

# Reduction in Purchases of Sugar-Sweetened Beverages Among Low-Income Black Adolescents After Exposure to Caloric Information

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The consumption of sugar-sweetened beverages (SSBs), which include soda, sport drinks, energy drinks, and fruit drinks, has been associated with adolescent obesity<sup>1</sup> and is highest among minority and lower-income adolescents, accounting for approximately 15% of their total daily intake.<sup>2</sup> For example, Black adolescents consume roughly the equivalent of 2 cans of soda daily.<sup>2</sup> Mounting evidence strongly supports limiting the intake of SSBs to improve energy balance, primarily because calories in liquid form may be less well compensated than are calories in solid form.<sup>3-5</sup> In other words, the average adolescent does not eat fewer calories from solid foods to account for calories consumed from liquids.

People generally underestimate the number of calories in the foods they consume.<sup>6</sup> A recent study asking participants to estimate the caloric content of 9 restaurant entrées found that 90% underestimated the caloric content of less healthy items by an average of more than 600 calories.<sup>6</sup> Although initiating and maintaining behavior changes on the basis of calorie information is theoretically a difficult and complex process,<sup>7</sup> there is some empirical evidence suggesting that consumer choices can be markedly affected by information.<sup>8,9</sup> For instance, 1 study found that when consumers are presented with calorie information they choose the high-calorie items approximately one third less often,<sup>6</sup> and another study found that when individuals are exposed to calorie information at the point of purchase, they buy food with fewer calories.<sup>10</sup> However, a recent systematic review of the broader literature suggests that the effect of caloric information on food consumption and purchases is weak or inconsistent.<sup>11</sup> This finding may be related to how caloric information was presented.

An important deficit shown in the literature, which may help improve the effectiveness of calorie-posting initiatives aimed at reducing

**Objectives.** We examined the effect of an intervention to provide caloric information about sugar-sweetened beverages (SSBs) on the number of SSB purchases.

**Methods.** We used a case-crossover design with 4 corner stores located in low-income, predominately Black neighborhoods in Baltimore, Maryland. The intervention randomly posted 1 of 3 signs with the following caloric information: (1) absolute caloric count, (2) percentage of total recommended daily intake, and (3) physical activity equivalent. We collected data for 1600 beverage sales by Black adolescents, aged 12–18 years, including 400 during a baseline period and 400 for each of the 3 caloric condition interventions.

**Results.** Providing Black adolescents with any caloric information significantly reduced the odds of SSB purchases relative to the baseline (odds ratio [OR]=0.56; 95% confidence interval [CI]=0.36, 0.89). When examining the 3 caloric conditions separately, the significant effect was observed when caloric information was provided as a physical activity equivalent (OR=0.51; 95% CI=0.31, 0.85).

**Conclusions.** Providing easily understandable caloric information—particularly a physical activity equivalent—may reduce calorie intake from SSBs among low-income, Black adolescents. (*Am J Public Health*. Published online ahead of print December 15, 2011; e1–e7. doi:10.2105/AJPH.2011.300350)

caloric intake, is identifying the most effective mode for presenting consumers with calorie information. Most efforts have focused on absolute caloric information (i.e., calorie count). For example, the Patient Protection and Affordable Care Act requires fast food restaurants to provide “clear and conspicuous” caloric information on menu boards beginning in mid-2012. In April 2011, the Food and Drug Administration invited public comment on 2 sets of proposed regulations that would ensure calorie labeling on menus and menu boards in chain restaurants, retail food establishments, and vending machines with 20 or more locations. Currently the law remains ambiguous about how those calories must be reported.<sup>12</sup> This lack of concrete guidelines may actually create an opportunity to improve the effectiveness of caloric information on purchasing behavior, particularly among groups at the highest risk for obesity.

