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ORIGINAL RESEARCH

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Online retail nudges to help parents with lower-income choose healthy beverages for their children: A randomized clinical trial

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Summary

Background: Nudges offer a promising tool to reduce sugary drink intake among children who are most at risk for diet-related disease.

Objective: To examine the impact of online store nudges on purchases of sugary drinks for children in lower-income households.

Methods: Caregivers with lower-income were recruited to an online shopping experiment and instructed to spend $10–$30 on three beverages for their child aged 1–5 years. Participants were randomized to navigate an online supermarket in its standard version ($n = 1106$) or a version with nudges ($n = 1135$), including a product placement nudge (i.e. placing healthy beverages in prominent positions) and a swap nudge (i.e. offering a swap of water, plain milk and/or 100% fruit juice upon selection of sugary drinks).

Results: On average, participants purchased 1887 (SD = 2113) and 620 (SD = 1528) calories from sugary drinks per basket in the control and experimental conditions, respectively. Model-based results indicate that those in the experimental condition purchased 1267 (95% CI: 1419, 1114) fewer calories from sugary drinks, and fewer grams of total sugar ($\beta = -253.5$ g (95% CI: −286.3, −220.6)) and added sugar ($\beta = -287.8$ g (95% CI: −323.1, −252.5)) purchased from sugary drinks.

Conclusion: Nudges may be an effective, acceptable, scalable strategy for leading caregivers in lower-income households to purchase fewer sugary drinks for their children.

KEYWORDS
added sugar, lower-income, nudges, online grocery, sugary drinks

1 | INTRODUCTION

Sugary drinks are a leading source of added sugar intake among young children,[1–3] and consumption of sugary drinks during childhood is associated with increased risk of obesity and dental caries during childhood and an increased risk of diet-related chronic diseases during adulthood.[4] There are clear disparities in sugary drink intake, with higher consumption among children in households with low incomes and those whose parents participate in the Supplemental Nutrition Assistance Program (SNAP),[3,5–10] potentially due to higher exposure to food and beverage marketing and wide accessibility and affordability of sugary drinks.[11] Low-cost, feasible strategies that reduce sugary drink purchases among caregivers are critical to reduce added sugar intake among children in lower-income households.

Several factors have accelerated growth in online food retail among caregivers in lower-income households, including the

expansion of the SNAP Online Purchasing Pilot.[12,13] The number of households that used SNAP benefits to make at least one online order doubled from ~1.5 million households in January 2021 to ~3 million households in March 2022.[14] Between a third and half of households with lower incomes in the United States have ever shopped online for groceries.[15,16] This rapid shift to online food retail provides a unique opportunity to utilize behavioural economic strategies (e.g. 'nudges') to reduce sugary drink purchases and encourage selection of healthier substitutes. Nudges, or 'any aspect[s] of the choice architecture that alters behavior in a predictable way without forbidding any options or significantly changing their economic incentives,'[17] compensate for humans' short-term, reactive cognitive processes that are more subject to error or biases. These processes can be applied to nutrition interventions by reducing the cognitive burden associated with selecting healthy options in retail food settings, potentially by modifying the functionality and presentation of healthy options.[18] Such nudging strategies are often logistically impractical in brick-and-mortar stores but feasible to implement online. Understanding whether nudges shift people toward healthier dietary choices could inform voluntary actions by retailers or policies that incentivize or mandate such nudges.

Product placement (e.g. modifying the location in which a product appears) and offering swaps at the point-of-selection (e.g. using pop-ups to suggest that an unhealthy product be replaced with a healthier option) are particularly promising opportunities for shifting caregivers' online sugary drink purchases to healthier options. Prior studies implementing such strategies in simulated online grocery stores have demonstrated significant reductions in saturated fat, sodium and total calories purchased.[19–23] These studies also demonstrated that participants reported liking receiving swap suggestions, and report that out-of-category swap suggestions (e.g. swapping low-fat cheese for whole-milk cheese) do not change swap acceptability.[20,24] However, no studies have tested the effectiveness of nudge strategies to reduce purchases of sugary drinks in online retail settings or focused on shifting online purchases of caregivers in lower-income households. To address these gaps, we sought to examine the impact of online store nudges on purchases of sugary drinks by caregivers of children age 1–5 years in lower-income households.

