (355.4g/d); however, this trend was reversed by 2018, with 362.4g/d volume purchased of products containing CS only versus 415g/d of products with neither CS nor NNS (Figure 3). In both 2002 and 2018, slightly more US households purchased products containing CS only than products containing neither CS nor NNS (Figure 1).

Household purchases of products containing NNS

A small but significant increase was observed in household purchases of products containing only NNS (65.7% in 2002 to 67.2% in 2018; $p<0.05$) (Figure 1). The increase was mainly driven by food products, with beverage products showing a smaller increase. However, when examining the volume per capita per day of products purchased that contained only NNS, a small but significant *decrease* was observed between 2002 and 2018 (102.2g/d to 100.0g/d; $p<0.05$) (Figure 2). Interestingly, non-Hispanic whites purchased almost twice the volume of products containing only NNS compared to Hispanics and non-Hispanic blacks in both survey years (Supplementary Table 4. This finding was mainly due to non-Hispanic whites having higher volume purchases of aspartame (*see next section*). Households without children purchased more than double the volume of products containing only NNS compared to households with children in 2018 (125.9±1.3g/d versus 46.3±0.8g/d; Supplementary Table 4. In volume terms, these changes overall and by race-ethnic subpopulation group were driven mainly by shifts in beverage purchases

Ranking of food and beverage groups by household purchase of products containing any NNS

For applicability, we present the top 10 food and beverage groups ranked based on volume of purchased products containing any NNS within each food or beverage group in Table 9. Most of the products containing NNS are found among beverages. Unsurprisingly, diet and low calorie (≤20kcal/100ml) soft and fruit drinks are the major source in 2002 and 2018, though there was a major drop in purchases of these beverages in 2018. This was partly made up by caloric soft and fruit drinks (>20kcals/100ml) shifting towards adding NNS in 2018 (moved in ranking from 5th place in 2002 to 2nd place in 2018). Additionally, there were important increases in the volume of coffee and teas and water purchased containing NNS. in 2018, purchases of sports and energy drink products containing NNS showed up on the top 10. In the foods categories, there were notable but relatively small increases in the amount of the top 10 food groups with products containing NNS compared to what was seen

for beverages. Nonetheless, it shows what food groups are beginning to have growth on NNS use over time and where future increase might be expected.

Changes in purchases of specific NNS types

Between 2002 and 2018 there was a large change in the prevalence of households purchasing specific NNS types. For example, between 2002 and 2018 the proportion of households purchasing products containing saccharin and aspartame decreased (1.3% to 1.1% for saccharin and 60.0% to 49.4% for aspartame; $p<0.05$; Figure 3) yet a large increase in the proportion of households purchasing reb-A and sucralose was observed (0.1% to 25.9% for reb-A and 38.7% to 71.0% for sucralose; $p<0.05$) (Figure 3). For all NNS types except for saccharin, products containing each NNS type were more often found among beverage purchases compared to foods. Aspartame had the highest volume per capita purchased of all NNS types, despite showing a significant decrease between 2002 and 2018 (94.7g/d to 80.0g/d; $p<0.05$) (Figure 4). A large increase in "All other NNS" was seen between 2002 to 2018 (40.3g/d to 91.9g/d; $p<0.05$), as well as large increases in reb-A (0g/d in 2002 versus 7.6g/d in 2018) and sucralose (15.4g/d in 2002 versus 49.4g/d in 2018). Saccharin contributed only <1g/d in volume purchased per capita (Figure 4). It's also important to note the relative sweetness of each NNS examined compared to sucrose. Supplementary Table 5 shows that sucralose has the highest relative sweetness, at 600× sweeter than sucrose, and reb-A the lowest with 240× sweeter than sucrose.

