Point-of-Purchase Price and Education Intervention to Reduce Consumption of Sugary Soft Drinks

Jason P. Block, MD, MPH, Amitabh Chandra, PhD, Katherine D. McManus, RD, MS, and Walter C. Willett, MD, DrPH

Objectives. We investigated whether a price increase on regular (sugary) soft drinks and an educational intervention would reduce their sales.

Methods. We implemented a 5-phase intervention at the Brigham and Women's Hospital cafeteria in Boston, Massachusetts. After posting existing prices of regular and diet soft drinks and water during baseline, we imposed several interventions in series: a price increase of 35% on regular soft drinks, a reversion to baseline prices (washout), an educational campaign, and a combination price and educational period. We collected data from a comparison site, Beth Israel Deaconess Hospital, also in Boston, for the final 3 phases.

Results. Sales of regular soft drinks declined by 26% during the price increase phase. This reduction in sales persisted throughout the study period, with an additional decline of 18% during the combination phase compared with the washout period. Education had no independent effect on sales. Analysis of the comparison site showed no change in regular soft drink sales during the study period.

Conclusions. A price increase may be an effective policy mechanism to decrease sales of regular soda. Further multisite studies in varied populations are warranted to confirm these results. (*Am J Public Health.* 2010;100:1427–1433. doi:10.2105/AJPH.2009.175687)

Consumption of regular (sugary) soft drinks has risen substantially over the past 25 years. Of all individual food types, soft drinks are the single largest contributor to caloric intake in the United States; they account for 7% of all calories consumed daily from 1999 through 2001 compared with 2.8% from 1977 through 1978.[1,2] The increased intake of regular soft drinks and other sugary beverages has significant health implications, including weight gain and an increased risk of developing diabetes.[3,4]

Individual-level interventions, those targeting 1 individual or a small group of individuals at a time, can lead to a reduction in sugary beverage consumption. One trial reduced the consumption of sugary beverages and achieved modest weight loss goals among adolescents who were randomized to receive home deliveries of noncaloric beverages and counseling on healthy beverage consumption.[5] A school-based nutrition education program for children aged 7 through 11 years achieved a modest reduction in carbonated beverage consumption and decreased the incidence of obesity and overweight.[6]

Population-level point-of-purchase strategies have the potential for larger effects at lower cost. Point-of-purchase interventions have successfully increased sales of fruits and vegetables in a cafeteria[7] and low-fat snack foods in vending machines[8] through the posting of educational messages and a reduction in the price of those items. Additionally, levying taxes has been associated with reduced cigarette smoking rates in several areas, including New York City[9] and the state of California.[10]

Public health leaders have called for the taxation of sugary beverages to discourage consumption and to raise public health funding for obesity prevention programs.[11,12] Alternatively, salient information about the health effects of regular soft drinks may affect consumption. To determine whether point-of-purchase strategies can reduce the consumption of regular soft drinks, we employed price and educational interventions in a hospital cafeteria.

METHODS

The cafeteria in Brigham and Women's Hospital, a 700-bed hospital in Boston, Massachusetts, was our intervention site. This cafeteria was open daily and served hospital staff, patients, and visitors. We also conducted the intervention at a beverage cart that was in the main lobby of the hospital, physically separated from the cafeteria and open only on weekdays.

We designed a 5-phase intervention with a sequential timeline, as shown in Figure 1. The intervention phases included (1) a baseline period during which original prices of all soft drinks and zero-calorie water were posted on the refrigerators selling those items; (2) a price increase on regular soft drinks of $0.45 (35%) with new prices posted on the refrigerators; (3) a washout period during which prices were returned to baseline; (4) an educational campaign with a poster and informational flyers posted at strategic locations in the cafeteria, all stating the same message: "Lose up to 15–25 pounds in one year and decrease your risk of diabetes by 1/2. Just skip one regular soda per day. For zero calories, try diet soda or water"; and (5) a combination phase with continuation of the educational poster and flyers and a reinitiation of the price increase of $0.45 on regular soft drinks. The baseline phase lasted 2 weeks and each intervention phase, including the washout period, lasted 4 weeks.