There are several reasons providing consumers with relative caloric information may

be more desirable than providing them with absolute caloric information. Absolute caloric information requires consumers to translate the information into interpretable equivalents—a task made more challenging by low levels of nutritional literacy and numeracy, which are highest among low socioeconomic status and minority groups<sup>13-15</sup> Information-based interventions that require less mental processing may be more successful than are information-based interventions requiring greater computation or comprehension effort.<sup>16</sup> Moreover, presenting relative caloric information in terms of its effect (i.e., minutes of running required to burn off a can of soda) may have a greater effect on food purchasing behavior. There is a large body of research suggesting that unfavorable information is more persuasive to consumers.<sup>17</sup>

We examined whether providing caloric information about SSBs significantly reduces the volume of SSB purchases among Black adolescents and tested whether varying forms of caloric information on SSBs differently

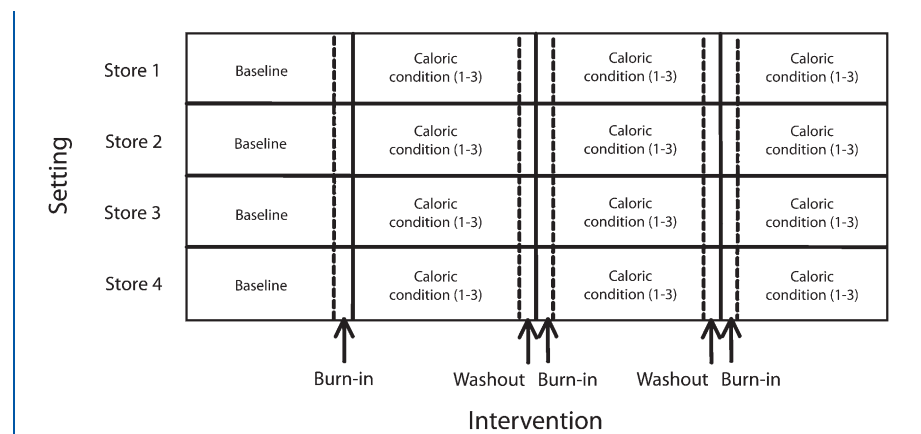
affects the volume of SSB purchases. We hypothesized that providing caloric information in an easily understandable format would reduce adolescent purchases of SSBs. In particular, we hypothesized that relative caloric information (i.e., percentage daily value or physical activity equivalent) would have a larger effect on SSB purchases than would absolute calorie information and that providing consumers with relative caloric information in the form of physical activity equivalents would have a larger impact on SSB sales than would providing relative caloric information in the form of percentage daily value. To our knowledge, no other study has evaluated potentially more effective modes for communicating caloric information about SSBs to adolescents at high risk for obesity and SSB consumption.

## METHODS

We designed an intervention to provide caloric information on SSBs in 4 stores and collected data on the purchases made before and after the intervention. Our design was a variant of the case-crossover design and allowed us to identify whether the change in SSB purchases after the intervention was greater than would be expected as a result of chance.<sup>18</sup> The target population was low-income Black adolescents, aged 12–18 years, living in Baltimore City, Maryland. The study design is summarized in Figure 1.

### Stores

We identified corner stores near middle and high schools in Baltimore City using Google maps. Corner stores were eligible for inclusion in this study if they were within walking distance to a middle or high school ( $\leq 5$  city blocks), the population of the zip code was at least 70% Black, and water and diet soda were available in the store's beverage cases. We obtained characteristics of the zip codes from the 2000 US Census. We further restricted this study to West Baltimore to avoid possible cross-contamination with a concurrent obesity-related corner store intervention in East Baltimore called Baltimore Healthy Stores.<sup>19</sup> Using these criteria, we approached 15 corner stores in the eligible areas to reach our target of 4 stores. The reasons for refusal were language barriers (5 stores),<sup>20</sup> lack of water or diet beverages for



**FIGURE 1—Study design: a store-based intervention to reduce sugar-sweetened beverage consumption among low-income Black adolescents, Baltimore, MD, April–October, 2011.**

purchase (8 stores), and concern that the intervention might negatively affect beverage sales (2 stores). We intentionally did not use existing business databases to identify all available corner stores and then take a random sample because recent research on the food environment suggesting that certain businesses are less likely to be included in commercial database listings.<sup>21</sup>