Discussion

Overall results

Using measures of household purchases from nationally representative samples of US households, a large shift was found between 2002 and 2018 in how NNSs were being purchased by US consumers. The current study observed, as previous studies have shown, that purchases of products containing CS have decreased in recent years,[10,27,28] yet the proportion of households purchasing products containing both CS and NNS together has increased by more than 30%. This increase was driven mainly by beverages rather than food, with the volume purchased per capita per day of beverage products with both CS and NNS increasing more than four-fold from 2002 to 2018. At the same time, a decrease in volume purchased per capita per day of beverage products containing only NNS was observed. The most recent study examining household purchases of products containing NNS (between 2000 and 2010) found that purchases of products containing NNS increased between 2000 and 2006, and began to decrease between 2006 and 2010.[10,29] Current results indicate that decline has continued through to 2018. In addition, most studies examining volume purchases or intake of NNS and CS have not also considered how comparing products containing neither CS nor NNS. The current study observed a changing trend, with US households in 2002 purchasing a higher volume of food and beverage products containing only CS versus neither CS nor NNS, with the opposite trend observed in 2018. This highlights the changing nature of both the US food supply and consumer purchasing behaviour over the past 16 years.

Although the current study found that foods contributed a larger volume per capita of purchases of products containing only CS (231g/d versus 131.4g/d in 2018), it was also observed that beverages were predominantly responsible for larger volume per capita purchases of products containing only NNS (96.1g/d for beverages versus 3.9g/d for foods in 2018) as well as products containing both CS and NNS (27.6g/d for beverages versus 8.5g/d for foods in 2018). Volume per capita purchases of beverage products containing only NNS did not change significantly between 2002 and 2018, however, purchases increased significantly for products containing both CS and NNS. This is in line with previous research which has shown that in both children and adults, consumption of reduced-calorie beverages (e.g., reduced-calorie sport drinks) has been increasing while consumption of no-calorie beverages (e.g., diet soda) has remained relatively stable.[4,9]

Race-ethnic subpopulation results

Although similar trends were observed when looking at specific demographic subgroups, non-Hispanic whites were found to purchase almost double the volume of products containing NNS compared to Hispanics and non-Hispanic blacks in both survey years. This supports research into consumption of NNS which demonstrates that non- Hispanic whites in the US have a higher prevalence of NNS consumption compared to non- Hispanic black and Hispanic race-ethnic groups.[9,10,30] Interestingly though, it was also found that non-Hispanic black households showed a 42% increase in the proportion of households purchasing beverage products containing both CS and NNS between 2002 and 2018, indicating that purchasing behaviour may be changing for this race-ethnic group.

Shifts in the types of non-nutritive sweeteners (NNS)

A change in the specific types of NNS that are being purchased by US households was also observed. For example, out of the four NNS types examined, both prevalence of households purchasing and the volume per capita purchased of saccharin and aspartame decreased, and reb-A and sucralose increased. Reb-A and sucralose are relatively new to the market, and results indicate that these types of sweeteners may in fact be replacing the use of the more traditionally used NNS, such as aspartame. Interestingly, despite saccharin being noted in the literature as one of the most commonly consumed NNS in the US,[20] it was found to contribute <1g/d in terms of purchased volume per capita. With the most recent RCT examining the differential effects of these four NNS types showing a negative effect of saccharin on body weight,[20] it is promising that it is not as widely consumed by US households and that other NNS types currently dominate the US food and beverage supply. That being said, saccharin is found in the common table-top sweetener *Sweet n Low®*, and hence a substantial portion of saccharin intake may have been missed in the present study if predominately used outside the home.

Aspartame remains a dominant NNS type purchased (by more than 50% of households in 2018), although the proportion of households purchasing products containing aspartame decreased by just under 10% between 2002 and 2018. At the same time, purchases of sucralose increased by more than 30%, driven mainly by beverage products. Reports suggest that sucralose accounts for the majority of the NNS market share in the US (passing aspartame which previously represented the majority).[31] New research conducted on 45

healthy adults found that the consumption of sucralose alongside carbohydrate (e.g., in drinks that contain both sucralose and caloric sugars) rapidly impairs glucose metabolism, resulting in decreases in brain sensitivity to sweet taste.[32]