We chose the amount of the price increase by analyzing the few available studies on the price elasticity of demand for regular soft drinks. Three studies each have found different levels of price elasticity of demand, from unit elastic (for every percentage change in price, the demand falls by an equivalent amount) to very inelastic (demand changes very little with price changes).[13–15] As a result, we levied a significant price increase to account for the possibility that regular soft drink demand would be inelastic.

We created the educational message using the energy calculation that 1 pound of weight

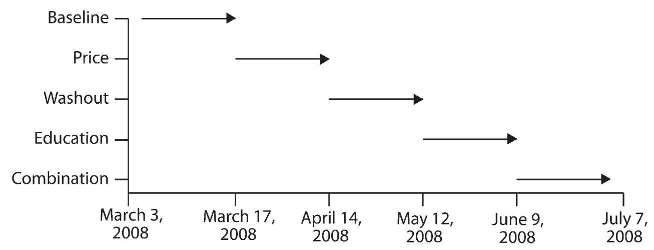


FIGURE 1—Four-phase timeline of soft drink point-of-purchase and education intervention: Brigham and Women's Hospital, Boston, MA, March 2008–July 2008.

loss requires a 3500-calorie deficit.[16] The cafeteria sells 20-ounce bottles of regular soda containing 250 calories, so decreasing intake by 1 bottle daily could lead to a 25-pound weight loss after 1 year if no other change in diet or activity occurred. Weight loss with caloric reduction can be variable,[17] and some people may drink 12-ounce cans of soda containing 150 calories. Because of this uncertainty, we reported a range of potential weight loss for the educational message.

Several weeks before the start of the intervention, we changed the cash registers in the cafeteria to include a button for regular soft drinks and another for diet soft drinks. Previously, the registers had 1 button for all soft drinks. The cafeteria management frequently reinforced the importance of proper assignment of soft drink categories to the cashiers through verbal and posted reminders. The study staff also visited the cafeteria frequently to reinforce this message at least 5 times per week throughout the course of the study during different cashier shifts. Additionally, we conducted blind purchasing of soft drinks and found that cashiers appropriately classified 96% (23 of 24) of purchases as diet or regular.

Measures

The primary outcome measures were daily sales of regular soft drinks, diet soft drinks, and zero-calorie water. Secondary outcome measures included sales of other categories of beverages: juice, coffee, sugary water, and fountain soft drinks. We defined regular soft drinks as carbonated beverages with calories (e.g., Pepsi and Tropicana Twister) and diet soft drinks as carbonated beverages without calories (e.g., Diet Pepsi). We defined juice as any fruit juice or noncarbonated, fruit-flavored beverage (e.g., Nantucket Nectars, Dole, Gatorade, Odwalla, and Snapple). Water included zero-calorie nonflavored or artificially flavored water (e.g., Dasani and Poland Spring), and sugary water included beverages marketed as water but sweetened with high-fructose corn syrup or other caloric sweeteners (e.g., Vitamin Water, Life Water, Gatorade Water, and O Water).

We also assessed secondary outcomes that could reveal unintended consequences of the intervention. We measured total quantity sales (quantity of 1 assigned to each item sold) and net monetary revenue to determine whether overall sales or revenue changed during the course of the intervention. We tracked snack food and dessert sales to measure whether the intervention increased sales of unhealthy foods. We collected all data from daily sales sheets provided by the cafeteria.

Analysis

We ran regression models with each of the primary and secondary outcomes, expressed as daily sales, as dependent variables. The primary predictors were the intervention phases, coded as dummy variables, with the baseline phase as the reference. Covariates were included in the models to control for temporal and other predicted fluctuations in sales: day of the week to account for fluctuations in sales by day and Easter, July Fourth, and Memorial Day holidays to account for predicted lower sales on those days. We also controlled for total sales of beverages that we hypothesized the intervention would not affect (milk and tea) to account for temporal fluctuations in sales. We used autoregressive regression procedures when evidence of temporally autocorrelated sales data were found or routine linear regression procedures if no such temporal autocorrelation was present. Using the parameter estimates and standard errors, we calculated the adjusted percentage change in the quantity of beverages sold from baseline, with 95% confidence intervals (CIs) for each of the beverage categories. We report these percentage changes rather than the absolute change in sales.