### Caloric Information Intervention

We examined 3 interventions to provide caloric information on SSBs: caloric condition 1—providing an absolute caloric count; caloric condition 2—providing a percentage of total recommended daily intake, hereafter referred to as percentage daily value; and caloric condition 3—providing a physical activity equivalent, represented as the number of minutes jogging. We used 250 calories for the absolute caloric count by obtaining this number directly from the nutritional label on a typical soda bottle. To translate 250 calories into an estimate of the percentage daily value, we assumed a sedentary lifestyle—on the basis of evidence suggesting that physical activity levels among Black adolescents are low compared with those among White adolescents<sup>22,23</sup>—and averaged the total recommended caloric intake for boys and girls. Using this approach, we calculated a bottle of soda to be equivalent to approximately 10% of total recommended daily intake. To translate calories into a physical activity equivalent, we used the energy balance equation, described in detail elsewhere.<sup>24</sup> Using this formula, we calculated that a 15-year-old individual

who weighs 110 pounds (50 kg) would need to replace sitting with jogging for 50 minutes to burn off 250 extra calories from a bottle of soda. We intentionally selected jogging (rather than potentially more enjoyable physical activities such as basketball or dancing) because of research suggesting that unfavorable information is more persuasive to consumers.<sup>17</sup>

For each type of calorie information, we placed a brightly colored 8.5 × 12 inch sign in a prominent location on each beverage case in each corner store. We used the following text on the signs for the 3 different caloric conditions: caloric condition 1—“Did you know that a bottle of soda or fruit juice has about 250 calories?”; caloric condition 2—“Did you know that a bottle of soda or fruit juice has about 10% of your daily calories?”; and caloric condition 3—“Did you know that working off a bottle of soda or fruit juice takes about 50 minutes of running?”

### Beverage Purchases Outcome

We obtained information on beverage purchases for a random sample of beverages purchased by Black adolescents who appeared to be between 12 and 18 years of age. For uniformity, the same member of the research team collected all the data. For the baseline period and each period when a caloric condition sign was posted, we collected a random sample of approximately 25 adolescent beverage purchases per store per week. When adolescents purchased more than 1 beverage, we recorded the drink touching the counter

first. For each beverage sale, we collected the buyer's gender; the date, time, and store location of purchase; and which of 8 types of beverage was purchased. The 5 SSB categories were soda, fruit drink, sport drink, vitamin water, and "hug" (a fruit drink packaged in 8-ounce bottles), and the 3 non-SSB categories were diet soda, water, and 100% juice.

**Data Collection**

At each of 4 corner stores, we collected baseline data before the intervention for approximately 4 weeks (Figure 1). Following baseline, we randomly assigned corner stores to each caloric condition for approximately

a 2-week period during which we collected beverage sales data. Before collecting data for each caloric condition, we allowed for a week of "burn-in" time during which we posted caloric information but did not record beverage sales. Between each caloric condition, we allowed for a week of "washout" time during which we removed caloric information and did not record beverage sales. We collected data over 6 months in 2010 and staggered it to account for possible seasonal variations in beverage purchases. We recorded beverage purchases in 2 stores from April to July and in 2 stores from July to October. Study staff conducted site visits at least once a week at

each store to make sure the signs providing the caloric information were appropriately displayed on the beverage refrigerators.

**Statistical Analysis**

We used the  $\chi^2$  test to test for differences in the frequency of SSB purchases by type of caloric information. We also used multivariate logistic regressions to examine the relationship between SSB purchases and type of caloric information. We separately modeled the relationship between SSB purchases and (1) any caloric information and (2) the 3 types of caloric information. The regression models controlled for the store where the beverage

**TABLE 1—Study Sample Characteristics, Overall and by Store: A Store-Based Intervention to Reduce SSB Consumption Among Low-Income Black Adolescents, Baltimore, MD, April–October, 2011**