Research suggests that as consumer preferences continue to shift toward more "natural" products, consumption of NNS types such as reb-A will likely increase more rapidly compared to other NNS types.[9] The present study supports this, showing a large increase in both the proportion of households purchasing, and the volume purchased, of reb-A. In addition to its appeal as a "natural" NNS, reb-A is also touted as being more palatable than other NNS and it is clear that food and beverage manufacturers are expanding the use of reb-A in newly formulated products, and the use of more traditional NNS types such as saccharin and aspartame have flatlined in North America.[33]

Limitations

Home purchase data such as that found in Homescan do not provide measures of individuals' actual intake, however this data are useful to characterize the variability in food consumption patterns at the population level. Another challenge of using Homescan is that estimates of per capita purchases might not be comparable with per capita intake from dietary intake surveys (e.g., NHANES). For example, in a given household all purchases of beverages containing NNS could be consumed by a single member of the household, rather than being consumed by all household members, affecting the per capita estimates made here. Homescan also does not capture food and drinks purchased from fast-food chains and other restaurants, which could have resulted in an underestimate of purchases in the present study.

Another limitation is the low proportion of households without a high school education. While our weights adjust for this, the Nielsen Homescan data had a smaller sample of lower education households for whom data was collected.

Moreover, in the absence of a requirement that nutrition facts panels contain the amount of each NNS used, it was not possible to determine the actual amounts of each sweetener types present in products. Chile is one of the few if not the only country that has this requirement now.

Strengths and unique contributions

To the knowledge of the authors, this is the first study to examine trends in purchases of US households on specific types of NNS and uses the most currently available household purchase data. Results indicate that a decline in purchases of products containing only CS is happening in tandem with an increase in purchases of products containing both CS and NNS. In addition, beverage purchases appear to be responsible for the majority of this change, and that this has occurred along with a large shift in the specific types of NNS that are being purchased by US households (and therefore being used by the food industry). New NNS types enter the market regularly, and it is important to monitor changes not only in the amount of products containing NNS that US consumers purchase, but also the types of NNS that are present in food and beverage products. A critical gap as NNS prevalence grows will be to add a legal requirement for amounts of NNS by type be added to nutrition facts panel

as is done in Chile. Without such information it would be very challenging to track intake of these mixes of NNS that are becoming more prevalent in our food supply to begin understanding if and what types of effects they may have on population health and in addressing disparities. Efforts to encourage or require food manufacturers to disclose the amounts of the various types of NNS in their products should be undertaken.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Research Question:

Has the prevalence and volume purchased of commonly-consumed types of NNS in packaged food and beverage products changed between 2002 and 2018 in the USA?

Key Findings:

The amount of products purchased containing caloric sweetener decreased between 2002 and 2018, yet increased for products containing both caloric sweetener and NNS. Regarding specific types of NNS, changes from 2002 to 2018 were noted in the prevalence of households purchasing products containing aspartame (reduced from 60.0% to 49.4%; $p<0.05$), reb-A (increased from 0.1% to 25.9%) and sucralose (increased from 38.7% to 71.0%). Beverages were predominantly responsible for larger volume per capita purchases of products containing only NNS as well as both caloric sweetener and NNS.