Comparison Site Analysis and Customer Survey

We collected data for the final 3 months of the study from a nearby hospital, Beth Israel Deaconess Hospital, as a comparison site. No interventions were underway at this site. We selected this period for this site analysis because Beth Israel implemented electronic scanners for their checkout process just before the washout period started at the intervention site. We included sales data from 2 cafeteria sites and a beverage stand on this hospital's campus. We used the same regression models for this comparison site analysis as for the intervention site. However, because we had only 3 months of data for this analysis, we used the washout period as the reference.

Two weeks after the completion of the intervention, we surveyed a convenience sample of cafeteria customers at the intervention site during weekdays for 1 week. We asked all individuals walking into the cafeteria at lunchtime, from 11:30 a.m. to 1:30 p.m. to fill out a brief questionnaire; 154 customers completed the survey. In addition to collecting basic information about why and how often the respondents dined at the cafeteria, the questionnaire included questions about beverage preferences, primary factors in beverage selection, and awareness of the interventions that we had recently completed. We conducted all analyses with SAS version 9.1 (SAS Institute, Cary, NC).

RESULTS

In the baseline phase, regular and diet soft drinks comprised 11% and 10% of total beverage sales, respectively, at the intervention site. Juice was the most popular beverage, representing 22% of total beverage sales. Table 1 presents mean sales at baseline.

TABLE 1—Mean Daily Beverages Sold in the Baseline Phase of a Soft Drink Point-of-Purchase and Education Intervention: Brigham and Women's Hospital, Boston, MA, March 2008–July 2008

Beverage Type	No. of Beverages, Mean (SD)	Total Beverages, %
Regular soft drinks	199 (49)	11
Diet soft drinks	174 (46)	10
Water	172 (43)	10
Sugary water	52 (15)	3
Juice	393 (79)	22
Coffee	326 (97)	19
Tea	142 (42)	8
Milk	150 (44)	9
Fountain drinks	154 (43)	9

During the study period, regular soft drink sales significantly declined in each of the phases compared with baseline (Figure 2), including a 26% decline (95% CI=39.0, 14.0) in sales when the price was increased and a 36% decline (95% CI=49.0, 23.0) during the combination phase. Diet soft drink sales increased by 20% (95% CI=7.0, 33.0) during the price phase and 14% (95% CI=0.3, 28.0) during the combination phase.

Sugary water sales significantly decreased during the washout and combination phases. Juice sales declined during the education and combination phases, and coffee sales increased during the washout, education, and combination phases. No changes were evident for water or fountain soft drink sales during any phase. Snack and dessert sales did not significantly change throughout the study period, nor did total quantity sales or net monetary revenue.

Because many of the changes in sales developed during the price increase phase and remained stable thereafter, we repeated the analysis using the washout phase as the reference. In this analysis, regular soft drink sales significantly declined by 17% (95% CI=30.0, 3.0) in the combination phase but had a nonsignificant sales increase of 9% (95% CI=–4.0, 22.0) in the education phase. Water sales did not change in the education phase but significantly increased by 7% (95% CI=1.0, 13.0) in the combination phase. Coffee sales also significantly increased by 5% in the combination phase (95% CI=1.0, 9.0). We did not note any changes for the other beverage categories. To test whether the combination price and educational intervention had a greater effect than the price increase alone, we compared regular soda sales during these 2 phases. Sales of regular soda were lower in the combination phase than in the price phase, but the difference did not reach statistical significance (P=.08).

Our comparison site analysis of beverage sales in the final 3 phases of the study compared sales in the education and combination periods to the washout period. At this site, we found no difference in regular soft drink sales throughout the study period (Figure 3). Diet soft drink sales did significantly increase during the education phase by 7% (95% CI=1.0, 12.0) and by 12% in the combination phase (95% CI=7.0, 18.0). Water sales increased during the combination phase by 9% (95% CI=2.0, 16.0), but not during the education phase. Coffee sales increased in both phases (combination phase, 7%; 95% CI=1.0, 14.0; education phase, 12%; 95% CI=6.0, 19.0) as did fountain beverage sales (combination phase, 19%; 95% CI=7.0, 30.0; education phase, 22%; 95% CI=10.0, 34.0). We did not note any differences in sales for juice or sugary water.