2 | MATERIALS AND METHODS

2.1 | Sample

The protocol for this trial was registered and published (ClinicalTrials.gov Identifier: NCT06222541). We used a survey research firm, CloudResearch, to recruit eligible participants from a convenience sample. CloudResearch sends an invitation to eligible participants with a survey name, duration, point amount and link; survey details are not provided. CloudResearch provides participants with points that can be redeemed for various cash and non-cash incentives and employs quality control mechanisms to minimize fraudulent responses. Eligible participants were adults aged ≥18 years who are the caregiver of at least one child aged 1–5 years, read and speak English, had a household income at or below 185% of the federal poverty level, and had access to a personal computer, laptop or tablet.

2.2 | Procedures

Participants were recruited to participate in an online shopping experiment in March–April 2023. Participants first completed a screening survey which included questions about sociodemographic characteristics, food shopping behaviours and the participant's child's beverage consumption behaviours (File S1). After completing the survey, participants were randomized in a 1:1 ratio to one of two conditions using a randomizer in Qualtrics. Participants were then presented with instructions regarding the shopping task in our experimental online grocery store (named 'Lola's Grocery'), and provided with unique hyperlinks for each condition. Participants in the experimental condition ($n = 1135$) completed an online shopping task with healthier beverage nudges (described below), while participants in the control condition ($n = 1106$) completed an online shopping task without healthier beverage nudges. A detailed description of methods for acquiring and cleaning online store data and the design of our two-dimensional platform, and its validity and acceptability, are published elsewhere.[25,26] Briefly, we used a platform called Gorilla developed by Cauldron Science, Ltd.,[27] which mimics the appearance and functionalities of a top US online grocery retailer, including browsing, search, product pages, shopping cart and checkout. The store has over 13 000 products, organized by department, aisle and shelf, with product images, price and nutrition information. To ensure the store was easy for participants to navigate, we conducted usability testing prior to the study.

Participants were instructed to select three beverages (single or multi-serving) for their youngest child aged 1–5 years, both at the end of the survey and again at the start of the shopping task. Participants were required to purchase a minimum of three items and spend between $10 and $30 in order to check out. After completing the shopping task, participants were required to answer questions about the process of shopping, their thoughts and attitudes while shopping, and—among those in the experimental condition—the swap options (File S1). After the study, participants reported that they felt the store was easy to use and felt like a real online store (Table S1). To incentivize participation and truthful responses, participants were notified they would be entered into a lottery upon completion of the shopping task and approximately one in 10 participants would have their cart items delivered to their household. At the end of the study, however, individuals who won the lottery were instead provided a gift card with the equivalent amount of money loaded onto it that they spent in the study. This approach was used to mitigate potential issues related to delivery, and to minimize the collection of personally identifiable information.

TABLE 1 Classification and definition of beverage types.

Product category	Definition	Recommendations	Examples
Category 1 (Most Healthy)	Unsweetened water (unflavored and flavoured) and plain milk	1–4 cups/day of water and 2 cups/day of whole-fat milk (12–23.9 month old child); 1–5 cups/day of water and 2–3 cups/day low-fat milk (2–5 years old child)	0% milk, 2% milk and bottled water
Category 2 (Less Healthy)	100% fruit juice products	4–6 oz. of 100% fruit juice per day for children >12 months	Diluted fruit juice drink and 100% fruit juice drinks
Category 3 (Least Healthy)	Beverages with added sweeteners, including non-caloric sweeteners and added sugar	Not recommended for young children	Fruit drinks, chocolate milk and soda