Characteristic	All (n=1600), No. (%) or Mean	Store 1 (n=400), No. (%) or Mean	Store 2 (n=400), No. (%) or Mean	Store 3 (n=400), No. (%) or Mean	Store 4 (n=400), No. (%) or Mean	P
<b>SSB</b>						
Yes	1413 (88)	354 (89)	346 (86)	362 (91)	351 (88)	.35
No	187 (12)	46 (12)	54 (14)	38 (10)	49 (12)	
<b>SSB type</b>						
Soda	643 (40)	142 (36)	144 (36)	170 (43)	187 (47)	<.001
Fruit drink	548 (34)	144 (36)	136 (34)	148 (37)	120 (30)	
Iced tea	129 (8)	31 (8)	43 (11)	34 (9)	21 (5)	
Sport drink	59 (4)	30 (8)	12 (3)	6 (2)	11 (3)	
Hug	34 (2)	7 (2)	11 (3)	4 (1)	12 (3)	
<b>Non-SSB type</b>						
Water	144 (9)	35 (9)	48 (12)	31 (8)	30 (8)	
100% juice	32 (2)	10 (3)	2 (1)	5 (1)	15 (4)	
Diet soda	11 (1)	1 (<1)	4 (1)	2 (1)	4 (1)	
<b>Sex</b>						
Male	800 (50)	193 (48)	211 (53)	201 (50)	195 (49)	.56
Female	799 (50)	207 (52)	189 (47)	199 (50)	204 (51)	
<b>Time of day</b>						
Before 4 p.m.	643 (40)	239 (60) 0 (0)	230 (58)	83 (21)	91 (23)	<.001
4 p.m. or after	957 (60)	161 (40)	170 (43)	317 (80)	309 (77)	
<b>Time of year</b>						
School year	782 (49)	160 (40)	140 (35)	200 (50)	282 (71)	<.001
Summer	818 (51)	240 (60)	260 (65)	200 (50)	118 (29)	
<b>Weekend</b>						
Yes	192 (12)	39 (10)	43 (11)	83 (21)	27 (7)	<.001
No	1408 (88)	361 (90)	357 (89)	317 (79)	373 (93)	
<b>SSB price, \$</b>						
	1.25	1.29	1.27	1.18	1.28	<.001

Note. SSB = sugar-sweetened beverage. Beverage purchases are from 4 corner stores in a low-income, predominantly Black neighborhood of Baltimore. Columns may not sum to 100% as the result of missing values or rounding error. The P values were obtained from the  $\chi^2$  test, which compares the study sample characteristics across the 4 stores. In the 2009–2010 school year, the last day of school was June 10, so we counted June as summer. The "Vitamin Water" brand is included in the sport drink category. Store 1 = Fayette Market and Convenience Store; Store 2 = Penn Supermarket; Store 3 = Blooming Sun; Store 4 = Melvin's Food Market.

**TABLE 2—Unadjusted Percentages of SSBs and non-SSBs by Type of Caloric Information: A Store-Based Intervention to Reduce SSB Consumption Among Low-Income Black Adolescents, Baltimore, MD, April–October, 2011**

Beverage	Postintervention				P
	Preintervention (No Information)	Caloric Condition 1 (Absolute Calories)	Caloric Condition 2 (Percentage Daily Value)	Caloric Condition 3 (Physical Activity Equivalent)	
All SSBs	93.3	87.5	86.5	86.0	.005
All non-SSBs	6.7	12.5	13.5	14.0	
Soda	43.0	41.3	38.0	38.5	<.001
Fruit drink	33.5	33.8	33.0	36.8	
Iced tea	7.3	8.3	10.0	6.8	
Sport drink	4.5	3.0	3.8	3.5	
Hug	5.0	1.3	1.8	0.5	
Water	5.0	9.8	10.5	10.8	
100% Juice	0.1	2.8	1.8	2.8	
Diet soda	1.0	0.0	1.3	0.5	

Note. SSB = sugar-sweetened beverage. Beverages were purchased from 4 corner stores in a low-income, predominantly Black neighborhood of Baltimore. Numbers may not sum to 100% as the result of rounding. The P values were obtained from the  $\chi^2$  test, which compares the percentage of purchases at baseline and at each caloric condition.

was purchased, the time of day (before 4 p.m. vs at or after 4 p.m.), the time of year (school year vs summer), the time of week (weekday vs weekend), and the average beverage price per store. For the time of year variable, we counted June as summer because the last day in the 2009–2010 school year was June 10. In addition, we tested for differential effects of caloric information on SSB purchases between boys and girls by interacting the information intervention with gender. We also ran multivariate logistical regressions for the odds of purchasing each of the 8 different types of beverages separately (i.e., odds of purchasing water vs any other drink). Our statistical analyses were performed using Stata version 9.2 (StataCorp LP, College Station, TX).