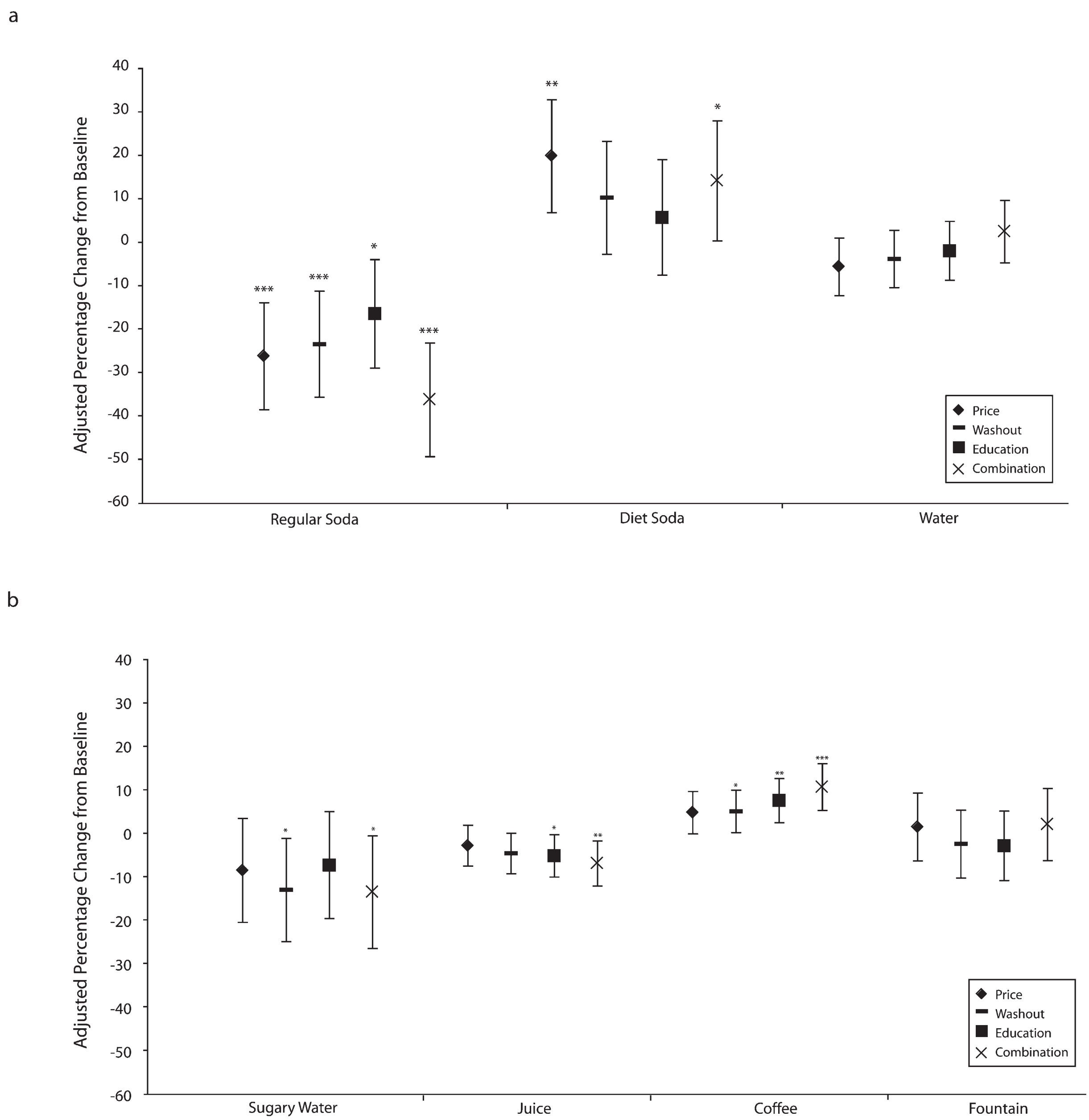
Of the 154 respondents to our intervention site survey, which we conducted 2 weeks after the completion of the intervention, 118 were employees of the hospital and had eaten in the cafeteria during the preceding 6 weeks. Among these hospital employees, 70% reported taste as an important reason for their beverage preferences, 46% reported calories or health, and 25% reported price. A total of 44% of the employees noticed that some intervention had occurred in the cafeteria. Of these employees, 82% noticed the educational intervention, and 18% noticed the price intervention. Employees who reported calories or health as an important reason for their beverage preferences noticed the educational intervention more than did those who did not report such reasons (Fisher exact test, P=.04). Those who drank regular soft drinks noticed the price intervention more than did those who do not drink these beverages (Fisher exact test, P=.04).