2.3 | Experimental condition

We tested two nudges in the experimental condition, including making healthier beverage options more prominent on the landing page and product shelves (i.e. 'product placement'); and offering healthier swaps for sugary drink products (i.e. 'swaps'). These two approaches allowed us to nudge participants at two points: when they were browsing products and again at the point-of-selection. To implement these nudges, we first established a hierarchy of beverage choices, from most healthy to least healthy (Table 1). We based our hierarchy on a consensus statement on healthy beverage consumption in early childhood from key national health and nutrition organizations.[28] Category 1 (Most Healthy) included unsweetened water (unflavored and flavoured) and plain unflavored milk, including non-lactose milk options (e.g. plant-based milk) for children with lactose intolerance; Category 2 (Less Healthy) included 100% fruit juice products (diluted and undiluted); and Category 3 (Least Healthy) included beverages with added caloric sweeteners. We also made changes to the design of the nudges based on feedback from usability testing, including incorporating feedback from two retail partners about their perceived desire for and feasibility of our nudges in real-world online stores (see File S1).

2.3.1 | Product placement nudge

To develop the product placement nudge, we leveraged the 'shelf rank' of products, which indicates a product's order on a shelf when sorted by best seller, data we received from the online food retailer. We modified the default order of beverages, such that participants in the experimental condition viewed beverage products in descending order of healthfulness on a shelf page (i.e. the healthiest beverages appeared at the top of the screen) (Figure S1). We first sorted beverage products by healthfulness, using our ranking above (i.e. Category 1, 2 then 3). Within Category 1, we sorted unsweetened water products before plain milk products, and sorted low-fat plain milk products before whole plain milk products for a 2–5 year old child, and vice-versa for a 12–23.9 month old child. Within Category 2, we sorted diluted 100% fruit juice products before undiluted 100% fruit juice. Then within Category 3, we sorted flavoured milks first (a source of key micronutrients), then products with non-caloric sweeteners, then products with caloric sweeteners. Next, we sorted on grams of total sugars within each beverage type (e.g. 100% fruit juice products with fewer total sugars were listed first).

In addition to modifying the default order of beverages, we modified which products appeared on the landing page. Participants in the experimental condition viewed eight beverage products from Category 1 in a random order on the landing page, including unsweetened water and unsweetened milk products (Figure S2). A message above the beverages read 'Shop Popular Beverages with No Added Sugar'. Participants in the control condition viewed eight non-food household items (e.g. utensils) in a random order. A message above the non-food items read 'Shop Popular Products for Families'.

2.3.2 | Swap nudge

To develop the swap nudge, we altered the design of the website to offer participants a healthier alternative (i.e. swap where participants in the experimental condition who added sugary drink products to their cart were shown a pop-up box offering two adjacent swap options) (Figure S3). One swap option included a Category 1 beverage, unsweetened water or plain milk. Depending on the participant's child's age, the plain milk swap options offered were either whole fat milk (12–23.9-month-old child) or low-fat milk (2-5-year-old child), and, depending on dairy preference, either lactose or non-lactose milk. The second swap option included 100% fruit juice products from Category 2. The two swap options were offered at the same time on the same screen. The swap pop-up box included a health message above the offered swaps that read 'Want a drink with LESS SUGAR than your current choice?' Participants were allowed to decline the swap altogether by clicking 'No Thanks' or the 'X' at the top-left corner of the pop-up box. Participants could also click to view a new swap option of the same type in the same position in the pop-up box by clicking the 'Show Me Another' button below the offered products. Category 3 beverages were not offered as swaps. Participants in the control condition were not offered swaps. To the extent possible, we selected swaps of similar price, portion size and serving style (see File S1 for additional details).

FIGURE 1 CONSORT flow diagram.