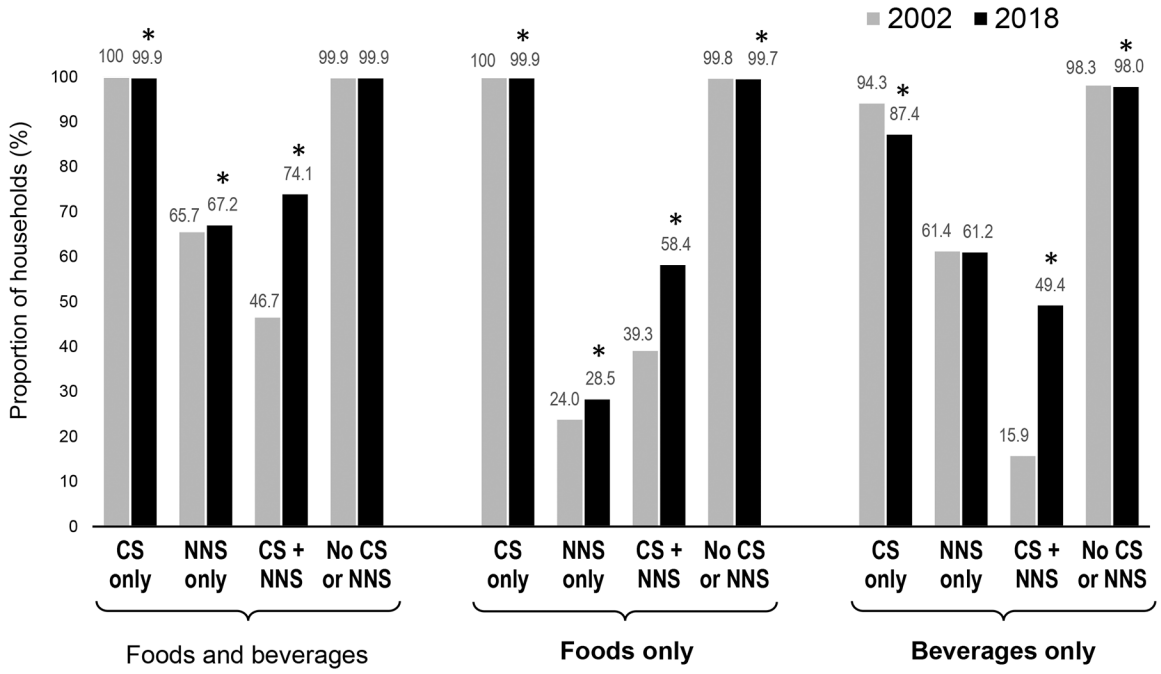

Figure 1: Estimated proportion of U.S. households[a] that purchased products containing caloric sweeteners (CS) and non-nutritive sweeteners (NNS) in a comparison of 2002 vs. 2018

[a] Sample sizes of households were 39,300 in 2002 and 61,101 in 2018. Authors' calculations are based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the years 2002 and 2018 from Nielsen Homescan Household Panel across the U.S. market, The Nielsen Company, 2019. The conclusions drawn from the Nielsen data are those of the authors and do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

* $P<0.05$

CS only: Products that contain caloric sweeteners as the only type of sweetener;

NNS only: Products that contain non-nutritive sweeteners as the only type of sweetener;

CS + NNS: Products that contain both caloric and non-nutritive sweeteners

No CS or NNS: Products that neither contain caloric sweeteners or non-nutritive sweeteners.

