## Title
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Authors
Epel, Elissa S
Hartman, Alison
Jacobs, Laurie M
et al.

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# Association of a Workplace Sales Ban on Sugar-Sweetened Beverages With Employee Consumption of Sugar-Sweetened Beverages and Health

Elissa S. Epel, PhD; Alison Hartman, BA; Laurie M. Jacobs, PhD; Cindy Leung, ScD, MPH; Michael A. Cohn, PhD; Leeane Jensen, MPH; Laura Ishkanian, MPH; Janet Wojcicki, PhD, MPH; Ashley E. Mason, PhD; Robert H. Lustig, MD, MSL; Kimber L. Stanhope, PhD, MS, RD; Laura A. Schmidt, PhD, MSW, MPH

Supplemental content

**IMPORTANCE** Reductions in sugar-sweetened beverage (SSB) intake can improve health, but are difficult for individuals to achieve on their own.

**OBJECTIVES** To evaluate whether a workplace SSB sales ban was associated with SSB intake and cardiometabolic health among employees and whether a brief motivational intervention provides added benefits to the sales ban.

**DESIGN, SETTING, AND PARTICIPANTS** This before-after study and additional randomized trial conducted from July 28, 2015, to October 16, 2016, at a Northern California university and hospital assessed SSB intake, anthropometrics, and cardiometabolic biomarkers among 214 full-time English-speaking employees who were frequent SSB consumers (≥360 mL [≥12 fl oz] per day) before and 10 months after implementation of an SSB sales ban in a large workplace, with half the employees randomized to receive a brief motivational intervention targeting SSB reduction.

**INTERVENTIONS** The employer stopped selling SSBs in all workplace venues, and half the sample was randomized to receive a brief motivational intervention and the other half was a control group that did not receive the intervention. This intervention was modeled on standard brief motivational interventions for alcohol used in the workplace that promote health knowledge and goal setting.

**MAIN OUTCOMES AND MEASURES** Outcomes included changes in SSB intake, Homeostatic Model Assessment of Insulin Resistance (HOMA-IR), and measures of abdominal adiposity. The primary associations tested were the correlation between changes in SSB intake and changes in HOMA-IR.

**RESULTS** Among the 214 study participants, 124 (57.9%) were women, with a mean (SD) age of 41.2 (11.0) years and a baseline mean (SD) body mass index of 29.4 (6.5). They reported a mean daily intake of 1050 mL (35 fl oz) of SSBs at baseline and 540 mL (18 fl oz) at follow-up—a 510-mL (17–fl oz) (48.6%) decrease ($P < .001$). Reductions in SSB intake correlated with improvements in HOMA-IR ($r = 0.16$; $P = .03$). Those not randomized to receive the brief intervention reduced their SSB intake by a mean (SD) of 246.0 (84.0) mL (8.2 [2.8] fl oz), while those also receiving the brief intervention reduced SSB intake by 762.0 (84.0) mL (25.4 [2.8] fl oz). From baseline to follow-up, there were significant reductions in mean (SE) waist circumference (2.1 [2.8] cm; $P < .001$).

**CONCLUSIONS AND RELEVANCE** This study's findings suggest that the workplace sales ban was associated with a reduction in SSB intake and a significant reduction in waist circumference among employees within 10 months. The randomized clinical trial portion of this study found that targeting those at high risk with a brief motivational intervention led to additional improvements. Workplace sales bans may offer a promising new private-sector strategy for reducing the health harms of SSB intake.

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**Author Affiliations:** Author affiliations are listed at the end of this article.

**Corresponding Authors:** Elissa S. Epel, PhD, Center for Health and Community, University of California, San Francisco, 3333 California St, Ste 465, San Francisco, CA 94143 (elissa.epel@ucsf.edu); Laura A. Schmidt, PhD, MSW, MPH, Philip R. Lee Institute for Health Policy Studies, University of California, San Francisco, 3333 California St, San Francisco, CA 94118 (laura.schmidt@ucsf.edu).