CONSORTCHECKLIST

Table. CONSORT 2010 Checklist of Information to Include When Reporting a Randomized Trial[a]

Section and Topic	Item No.	Checklist Item	Reported on Page No.
Title and abstract			
	1a	Identification as a randomized trial in the title	
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	
	2b	Specific objectives or hypotheses	
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	
Participants	4a	Eligibility criteria for participants	
	4b	Settings and locations where the data were collected	
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	
Outcomes	6a	Completely defined prespecified primary and secondary outcome measures, including how and when they were assessed	
	6b	Any changes to trial outcomes after the trial commenced, with reasons	
Sample size	7a	How sample size was determined	
	7b	When applicable, explanation of any interim analyses and stopping guidelines	
Randomization			
Sequence generation	8a	Method used to generate the random allocation sequence	
	8b	Type of randomization; details of any restriction (such as blocking and block size)	
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	
	11b	If relevant, description of the similarity of interventions	
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analyzed for the primary outcome	
	13b	For each group, losses and exclusions after randomization, together with reasons	
Recruitment	14a	Dates defining the periods of recruitment and follow-up	
	14b	Why the trial ended or was stopped	
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	
Numbers analyzed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing prespecified from exploratory	
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	
Comment Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	
Generalizability	21	Generalizability (external validity, applicability) of the trial findings	
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	
Other information			
Registration	23	Registration number and name of trial registry	
Protocol	24	Where the full trial protocol can be accessed, if available	
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	

[a]We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomized trials, noninferiority and equivalence trials, nonpharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up-to-date references relevant to this checklist, see http://www.consort-statement.org.

TABLE 2 Sociodemographic characteristics from pre-shopping survey and shopping task characteristics, overall and by condition.

	All ($n = 2241$) Mean (SD) or n (%)	Control condition ($n = 1106$) Mean (SD) or n (%)	Healthy nudges condition ($n = 1135$) Mean (SD) or n (%)
Sociodemographic characteristics			
Age	24.1 (8.4)	24.4 (8.3)	23.8 (8.5)
Female	1891 (84.4%)	927 (83.8%)	964 (84.9%)
Household size, total	4.5 (1.5)	4.6 (1.5)	4.5 (1.5)
Hispanic, Latino, or Spanish	384 (17.1%)	200 (18.1%)	184 (16.2%)
Race[a]			
American Indian or Alaska Native	122 (5.4%)	59 (5.4%)	63 (5.5%)
Asian	39 (1.7%)	14 (1.3%)	24 (2.1%)
Black or African American	417 (18.6%)	219 (19.8%)	198 (17.4%)
Middle Eastern or North African	10 (0.5%)	4 (0.4%)	6 (0.5%)
Native Hawaiian or Pacific Islander	23 (1.0%)	10 (0.9%)	13 (1.2%)
White	1699 (75.8%)	827 (74.8%)	871 (76.8%)
Other	72 (3.2%)	41 (3.7%)	31 (2.8%)
Education			
Some high school or less	188 (8.4%)	88 (8.0%)	100 (8.9%)
High school graduate or other post high school vocational training	978 (38.0%)	478 (37.5%)	500 (38.5%)
Some college, no degree	649 (29.2%)	324 (29.5%)	325 (28.9%)
Associate's or Bachelor's degree	370 (10.4%)	187 (11.3%)	183 (9.6%)
Master's, Doctorate, or professional degree	40 (1.3%)	22 (1.4%)	18 (1.3%)
Income, % below 185% FPL	1770 (79.0%)	877 (79.3%)	893 (78.7%)
Marital status			
Now married	699 (31.2%)	345 (31.2%)	354 (31.2%)
Single/Never married	655 (29.2%)	315 (28.5%)	340 (30.0%)
Domestic partnership/Living with partner	552 (24.6%)	263 (23.8%)	289 (25.5%)
Widowed, divorced, or separated	319 (1.9%)	177 (2.3%)	142 (1.5%)
Prefer not to answer	16 (0.7%)	6 (0.5%)	10 (0.9%)
Employed	1203 (53.7%)	612 (55.4%)	590 (52.0%)
SNAP participation, currently	1512 (67.5%)	748 (67.6%)	764 (67.3%)
WIC participation, currently	776 (34.6%)	377 (34.1%)	399 (35.1%)
Responsible for most of household food shopping	2182 (97.4%)	1083 (97.9%)	1099 (96.8%)
Shopping task characteristics			
Sugary drink calories purchased per basket	1245 (1946)	1887 (2113)	620 (1528)
Total calories purchased per basket	3563 (2168)	3515 (2338)	3609 (1989)
Total beverage calories purchased per basket	3551 (2174)	3503 (2347)	3599 (1991)
Total dollars spent per basket	$17.48 (6.21)	$18.77 (6.33)	$16.21 (5.83)
Total dollars spent on sugary drinks per basket	$4.56 (6.26)	$7.01 (6.85)	$2.16 (4.49)
Total dollars spent on unsweetened water per basket	$1.67 (2.98)	$0.48 (1.80)	$2.83 (3.42)
Total dollars spent on unsweetened milk per basket	$1.82 (3.11)	$0.36 (1.23)	$3.25 (3.68)
Total dollars spent on 100% fruit juice per basket	$5.03 (5.89)	$5.07 (5.92)	$4.99 (5.88)
Total sugar (g) from all beverages purchased per basket	668.2 (498.6)	774.9 (538.8)	564.1 (431.6)
Total sugar (g) from sugary drinks purchased per basket	280.9 (449.9)	426.7 (491.2)	138.9 (351.9)
Total added sugar (g) from all beverages purchased per basket	248.8 (416.9)	376.7 (464.1)	124.2 (319.2)
Total added sugar (g) from sugary drinks purchased per basket	247.7 (416.2)	376.1 (462.9)	122.6 (318.8)
Total volume of beverages purchased per basket	430.2 (307.9)	364.0 (266.8)	494.7 (331.0)