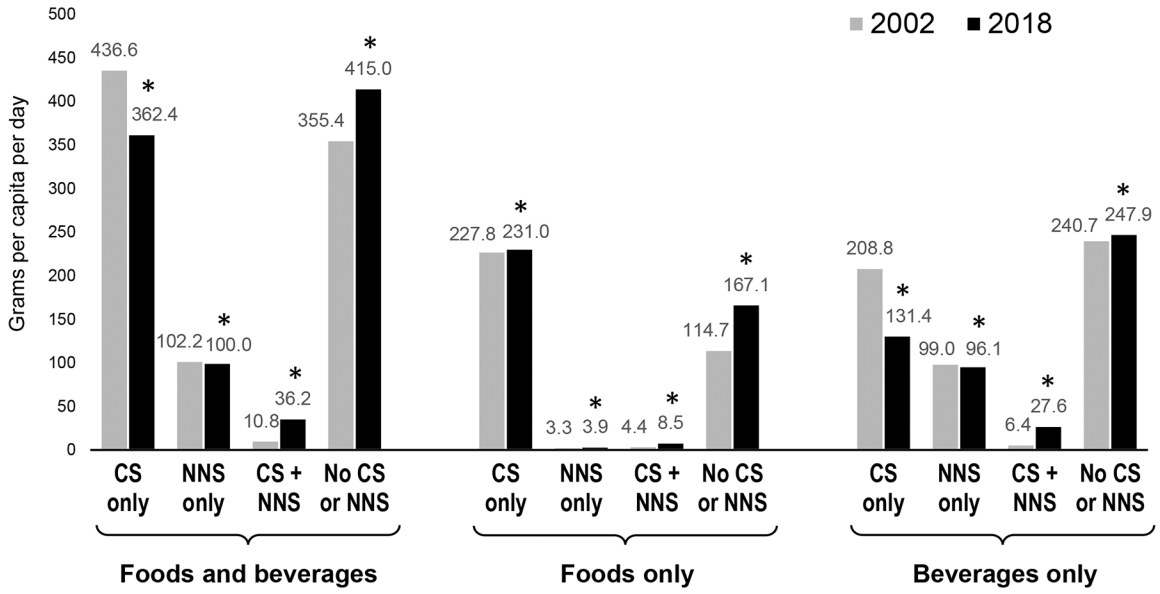

Figure 2: Estimated volume of food and beverage products containing non-nutritive sweeteners (NNS) and caloric sweeteners (CS) purchased by U.S. households[a] in a comparison of 2002 vs. 2018

[a] Sample sizes of households were 39,300 in 2002 and 61,101 in 2018. Authors' calculations are based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the years 2002 and 2018 from Nielsen Homescan Household Panel across the U.S. market, The Nielsen Company, 2019. The conclusions drawn from the Nielsen data are those of the authors and do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

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No CS or NNS: Products that neither contain caloric sweeteners or non-nutritive sweeteners.

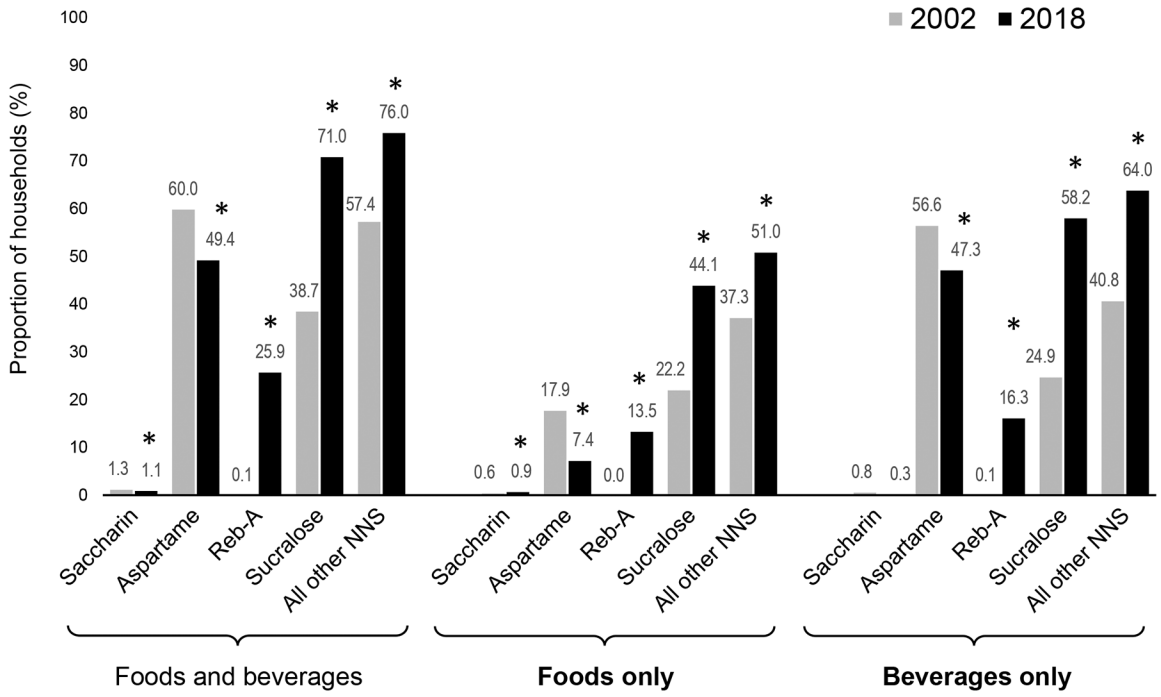

Figure 3: Estimated proportion of U.S. households[a] that purchased specific types of non-nutritive sweeteners (NNS) from packaged foods and beverages in a comparison of 2002 vs. 2018