DISCUSSION

In a point-of-purchase intervention in a hospital cafeteria, sales of regular soft drinks declined significantly when we increased their price by $0.45. After an initial reduction in sales from the price increase, sales remained at this stable, reduced level until we reinstituted the price increase during a combination price and education phase. The education intervention alone, which included posting messages regarding the health effects of regular soft drinks, had no statistically independent effect on sales. Trends in coffee sales directly contrasted with regular soft drink sales, initially increasing during the price phase and then increasing further during the combination phase. We noted sporadic changes for other beverage categories, including diet soft drinks, water, juice, and sugary water.

Importantly, during the intervention, sales did not increase for any high-caloric beverage type, which could have offset any positive changes from a reduction in regular soda sales. The comparison site analysis, conducted with data from a control site during the final 3 phases of our study, showed no appreciable changes in regular soft drink sales. However, we noted increases in coffee and water sales in a pattern similar to that of the intervention site, suggesting perhaps some temporal trends in coffee or water consumption as an explanation for this finding in both sites.

The change in regular soft drink sales was the most robust finding during the course of the study. We noted sales declines only at the intervention site during both phases that involved a price increase. The sales decline in

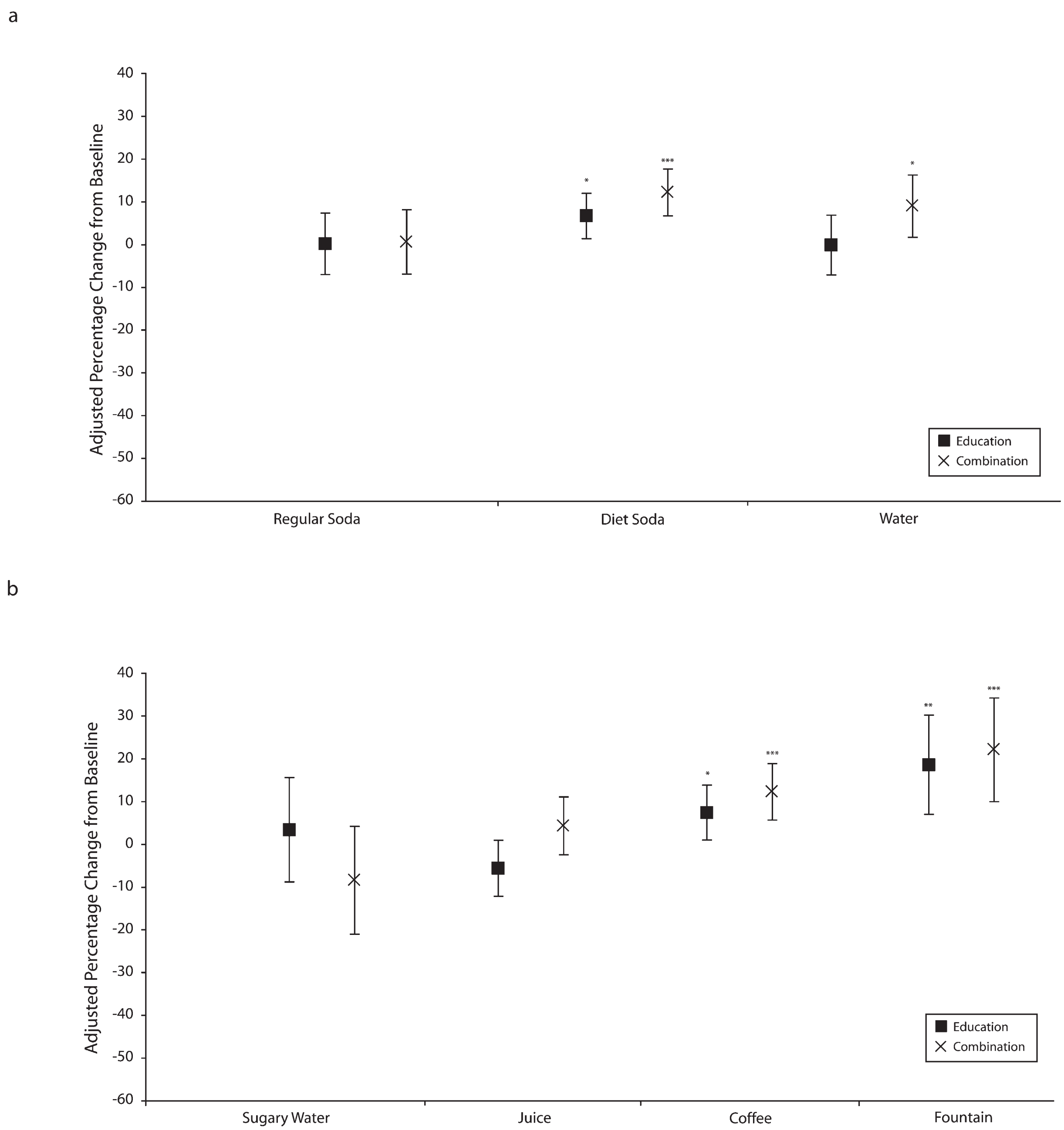


Notes. *$P<.05$; **$P<.01$; ***$P<.001$

FIGURE 2—Adjusted percentage change in beverage sales at the intervention site, by intervention phase for (a) regular soda, diet soda, and water and (b) sugary water, juice, coffee, and fountain drinks: Brigham and Women's Hospital, Boston, MA, March 2008–July 2008.

regular soft drinks during the price increase phase corresponded to a price elasticity of demand of –0.7, which is mildly inelastic. Products with similar elasticity include physician services and travel in taxis.[18] The 95% CI for elasticity was –0.4 to –1.1, a range that spans from moderately inelastic to unit elastic. With this range of elasticity, a 10% increase in price should result in a 4% to 11% decrease in the quantity of sales.