(Continues)

TABLE 2 (Continued)

	All ($n = 2241$) Mean (SD) or *n* (%)	Control condition ($n = 1106$) Mean (SD) or *n* (%)	Healthy nudges condition ($n = 1135$) Mean (SD) or *n* (%)
Total volume of sugary drinks purchased per basket	113.4 (180.2)	171.4 (187.6)	56.8 (152.8)
Total volume of unsweetened water purchased per basket	124.5 (231.4)	37.5 (137.5)	209.3 (269.7)
Total volume of unsweetened milk purchased per basket	61.4 (94.0)	11.7 (35.8)	109.8 (107.0)
Total volume of 100% fruit juice purchased per basket	92.2 (118.4)	99.2 (115.2)	85.4 (121.0)
Percent of beverages selected from the top row of a beverage shelf out of total beverages selected	12.5 (20.2)	7.6 (17.2)	17.3 (21.6)

[a]Participants were allowed to check all choices that applied, so percentages exceed 100%.

2.4 | Outcomes and measures

Our primary outcome was total calories purchased from sugary drinks. Secondary outcomes included (1) total calories, total added sugars and total sugars purchased; (2) total volume of sugary drinks, healthy substitutes and total beverages purchased; (3) proportion of swaps accepted; (4) proportion of beverages with a high shelf ranking accepted; and (5) number of beverage products selected from the top row of a beverage 'shelf' (i.e. the first three products) as a proportion of total beverages selected.

2.5 | Statistical analysis

We used ordinary least squares regression to regress the outcome variable on an indicator variable for the experimental condition, with the control condition as referent. To calculate our sample size, we used estimates from a similar study that found that health warnings led to a reduction of −31.4 calories of sugary drinks purchased in a naturalistic laboratory store.[29] Based on the assumption that our effect size would be smaller, pre-specified analyses indicated that enrollment of 2128 caregivers would provide 80% power to detect at least a difference of 15 calories between conditions.