Sugar-sweetened beverage (SSB) intake has emerged as an important risk factor for obesity and cardiometabolic disease, and is implicated in 180 000 deaths per year globally.[1] Sugar-sweetened beverages (defined as sodas, sports or energy drinks, "fruit" drinks, and sweetened bottled teas and coffees) account for 34% of the added sugar in the American diet.[2] Socioeconomically disadvantaged populations consume disproportionately more SSBs.[3] Meta-analyses report that SSBs confer greater risk for adverse metabolic health outcomes than do equivalent amounts of added sugar in foods.[4,5] In 2015, the US Dietary Guidelines Added Sugars Subcommittee recommended that Americans reduce SSB intake to prevent obesity and type 2 diabetes.[6]

Health systems, schools, and private employers have begun to discourage SSB intake through modifications in the workplace food environment that nudge consumers toward healthier beverage options.[7] However, simply promoting healthy products without removing unhealthy, hyperpalatable alternatives from the environment may dampen health outcomes, particularly for individuals challenged by hedonic drives to consume sugar.[8,9]

Private employers have begun to ban the sale of SSBs in their cafeterias and vending machines. Health sector institutions, including the Cleveland Clinic, University of Michigan Health System, Baylor Health Care System, and Geisinger Clinic, have led the deployment of institutional SSB sales bans.[10,11] The Healthier Hospital Initiative, comprising more than 500 US hospitals, promotes healthy beverage policies, including SSB sales bans.[12] In 2018, the National Health Service of the United Kingdom stopped selling SSBs in hospitals throughout England. So far, to our knowledge, no peer-reviewed studies have examined the association of this approach with employee health.

In 2015, the University of California at San Francisco (UCSF) implemented a comprehensive workplace sales ban that eliminated SSB sales across all campus and medical center venues. We evaluated the sales ban's association with SSB intake, abdominal adiposity, and insulin sensitivity in UCSF employees who reported heavy SSB intake (≥360 mL [≥12 fl oz] per day) prior to implementation of the sales ban. Before the implementation, we randomized half the study participants to also receive a brief motivational intervention targeting reductions in SSB intake. We hypothesized that a sales ban would be associated with reduced SSB intake, abdominal adiposity, and insulin resistance, and that reductions in SSB intake would be associated with improvements in insulin sensitivity, and, secondarily, abdominal adiposity. We also hypothesized that participants who received a brief motivational intervention in a randomized trial, modeled on commonly used workplace interventions for alcohol, would show greater improvements in SSB intake compared with a control group that did not receive this intervention.

## Key Points

**Question** Was a workplace sales ban on sugar-sweetened beverages (SSBs) associated with a reduction in employee intake of sugar-sweetened beverages and improvement in their cardiometabolic health?

**Findings** In this before-after study and trial that included 214 adults who regularly drank SSBs, participants reported consuming less SSBs after a workplace sales ban and a reduction in waist circumference and sagittal diameter but no change in body mass index or insulin sensitivity. Those randomized to receive a brief motivational intervention had greater improvements.

**Meaning** A workplace sugar-sweetened beverage sales ban, especially if combined with a brief intervention, may be a feasible and effective way to improve employee health.

## Methods

On November 1, 2015, the UCSF Healthy Beverage Initiative eliminated the sale of SSBs in all UCSF venues, including cafeterias, vending machines, hospital food services, and retail outlets. Employees, students, and visitors could still drink SSBs on campus if they brought them into university buildings or grounds. The study took place at one of the UCSF main campuses that had a clinical research center. The Committee on Human Research at UCSF approved all study procedures and all participants provided written informed consent prior to participation. We assured participants that their survey responses would not be shared with their supervisors or associated with any university records.