Soft drinks have been increasingly recognized as a major contributor to the obesity epidemic. Adolescents aged 12 through 19 years and young adults aged 19 through 39 years consume nearly 200 calories and 230 calories per day from soft drinks, respectively.[2,19] They consume an additional 150 calories and 100 calories, respectively, from other sugary beverages, such as fruit drinks and juices. Heavy sugary beverage consumption can have significant health implications for



Notes. *P < .05; **P < .01; ***P < .001

FIGURE 3—Adjusted percentage change in beverage sales at the comparison site, by intervention phase for (a) regular soda, diet soda, and water and (b) sugary water, juice, coffee, and fountain drinks: Beth Israel Deaconess Hospital, Boston, MA, March 2008–July 2008.

adolescents. After 2 years of follow-up, adolescents enrolled in a cohort study from public schools in Massachusetts had a 40% increased odds of becoming obese for every additional daily serving of a sugary beverage.[20]

Other studies have confirmed increased rates of metabolic complications with regular soft drink consumption in adults. In the Nurses' Health Study, women who increased their regular soft drink consumption from 1 or fewer per week to 1 or more per day gained a mean of 10 pounds over the course of 4 years and increased their risk of developing diabetes by 83%.[3] African American women, in another study with a large cohort, who consumed 2 or more regular soft drinks daily had a 24% increased risk of developing diabetes after 10 years of follow-up, compared with those drinking less than 1 per month.[21] Among middle-aged adults in the Framingham Heart Study cohort, drinking 1 or more soft drinks per day led to a 30% increase in the incidence of obesity and increased cardiometabolic risk factors, compared with those drinking less than 1 per day.[4] A recent systematic review of 88 studies confirmed these findings.[22] Regular soft drink consumption was associated with increased energy intake and weight gain among children and adults and an elevated risk of diabetes among adults.