Among the 5377 individuals assessed for eligibility, we excluded participants who failed a Captcha verification question ($n = 20$), failed a fraud question and an attention check question ($n = 45$), and/or did not finish the survey ($n = 2347$) or shopping task ($n = 776$). We also excluded non-beverage purchases from analyses. Those who completed the survey only (versus survey and shopping task) were less likely to be male (12.4% vs. 15.6%; $p = 0.03$), older (24.1 vs. 22.5 years; $p < 0.001$), white (70.0% vs. 75.8%; $p = 0.001$), unemployed (39.5% vs. 46.3%; $p = 0.001$) and have more than a high school degree (41.9% vs. 48.0%; $p < 0.001$).

3 | RESULTS

The final sample included 2241 adults with a median household size of 4.5 (IQR = 3, 5) persons (Figure 1). Approximately 68% of participants reported currently receiving SNAP benefits (Table 2); and 81% reported ever shopping online for groceries (Table S2). On average, participants in the experimental condition purchased 620 (SD = 1528) calories from sugary drink products, compared with 1887 (SD = 2113) calories in the control condition. This difference of 1267 calories was statistically significant (95% CI: 1419, 1114) (Table 3). We also observed fewer total dollars spent on sugary drinks ($\beta =$ $-2.56 (95% CI: −3.06, −2.06)). Those in the experimental condition also purchased fewer grams of *total* sugar from all beverages ($\beta = -210.8$ g (95% CI: −251.2, −170.4)) and from sugary drinks ($\beta = -287.8$ g (95% CI: −323.1, −252.5)), with similar results for *added* sugars purchased from all beverages and sugary drinks. In contrast, we observed no difference in calories purchased from all beverages between conditions ($\beta = 96$ kcal (95% CI: −84, 276)).

Similarly, we observed that those in the experimental condition purchased fewer fluid ounces of sugary drinks ($\beta = -115$ oz. (95% CI: −129, −101)), and more fluid ounces of all beverages ($\beta = 131$ (95% CI: 106, 156)), than those in the control condition (Table 3). The volume of unsweetened water products ($\beta = 171.8$ oz. (95% CI: 154.0, 189.6)) and unsweetened milk products ($\beta = 98.1$ oz. (95% CI: 91.5, 104.8)) purchased was also higher in the experimental condition, but the total volume of 100% fruit juice purchased ($\beta = -13.8$ oz. (95% CI: −23.5, −4.0)) was lower compared to the control condition. We also observed higher spending on unsweetened water products and milk products, but no difference in spending on 100% fruit juice between conditions; and lower spending overall in the experimental group.

Participants in the experimental condition selected 9.8% (95% CI: 8.1, 11.4) more of their beverage purchases from the top row compared to those in the control condition (Table 3). Yet, in the post-shopping questionnaire, twice as many participants in the experimental condition (40%) reported that beverages without added sugars showed up first at the top of the screen when they clicked on a shelf category, compared to the control condition (20%). About 49% ($n = 510$) of participants in the experimental condition were offered a swap as a result of selecting a sugary drink product; of those, 248 participants accepted a swap (49%). On average, participants were offered 5.7 (SD = 12.1) swap products, accepted 1.5 (SD = 0.9) swap products and viewed 8.2 (SD = 11.2) additional swap products by

TABLE 3 Model-based estimates for primary and secondary outcomes from the shopping task.