[a] Sample sizes of households were 39,300 in 2002 and 61,101 in 2018. Authors' calculations are based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the years 2002 and 2018 from Nielsen Homescan Household Panel across the U.S. market, The Nielsen Company, 2019. The conclusions drawn from the Nielsen data are those of the authors and do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

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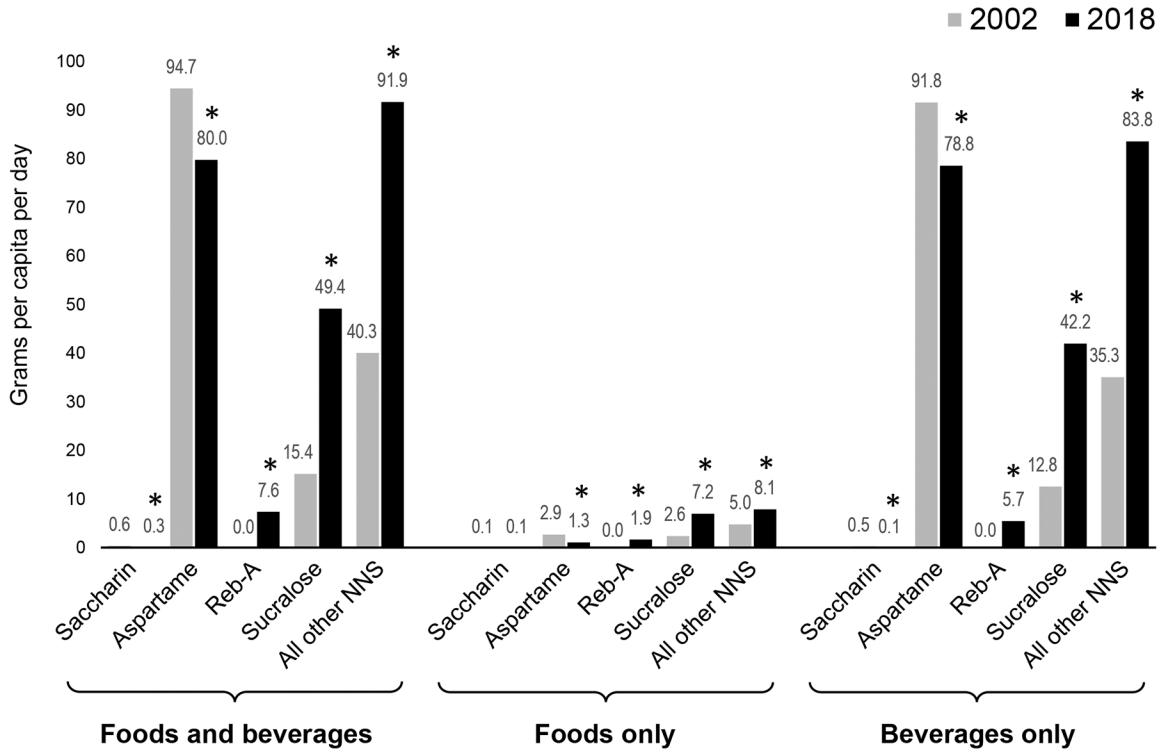

Figure 4: Estimated volume of food and beverage products containing specific types of non-nutritive sweeteners (NNS) purchased by U.S. households[a] in a comparison of 2002 vs. 2018

[a] Sample sizes of households were 39,300 in 2002 and 61,101 in 2018. Authors' calculations are based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the years 2002 and 2018 from Nielsen Homescan Household Panel across the U.S. market, The Nielsen Company, 2019. The conclusions drawn from the Nielsen data are those of the authors and do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

* $P<0.05$

Table 9

The top ten food and beverage groupings for purchased products containing any Non-Nutritive Sweeteners (with or without caloric sweeteners), a comparison of 2002 vs. 2018.