## RESULTS

Table 1 reports the characteristics of the entire study sample, combining the pre- and postintervention periods. Overall, most adolescents who purchased a beverage bought a SSB (88%). The most common types of SSBs purchased were soda (40%) and fruit drinks (34%). In addition, half of the beverage purchases we observed were made by male adolescents (50%), most beverages were purchased at or after 4 p.m. (60%), half of the beverages were purchased during the school year

(49%), and most of the beverages were purchased during the week (88%). Some study characteristics varied significantly by store: type of beverage purchased, time of day of beverage purchase, time of year of beverage purchase, time of week of beverage purchase, and beverage price ( $P < .001$ ). Gender was not determined for 1 purchase.

### Frequency of Purchases by Type of Caloric Information

Table 2 presents the frequency of each beverage type pre- and postintervention, unadjusted for potential covariates. At baseline, SSBs accounted for 93.3% of all beverage purchases compared with 87.5% during caloric condition 1, 86.5% during caloric condition 2, and 86.0% during caloric condition 3. Put differently, non-SSBs accounted for 6.7% of all beverage purchases compared with 12.5% during caloric condition 1, 13.5% during caloric condition 2, and 14.0% during caloric condition 3. The unadjusted frequency of SSB purchases overall was significantly lower ( $P = .005$ ) following the intervention. Moreover, the frequency of the different beverage types changed significantly ( $P < .001$ ) following the intervention.

### Beverage Purchases and Caloric Information

Table 3 presents the adjusted association between the odds of making an SSB purchase

and providing any calorie information and providing the 3 different types of caloric information. After adjusting for potential confounders (gender, store, time of day, time of year, weekend vs weekday, and average beverage price), providing any calorie information to Black adolescents (compared with the baseline in which none was provided) reduced the odds of an SSB purchase by approximately 40% (odds ratio [OR] = 0.56; 95% confidence interval [CI] = 0.36, 0.89).

When we identified the 3 caloric conditions separately, providing adolescents with caloric information in the form of a physical activity equivalent (represented as the minutes of running necessary to burn off a bottle of soda or fruit juice), compared with providing no information, reduced the odds of an SSB purchase by half (OR = 0.51; 95% CI = 0.31, 0.85). Providing adolescents with caloric information in the form of percentage daily value had a marginally significant ( $.05 < P < .1$ ) reduction in the odds of an SSB purchase of about 40% (OR = 0.59; 95% CI = 0.34, 1.02). We observed no significant association between the odds of an SSB purchase and providing absolute calorie information. Although these 3 ORs for the different types of information were not significantly different from each other in a formal test, the magnitude of the point estimates for the ORs for each type of calorie information was consistent with our hypothesis that relative caloric information (i.e., percentage daily value and physical activity equivalent) would have a larger effect on SSB purchases than would absolute calories and that between the 2 types of relative calorie information, the physical activity equivalent would have the greatest effect. Other significant predictors ( $P < .05$ ) in both models included the time of year (summer or school year) and whether the beverage purchase was made on a weekend or weekday.

In a separate model (not shown), we examined whether the impact of calorie information on SSB purchases differed for male and female adolescents. We did not observe a significant gender effect in the calorie information model or the type of calorie information model.