	β (95% CI)
Primary outcome[a]	
Sugary drink calories purchased per basket	**−1266.8 (−1419.3, −1114.4)**
Secondary outcomes[a]	
Total beverage calories purchased per basket	96.1 (−84.1, 276.2)
Total dollars spent on all beverages per basket	**$-2.56 (−3.06, −2.06)**
Total dollars spent on sugary drinks per basket	**-$4.85 (−5.33, −4.37)**
Total dollars spent on unsweetened water per basket	**$2.34 (2.12, 2.57)**
Total dollars spent on unsweetened milk per basket	**$2.89 (2.66, 3.12)**
Total dollars spent on 100% fruit juice per basket	$-0.08 (−0.57, 0.40)
Total sugar (g) from beverages purchased per basket	**−210.8 (−251.2, −170.4)**
Total sugar (g) from sugary drinks purchased per basket	**−287.8 (−323.1, −252.5)**
Total added sugar (g) from beverages purchased per basket	**−252.6 (−285.5, −219.6)**
Total added sugar (g) from sugary drinks purchased per basket	**−253.5 (−286.3, −220.6)**
Total volume of beverages purchased per basket	**130.7 (105.7, 155.6)**
Total volume of sugary drinks purchased per basket	**−114.7 (−128.8, −100.5)**
Total volume of unsweetened water purchased per basket	**171.8 (154.0, 189.6)**
Total volume of unsweetened milk purchased per basket	**98.1 (91.5, 104.8)**
Total volume of 100% fruit juice purchased per basket per basket	**−13.8 (−23.5, −4.0)**
Percent of beverages selected from the top row of a beverage shelf out of total beverages selected	**9.8 (8.1, 11.4)**

Note: Bold indicates $p < 0.05$.
[a]All outcomes correspond to all beverages purchased per basket (i.e. per shopping trip).

clicking 'Show Me Another' in the pop-up box. Among those offered swaps, 78% and 55% somewhat or strongly agreed the swap messaging made them think about the sugar content of the beverage and encouraged them to purchase a beverage with less sugar, respectively (Figure 2).

4 | DISCUSSION

Nudges led participants to purchase ~1300 fewer calories from sugary drinks in our experimental online store, including fewer grams of total sugar and added sugar from all beverages. We also observed no effect on total calories purchased from all beverages, suggesting that caregivers substituted sugary drinks with other, more nutrient-dense, caloric beverages that support optimal development of young children. Indeed, caregivers exposed to nudges purchased a larger volume of unsweetened milk and unsweetened water products, and a smaller volume of 100% fruit juice products. These shifts are nutritionally beneficial, considering that unsweetened milk and unsweetened water are the recommended beverages for children age 1–5 years, whereas 100% fruit juice should be consumed in moderation.[28] Furthermore, we observed lower overall spending in the experimental group, potentially due to the lower average price of sugary drink products ($4.22 (SD = 2.84)) in our store relative to the average price of unsweetened water products ($3.23 (SD = 2.00)) and milk products ($2.98 (SD = 1.41)).

Our findings suggest that nudging can be a promising food policy or voluntary intervention by retailers. In Berkeley, CA and Perris, CA, for example, healthy checkout policies ban the placement of items in checkout aisles with high added sugars,[30,31] and the United Kingdom implemented legislation that restricts the promotion of unhealthy foods in key store locations, including online checkout pages,[32] suggesting that online nudge policies are feasible. Though no swap policies currently exist, retailers may consider voluntary intervention given how in this study the effect of the nudges was 'cost neutral' and about half of caregivers accepted a swap when offered and were willing to spend time viewing eight swap options on average. Our retailer partners also found the nudges to be acceptable and feasible in usability testing.

Our findings are consistent with previous work, including two studies that found offering swaps in online supermarkets resulted in lower energy per shopping basket and improvements in nutrient profiling scores of product choices.[21,23] In contrast, a previous study found that placing healthy products on the check-out page had no effect on the percentage of healthy products purchased,[33] and another study found that ordering online products by carbon footprint had found no effect on the probability of choosing more sustainable products.[34] Our results, however, suggest that modifications to the placement of beverage products by sugar content may more strongly influence purchasing behaviours than other factors, and that caregivers in lower-income households may navigate beverage product selection differently than other types of consumers or other types of