The consumption of sugary beverages may have an even greater impact on weight gain than does the consumption of sugar in solid form. In a crossover trial, DiMeglio and Mattes found that the consumption of a prescribed 450 calories per day of regular soft drinks led to an overall increase in caloric intake and weight gain; consumption of 450 calories per day of jelly beans led to a limited overall increase in caloric intake because of reduced consumption of other foods during this phase.[23] These results suggest that the consumption of liquid sugar may be more obesogenic than is the consumption of solid sugar.

Limitations

This study has several limitations. First, we conducted our intervention at only 1 site. Because of the sequential ordering of multiple interventions, all subsequent intervention phases could be biased after the first intervention (in this case, the price increase). However, results were similar in both phases that involved a price increase on regular soft drinks, increasing the robustness of the finding that a price increase is associated with a decline in regular soft drink sales. Furthermore, we did not find changes in regular soda sales at the comparison site, but we did not have comparison site data for the entire study period. Second, sales did not revert to baseline levels during the designated washout phase, perhaps demonstrating that the washout period was inadequate. Many of the cafeteria's customers are employees who eat there frequently; thus, a complete washout may require more than 4 weeks.

Third, the use of a manual cash register may lead to misclassification of purchases and bias our results toward finding no effect. We educated cashiers about the change in advance and routinely monitored their compliance with frequent study staff visits during the course of the study. Blind purchasing documented 96% accuracy. Fourth, we were unable to change the price of fountain drinks. We documented that no change in overall fountain soft drink sales occurred at the intervention site during the study period. Fifth, we could not track individual purchases, and some individuals may have purchased regular soft drinks elsewhere within the hospital. Yet, the only nearby food establishment sells soft drinks for an even higher price than our intervention price.

Conclusions

In this point-of-purchase intervention, regular soft drink sales declined by 26% with a $0.45 (35%) increase in price, resulting in a price elasticity of demand that was mildly inelastic. We noted no independent changes in sales during an educational intervention. These results are consistent with prior population-level studies that have documented altered health behaviors, such as cigarette smoking and consumption of high-fat snacks, with price increases or taxation.[8–10] Policymakers and public health advocates have proposed the taxation of regular soft drinks as a means to reduce the consumption of these products and raise revenue for public health purposes.[11,12] Our results may have implications for these proposed policies.

The findings from this study require confirmation through multisite research studies in varied populations. Additionally, future research should test price increases on fruit juices and other sugary beverages and should examine several price levels to determine what price increase is most effective in reducing sugary beverage sales while maintaining revenue neutrality for a cafeteria or food establishment. ■

About the Authors

Jason P. Block is with the Department of Population Medicine, Harvard Medical School, Boston, MA, and Harvard Pilgrim Health Care Institute, Boston. Amitabh Chandra is with the Harvard Kennedy School, Harvard University, Cambridge, MA. Katherine D. McManus is with the Department of Nutrition, Brigham and Women's Hospital, Boston, MA. Walter C. Willett is with the Department of Nutrition, Harvard School of Public Health, Boston, MA.

Correspondence should be sent to Jason Block, Department of Population Medicine, 133 Brookline Avenue, 3rd Floor, Boston, MA 02215 (e-mail: jason_block@harvardpilgrim.org). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints/Eprints" link.

This article was accepted November 19, 2009.

Contributors

J. P. Block originated and supervised the study, completed the analysis, and led the writing. A. Chandra assisted with the study design and analysis and contributed to the writing. K. D. McManus assisted with the study design and study implementation and contributed to the writing. W. C. Willett supervised the study, assisted with the study design, and contributed to the writing.

Acknowledgments

The Robert Wood Johnson Foundation Health and Society Scholars program at the Harvard School of Public Health supported this research and J. P. Block during the course of this study (grant 053572).

We are grateful for the helpful participation in this project of Al Bissonnette, Nicole Binns, Mark Singletary, Hudson Fontes, James Dimarzio, and Kara Reinhardt Block, MD.

Human Participant Protection

The institutional review boards of Brigham and Women's Hospital and Beth Israel Deaconess Hospital approved this study.