We also examined the effect of providing any information on the odds of purchasing each of the 8 different types of beverages to learn more about which types of SSB and non-



**TABLE 3—AORs for SSB purchases by Caloric Information and Covariates: A Store-Based Intervention to Reduce SSB Consumption Among Low-Income Black Adolescents, Baltimore, MD, April–October, 2011**

Characteristic	Any Caloric Information, AOR (95% CI)	Type of Caloric Information, AOR (95% CI)
Any caloric information		
Yes	0.56* (0.36, 0.89)	
No (Ref)	1.00	
Caloric condition		
Absolute calories		0.62 (0.37, 1.04)
Percentage daily value		0.59** (0.34, 1.02)
Physical activity equivalent		0.51* (0.31, 0.85)
Baseline (no information) (Ref)	1.00	1.00
Sex		
Female	1.14 (0.84, 1.56)	1.15 (0.84, 1.57)
Male (Ref)	1.00	1.00
Store		
Store 1	0.83 (0.49, 1.41)	0.82 (0.48, 1.40)
Store 2	0.68 (0.40, 1.15)	0.62 (0.37, 1.04)
Store 3	1.26 (0.79, 2.01)	1.26 (0.79, 2.02)
Store 4 (Ref)	1.00	1.00
Time of day		
Before 4 p.m.	1.49 (0.89, 2.48)	1.53 (0.91, 2.60)
4 p.m. or after (Ref)	1.00	1.00
Time of year		
School year	0.74 (0.48, 1.14)	0.73 (0.47, 1.13)
Summer (Ref)	1.00	1.00
Weekend		
Yes	0.51* (0.27, 0.95)	0.49* (0.26, 0.93)
No (Ref)	1.00	1.00
Average beverage price	0.49* (0.25, 0.97)	0.49* (0.25, 0.97)

Note. AOR = adjusted odds ratio; CI = confidence interval; SSB = sugar-sweetened beverage. Beverage purchases are from 4 corner stores in a low-income, predominantly Black neighborhood of Baltimore. These are the results from a logistic regression for the odds that a purchased beverage was an SSB. This table presents the full model with all covariates. Sample size was  $n = 1599$ . \* $P < .05$ ; \*\* $P < .1$ .

SSB purchases were affected. For example, we ran a logistic regression similar to that shown in the first column of Table 3 using soda versus any other beverage as the dependent variable. Figure 2 illustrates the adjusted distribution of beverage purchases before and after the intervention. Among the SSBs, the frequency of iced tea ( $P = .01$ ) and sport drinks ( $P = .04$ ) declined significantly; we also observed a decline in soda and hugs purchases, but the changes were not significant. Among the non-SSBs, the frequency of water increased significantly ( $P = .003$ ); we also observed a slight increase in purchases of 100% juice, but that change was not statistically significant.