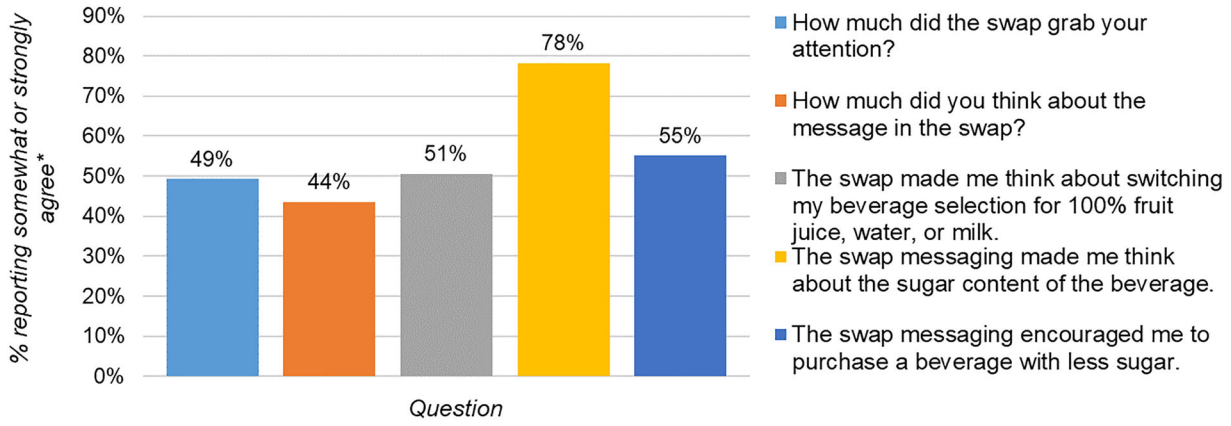

FIGURE 2 *Response options: 1 = Strongly disagree; 2 = Somewhat disagree; 3 = Neither agree nor disagree; 4 = Somewhat agree; 5 = Strongly agree.

products. That said, our effect size is approximately equivalent to the daily recommended caloric intake for children 1–5 years, but caregivers were instructed to purchase three beverage products, typically sold with multiple servings, so the magnitude of effect is likely smaller for daily consumption.[35]

Strengths of this study include the use of a realistic online experimental store with over 13 000 products. Hypothetical beverage selections may not have reflected real-world purchases, but participants reported that their beverage purchases were similar to their regular beverage purchases and we expect that the lottery incentivized participants to select beverages they actually wanted to give to their child. The results may not generalize to all caregivers with lower incomes, given how participants who did not complete the shopping task were slightly more likely to be female, younger, non-white, employed and have lower educational attainment; and also given how the study sample included a higher percentage of white participants relative to the racial/ethnic distribution of individuals with lower incomes in the United States.[36] Importantly, we cannot disentangle the effects of the two types of nudges, and cannot know which specific pair of products were swapped per participant. However, we were able to track participants' engagement with swap offers (e.g. rate of acceptance) and products shown at the top of a shelf, which provides some insight into potential mechanisms.

5 | CONCLUSION

Our experiment provides compelling evidence that the combination of swaps and product placement nudges is an effective strategy for motivating caregivers to purchase healthier products in online stores, including shifting to purchases of beverage products with fewer added sugars for children in lower-income households. Our results add to a growing body of work showing that nudge strategies in online retail spaces are feasible, acceptable and low cost. In the future, researchers should partner with retailers to explore the impact of real-world implementation of online swaps and product placement nudges, especially in communities with lower incomes.

AUTHOR CONTRIBUTIONS

All authors conceived and designed the experiment, and interpreted the data. PER and LST obtained funding and supervised team members. PER conducted statistical analyses. CS and CEP provided administrative support. All authors were involved in writing the paper and had final approval of the submitted and published versions.

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CONFLICT OF INTEREST STATEMENT

None reported.

DATA AVAILABILTY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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