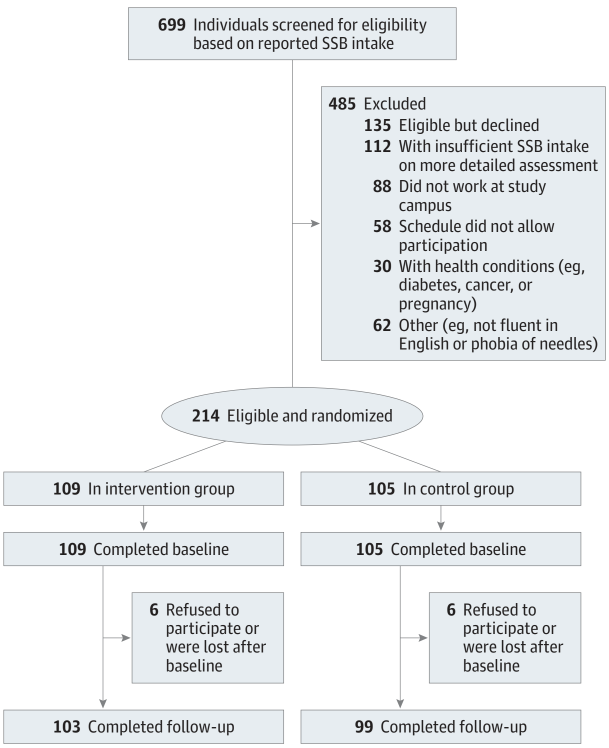
### Procedures and Recruitment

For an approximately 2-month period preceding the SSB sales ban (July 28 to October 1, 2015), we surveyed a representative sample of 2556 employees about their daily patterns of beverage intake (including SSBs and non-SSBs), and all participants completed a baseline assessment before implementation of the sales ban. Lower-income service and manual workers were oversampled because of their higher intake of SSBs and increased risk of cardiometabolic diseases. Employees completed either an online Qualtrics survey or paper questionnaire, offered in English, Spanish, and Chinese (depending on the participant's preference). Participants received a $25 gift card. Identical repeated surveys were performed at 6 and 12 months.

The baseline survey identified high-risk employees with heavy SSB intake for this study. Inclusion criteria were: (1) drinking at least 360 mL (12 fl oz) of SSBs daily for the past 3 months; (2) full-time employment at UCSF, at the same campus where the study took place; (3) ability to fast for phlebotomy; and (4) having no definitive plans to leave UCSF. Exclusion criteria included: not speaking English, having type 1 or type 2 diabetes, being unwilling or medically advised not to fast for phlebotomy, reporting a vasovagal response to phlebotomy, being pregnant or nursing, or regularly working the night shift. Night shift workers may have stronger motivations to drink SSBs to stay alert, and are more vulnerable to metabolic dysregulation.[13]

We screened 699 survey participants who reported drinking 360 mL or more (≥12 fl oz) of SSBs per day for potential eligibility, interest, and ability to participate given their schedules and campus locations (**Figure 1**). Two months prior to implementation of the SSB sales ban, we screened participants by telephone, email, and in person. We successfully recruited

Figure 1. Intervention Enrollment Flowchart




The most common reasons for ineligibility were insufficient sugar-sweetened beverage (SSB) intake and working at a different campus and inability to make a morning blood draw; the most common reason for declining to participate was being too busy (details in trial protocol in Supplement 1). Twelve participants were lost to follow-up because they had left University of California San Francisco for other jobs or moved (n = 5), became pregnant (n = 5), or developed a condition that made them ineligible (n = 2). Of the 202 participants total who completed the follow-up survey, 184 of them also completed the in-person assessment/blood draw. The reasons that 18 did not complete the blood draw included illness/schedule conflicts (n = 13) or lack of interest (n = 5).

214 employees who met all inclusion criteria, including availability for a morning phlebotomy appointment. Of the 349 individuals deemed eligible after screening, 135 declined and 214 (61.3% of the eligible sample) were enrolled.

At the end of the baseline assessment, we randomly assigned 109 participants to receive a brief motivational intervention targeting reductions in SSB intake and 105 participants to be in a control group that did not receive the intervention. A research assistant (A.H.) performed the randomization using a computer-generated program that used block randomization to randomize participants to control (0) or intervention (1) (details in the trial protocol in Supplement 1).