A. Top 10 Beverage groups in 2002 vs 2018 (ranked based on greatest volume per capita per day of purchased products containing any non-nutritive sweetener within each group)

2002		2018	
Beverage Group	**Mean (SE)**	**Beverage Group**	**Mean (SE)**
soft drinks and fruit drinks diet/low calorie (≤20 kcal/100g)	91.07 (1.12)	soft drinks and fruit drinks diet/low calorie (≤20 kcal/100g)	58.21 (0.74)
coffee/tea caloric (>20 kcal/100g)	5.83 (0.25)	soft drinks and fruit drinks caloric (>20 kcal/100g)	24.41 (0.35)
water non-caloric (0 kcal/100g)	3.02 (0.12)	water non-caloric (0 kcal/100g)	10.62 (0.20)
coffee/tea non-caloric/low calorie (≤20 kcal/100g)	1.29 (0.07)	coffee/tea caloric (>20 kcal/100g)	9.56 (0.30)
soft drinks and fruit drinks caloric (>20 kcal/100g)	1.19 (0.04)	coffee/tea non-caloric/low calorie (≤20 kcal/100g)	6.56 (0.18)
cocoa and sweetened milk beverages powdered	1.16 (0.04)	cocoa and sweetened milk beverages powdered	3.42 (0.16)
water diet/low calorie (≤10 kcal/100g)	0.67 (0.05)	Sports drinks diet/low calorie (≤20 kcal/100g)	3.33 (0.10)
<100% fruit juice low calorie (≤20 kcal/100g)	0.60 (0.03)	<100% fruit juice low calorie (≤20 kcal/100g)	2.12 (0.07)
<100% vegetable juice low calorie (≤20 kcal/100g)	0.20 (0.01)	energy drinks diet/low calorie (≤20 kcal/100g)	1.45 (0.06)
<100% vegetable juice caloric (>20 kcal/100g)	0.18 (0.01)	<100% fruit juice caloric (>20 kcal/100g)	1.15 (0.03)

Source: Authors' calculations based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the years 2002 and 2018 from Nielsen Homescan Household Panel across the U.S. market, The Nielsen Company, 2019. The conclusions drawn from the Nielsen data are those of the authors and do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

B. Top 10 Food groups in 2002 vs 2018 (ranked based on greatest volume per capita per day of purchased products containing any non-nutritive sweetener within each group)

2002		2018	
Food Group	**Mean (SE)**	**Food Group**	**Mean (SE)**
yogurt	1.82 (0.04)	yogurt	2.47 (0.04)
dairy-based desserts	1.31 (0.04)	dairy-based desserts	1.82 (0.03)
candy and sweet snacks	1.02 (0.03)	dairy products, other	1.51 (0.03)
grain-based bars	0.65 (0.01)	candy and sweet snacks	1.43 (0.03)
grain-based desserts	0.49 (0.01)	bread and bread products	1.09 (0.02)
sweeteners	0.46 (0.01)	sweeteners	0.60 (0.01)
salty snacks	0.36 (0.01)	grain-based bars	0.57 (0.01)
sauces, dips, and condiments	0.32 (0.01)	grain-based desserts	0.56 (0.01)
soups and stews	0.27 (0.01)	fruit	0.47 (0.01)
cereal	0.23 (0.01)	sauces, dips, and condiments	0.41 (0.01)

Source: Authors' calculations based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the years 2002 and 2018 from Nielsen Homescan Household Panel across the U.S. market, The Nielsen Company,

B. Top 10 Food groups in 2002 vs 2018 (ranked based on greatest volume per capita per day of purchased products containing any non-nutritive sweetener within each group)			
2002		**2018**	
Food Group	**Mean (SE)**	**Food Group**	**Mean (SE)**
2019. The conclusions drawn from the Nielsen data are those of the authors and do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.			