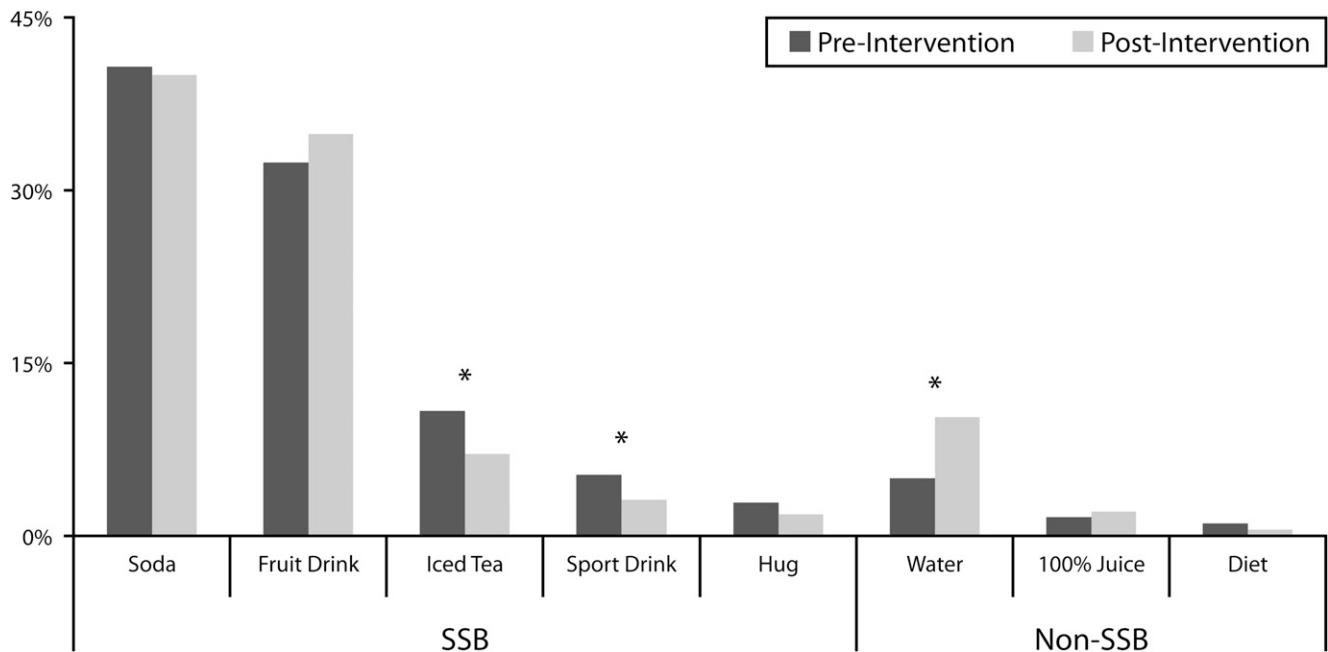
## DISCUSSION

We are among the first to examine differences in the effectiveness across modes for communicating caloric information about SSBs to adolescents at high risk for obesity and SSB consumption. Overall, we found that providing easily understandable caloric information—particularly in the form of a physical activity equivalent—may be an effective strategy for lowering calorie intake from SSBs among low-income Black adolescents and encouraging increased water consumption. Although we found support for our hypothesis that providing any caloric information reduced purchases

of SSBs among Black adolescents, our results also show that providing relative caloric information (i.e., percentage daily value or physical activity equivalent) has a larger effect on reducing SSB purchases than does providing absolute calorie information (i.e., calorie count), and that providing consumers with relative caloric information in the form of physical activity equivalent (i.e., minutes of running to burn off a bottle of soda or fruit juice) has a larger impact on SSB sales than does providing it in the form of percentage daily value.

Another interesting finding was the way the distribution of the various types of beverages changed after the intervention. We observed that purchases of iced tea and sport drinks declined significantly and purchases of water increased significantly. Our finding that the frequency of fruit drink purchases increased after the intervention was notable. This increase could be owing to a perception among adolescents that fruit drink is healthier than are soda and iced tea. Another possibility is that adolescents trying to make a healthier choice do a poor job at distinguishing between fruit drink and 100% juice.

Although to our knowledge this is the first study to evaluate the effectiveness of different modes for communicating caloric information about SSBs to adolescents, there are important comparisons with other studies evaluating the impact of caloric information on purchasing behavior. This body of research generally finds that absolute calorie information does not affect purchasing behavior overall<sup>11</sup> or among low-income minority individuals.<sup>25</sup> Research showing no effect of calorie labeling on purchasing behavior or a weak or inconsistent effect has been partially attributed to the low level of importance consumers may place on nutrition when purchasing food outside the home.<sup>11</sup> However, another plausible explanation is that consumers do a poor job at interpreting absolute caloric information because of low levels of nutritional literacy and numeracy, particularly among low socioeconomic status and minority groups.<sup>13–15</sup> This supports our finding that providing caloric information in the form of a physical activity equivalent (i.e., minutes of running to burn off a bottle of soda) actually reduces SSB purchases. Previous calorie labeling studies that have demonstrated effectiveness have accompanied the caloric information with promotional messages.<sup>26,27</sup> The fact that we



Note. SSB = sugar-sweetened beverage. These estimates are the predicted probabilities from 8 separate logistical regression models predicting the odds that a purchased beverage was that particular type. These estimates are, therefore, adjusted for gender, store, time of day, time of year, time of week (weekend vs weekday), and average beverage price.  $P < .05$

**FIGURE 2—Beverage purchases from 4 corner stores in a low-income, predominantly Black neighborhood of Baltimore: a store-based intervention to reduce sugar-sweetened beverage consumption among low-income Black adolescents, Baltimore, MD, April–October, 2011.**

observed an effect on behavior in the absence of additional prompts suggests that providing caloric information in the form of a physical activity equivalent (rather than absolute calories) may encourage adolescents to give caloric information greater consideration in their purchasing process.