Participants randomized to the brief motivational intervention immediately met with the health educator for a brief (approximately 15 minutes) motivational interview using an adapted version of a standard alcohol brief intervention.[14] Health educators trained in motivational interviewing described the amount of sugar ingested given the daily amount of SSBs consumed (using sugar cubes in a cup), gave personal guidance on risk and reducing sugar intake, helped the participant set a health goal associated with SSB intake (trial protocol in Supplement 1), and provided educational materials. Health educators made brief (approximately 5 minutes) "booster" telephone calls to revisit goals at 1 week after the baseline visit, 1 month after implementation of the SSB sales ban, and 6 months after implementation of the SSB sales ban (trial protocol in Supplement 1).

The (masked to condition) research staff reassessed the participants 10 months after baseline, from May 30 to August 30, 2016. A total of 202 of 214 study participants completed both survey assessments (retention rate, 94.4%; Figure 1). Participants who completed both survey assessments and clinic visits were compensated $125 ($50 for the baseline visit and $75 for the follow-up).

## Measures

All participants were assessed in the clinic at baseline and after 10 months using identical instruments and procedures. Sugar-sweetened beverage consumption was assessed separately via surveys at baseline and 6 and 12 months. Outcomes included changes in SSB intake, insulin sensitivity as measured by Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) (primary outcome),[15] and abdominal adiposity as measured by waist to hip ratio, waist circumference, and sagittal diameter.

### Survey Measures

Survey measures include sociodemographic questions (including race/ethnicity, job class, age, sex, place of birth, and primary language spoken at home) and beverage intake using a 15-item beverage intake questionnaire.[6] This standardized instrument asks about the type, frequency, and amount (ounces) of specific types of beverages consumed on a typical day. Daily intake was calculated for each beverage type by multiplying the frequency of intake and serving size. All regular or nondiet sodas, "fruit" drinks, sports or energy drinks, and sweetened coffee or tea drinks were counted as SSBs.

### Anthropometric Measures

Anthropometric measurements included weight measurement using a digital scale with shoes off and height using a stadiometer. In addition, trained assistants (including A.H.) measured waist and hip circumferences using a cloth tape measure and sagittal diameter using an anthropometer measuring stick device, twice each with means taken.

### Biomarkers

Participants had 30 mL of blood drawn while they were in a fasting state; samples were immediately processed into serum, plasma, and whole blood aliquots, and frozen at −80°C for batch assay by the research laboratory of Peter Havel, DVM, University of California, Davis. Fasting blood samples were assayed for glucose, insulin, and exploratory biomarkers, including hemoglobin A1c, lipid profile (including cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, triglycerides, apolipoprotein A1, and apolipoprotein B), uric acid, γ-glutamyl transpeptidase, and alanine aminotransferase.

Table. SSB Intake and Cardiometabolic Outcomes at Baseline and Post-SSB Sales Ban, by BMI