References

1. Block G. Foods contributing to energy intake in the US: data from NHANES III and NHANES 1999–2000. *J Food Compost Anal.* 2004;17(3–4):439–447.
2. Nielsen SJ, Popkin BM. Changes in beverage intake between 1977 and 2001. *Am J Prev Med.* 2004;27(3):205–210.
3. Schulze MB, Manson JE, Ludwig DS, et al. Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. *JAMA.* 2004;292(8):927–934.
4. Dhingra R, Sullivan L, Jacques PF, et al. Soft drink consumption and risk of developing cardiometabolic risk factors and the metabolic syndrome in middle-aged adults in the community. *Circulation.* 2007;116(5):480–488.
5. Ebbeling CB, Feldman HA, Osganian SK, et al. Effects of decreasing sugar-sweetened beverage consumption on body weight in adolescents: a randomized, controlled pilot study. *Pediatrics.* 2006;117(3):673–680.
6. James J, Thomas P, Cavan D, et al. Preventing childhood obesity by reducing consumption of carbonated drinks: cluster randomised controlled trial. *BMJ.* 2004;328(7450):1237.
7. Jeffery RW, French SA, Raether C, et al. An environmental intervention to increase fruit and salad purchases in a cafeteria. *Prev Med.* 1994;23(6):788–792.
8. French SA, Jeffery RW, Story M, et al. Pricing and promotion effects on low-fat vending snack purchases:

the CHIPS study. *Am J Public Health.* 2001;91(1): 112–117.

9. Frieden TR, Mostashari F, Kerker BD, et al. Adult tobacco use levels after intensive tobacco control measures: New York City, 2002–2003. *Am J Public Health.* 2005;95(6):1016–1023.

10. Sung HY, Hu TW, Ong M, et al. A major state tobacco tax increase, the master settlement agreement, and cigarette consumption: the California experience. *Am J Public Health.* 2005;95(6):1030–1035.

11. Brownell KD, Frieden TR. Ounces of prevention—the public policy case for taxes on sugared beverages. *N Engl J Med.* 2009;360(18):1805–1808.

12. Brownell KD, Farley T, Willett WC, et al. The public health and economic benefits of taxing sugar-sweetened beverages. *N Engl J Med.* 2009;361(16):1599–1605.

13. Bergtold J, Akobundu E, Peterson EB. The FAST method: estimating unconditional demand elasticities for processed foods in the presence of fixed effects. *J Agric Resource Econ.* 2004;29(2):276–295.

14. Xiao H, Kinnucan HW, Kaiser HM. *Advertising, Structural Change, and U.S. Non-alcoholic Drink Demand.* Ithaca, NY: National Institute for Commodity Promotion Research & Evaluation; March 1998.

15. Yen ST, Lin B, Smallwood DM, et al. Demand for nonalcoholic beverages: the case of low-income households. *Agribusiness.* 2004;20(3):309–321.

16. National Institutes of Health, National Heart, Lung, and Blood Institute. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults—the evidence report. *Obes Res.* 1998;6(suppl 2):51S–209S.

17. Bouchard C, Tremblay A, Després JP, et al. The response to long-term overfeeding in identical twins. *N Engl J Med.* 1990;322(21):1477–1482.

18. Gwartney JD, Stroup RL. *Economics: Private and Public Choice.* 8th ed. Fort Worth, TX: Dryden Press; 1997.

19. Wang YC, Bleich SN, Gortmaker SL. Increasing caloric contribution from sugar-sweetened beverages and 100% fruit juices among US children and adolescents, 1988–2004. *Pediatrics.* 2008;121(6):e1604–e1614.

20. Ludwig DS, Peterson KE, Gortmaker SL. Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet.* 2001;357(9255):505–508.

21. Palmer JR, Boggs DA, Krishnan S, et al. Sugar-sweetened beverages and incidence of type 2 diabetes mellitus in African American women. *Arch Intern Med.* 2008;168(14):1487–1492.

22. Vartanian LR, Schwartz MB, Brownell KD. Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. *Am J Public Health.* 2007;97(4):667–675.

23. DiMeglio DP, Mattes RD. Liquid versus solid carbohydrate: effects on food intake and body weight. *Int J Obes Relat Metab Disord.* 2000;24(6):794–800.