This study has several strengths. First, we studied adolescent purchasing behavior in a real-world setting rather than in a controlled laboratory environment or hypothetical setting—an approach that maximizes the internal and external validity of our results. Second, we focused on the mode of communicating caloric information; most prior interventions evaluating the impact of caloric posting on behavior have used absolute caloric information, even though this is less persuasive to consumers.<sup>11,25</sup> Third, we focused on Black adolescents because low socioeconomic status minorities are at especially high risk for SSB consumption and obesity<sup>2,28</sup> and because this group has less nutritional knowledge, poorer diet quality, and a declining use of caloric information on food nutrition labels.<sup>13,14,29</sup> Fourth, our study design (i.e., a variant of the case-crossover design) should have

partially or completely eliminated confounding as the result of demographic characteristics, taste preferences, and other fixed characteristics for which we did not have data.

There are also several limitations of this study worth noting. The generalizability of study results are constrained by the focus on urban, Black neighborhoods in 1 city and the inclusion of only 4 corner stores. The translation of calories into percentage daily value and the translation of calories into a physical activity equivalent were founded on averages for adolescent males and females 12 to 18 years of age obtained from the literature. Because the daily caloric recommendations differ by age and activity level and the physical activity equivalents differ by gender, our use of averages may lead to some imprecision for the magnitude of the effect on different individuals. However, average estimates have been calculated previously<sup>30</sup> and should not dramatically change results.

Because we opted not to interview the adolescents (to not disrupt the true impact of the SSB signage on behavior), we do not know how many actually noticed the caloric

information. We did not measure actual SSB consumption, so possible waste (resulting from unfinished SSBs) is not knowable. Although we did collect a random sample of adolescent beverage sales from each store, adolescents who frequented a corner store may have been sampled more than once. This analysis was not able to account for autocorrelation (i.e., similarities between observations over time) because we did not have a unique identifier for each study participant. However, our study design should eliminate confounding resulting from demographic characteristics, taste preferences, and other fixed characteristics.

The later caloric conditions in each store may have included some carryover effects from earlier caloric conditions. Thus, the washout period may not have totally eliminated the effect of the previously posted signs. Although we were unable to eliminate this possibility, our randomization of the order of caloric conditions across stores suggests that differential carryover by condition should not be a problem. We did not gather information on beverage purchases during the washout

period, so we are unable to compare purchases during that period to purchases during a particular caloric condition at each store.

To test whether there was a cumulative effect, we compared the percentage of SSB purchases during the intervention period providing caloric information by whether that information was provided first, second, or third. We found no difference in the percentage of SSB purchases according to the timing. Although this implies that the results are not biased by an inadequate washout period, it has an interesting implication for the effectiveness of posting caloric information: the behavior modification may only occur when one sees the information at the point of purchase rather than simply having seen the information in the past. Finally, we did not collect data on the volume of the purchased beverage (i.e., 12-oz can vs 16-oz bottle). Therefore, we do not know whether the intervention led some adolescents to purchase a smaller-volume SSB.

Future work should explore whether the type of physical activity equivalent used to present calorie information (e.g., running, biking, swimming, dancing) differentially affects SSB purchases among other groups at high risk for obesity and SSB consumption, such as Hispanics. Going forward, a key challenge will be understanding possible short-term or long-term changes in revenue resulting from caloric information, as declines may considerably diminish sustainability or interest in participation among store and restaurant owners. Because of the inclusion of mandatory calorie labeling in the recent health reform bill,<sup>12</sup> it is also important to explore the most effective strategies for presenting caloric information to consumers on fast food restaurant menu boards. ■

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### Contributors

S.N. Bleich, B.J. Herring, and T.L. Gary-Webb conceptualized the study and developed the hypotheses. S.N. Bleich analyzed the data, drafted the article, and is the guarantor. All authors contributed to the interpretation of study findings and to the final draft of the article.

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### Human Participant Protection

The Johns Hopkins Bloomberg School of Public Health institutional review board approved the study.

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