| | Full Sample | | | | Lean (BMI <25) | | | | Overweight or Obese (BMI >25) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean (SD) | | | | Mean (SD) | | | | Mean (SD) | | |
| Outcome | No. | Baseline | Follow-up | *P* Value | No. | Baseline | Follow-up | *P* Value | No. | Baseline | Follow-up | *P* Value |
| Daily SSB intake, mL[a] | | | | | | | | | | | | |
| 6 mo After sales ban | 195 | 1050.0 (804.0) | 540.0 (591.0) | <.001 | 47 | 870.0 (666.0) | 687.0 (699.0) | .05 | 136 | 1083.0 (828.0) | 495.0 (522.0) | <.001 |
| 12 mo After sales ban | 181 | 1053.0 (804.0) | 522.0 (642.0) | <.001 | 45 | 834.0 (609.0) | 528.0 (672.0) | .002 | 128 | 1116.0 (840.0) | 531.0 (645.0) | <.001 |
| Adiposity (10 mo after sales ban) | | | | | | | | | | | | |
| BMI | 171 | 29.4 (6.5) | 29.5 (6.5) | .38 | 48 | 22.5 (2.3) | 22.7 (2.4) | .04 | 123 | 32.1 (5.5) | 32.1 (5.5) | .45 |
| Waist circumference, cm | 170 | 98.7 (16.7) | 96.5 (15.8) | <.001 | 48 | 81.6 (7.7) | 80.4 (7.6) | .03 | 122 | 105.4 (14.3) | 102.8 (13.5) | <.001 |
| Sagittal diameter, cm | 171 | 24.7 (5.6) | 24.3 (5.6) | .01 | 49 | 19.4 (2.6) | 19.4 (3.0) | .47 | 122 | 26.9 (5.0) | 26.3 (5.1) | <.001 |
| Waist to hip ratio | 170 | 0.94 (0.09) | 0.94 (0.10) | .28 | 48 | 0.88 (0.09) | 0.88 (0.08) | .45 | 122 | 0.96 (0.09) | 0.96 (0.09) | .21 |
| HOMA-IR (10 mo after sales ban) | 180 | 4.7 (3.4) | 4.8 (3.7) | .33 | 49 | 3.0 (1.3) | 3.0 (1.3) | .43 | 120 | 5.3 (3.8) | 5.2 (3.1) | .30 |

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); HOMA-IR, Homeostatic Model Assessment of Insulin Resistance; SSB, sugar-sweetened beverage.

[a] To convert milliliters to fluid ounces, divide by 30.

## Statistical Analysis

Data were double checked (trial protocol in Supplement 1) and all analyses were performed on a per protocol basis using data from the whole sample. Secondary analysis parsed participants with a baseline body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared) of below 25 (lean; n = 48), vs 25 or above (overweight or obese; n = 137). Planned analyses, per registration with ClinicalTrials.gov (NCT02585336), examined the following 3 outcomes: HOMA-IR (primary), SSB intake (secondary), and abdominal adiposity (secondary). Analyses examined: (1) the association of the SSB sales ban with self-reported SSB intake, abdominal adiposity, and HOMA-IR; (2) any additional association of the brief intervention with SSB intake; and (3) the association between SSB intake and changes in HOMA-IR (primary analysis). All other biomarkers were considered exploratory outcomes. We used 2-sided hypothesis tests, with $P < .05$ considered statistically significant for the primary analyses.

We first analyzed change scores in daily SSB intake, adiposity, and HOMA-IR, at baseline and the follow-ups. We used paired *t* tests to examine whether differences at each time point were significantly different from zero, across the sample and by BMI group (**Table**). In addition to these unadjusted analyses, multiple regressions assessed whether changes in SSB intake at 6 months were associated with changes in HOMA-IR and abdominal adiposity, controlling for covariates such as sex, BMI, and baseline levels of the outcomes (eTable 2 in Supplement 2).

A final set of analyses tested for any added associations of the brief intervention using *t* tests and multiple regression models incorporating the covariates above. In secondary analyses, we explored whether the intervention was more effective for those with high BMI by testing an interaction between BMI and intervention group (eTable 3 in Supplement 2) and changes in exploratory biomarkers using *t* tests of change scores (eTable 4 in Supplement 2). The data were analyzed from 2018 to 2019.

## Results

The mean (SD) age of study participants was 41.2 (11.0) years (range, 18-68 years) at baseline (eTable 1 in Supplement 2). The sample included 124 women and 90 men, with broad ethnic representation: 58 Asian-American individuals (27.1%), 32 black individuals (15.0%), 42 Latino individuals (19.6%), 47 white individuals (22.0%), and 35 individuals of unknown or unstated race/ethnicity (16.4%). Study participants worked predominantly in service and technical occupations (77 [36.0%]), with 25 individuals (11.7%) in medical and/or academic job classifications. A total of 24 of 83 men (28.9%) and 55 of 117 women (47.0%) were obese (BMI ≥30).

The Table reports outcomes (SSB intake, anthropometrics, and HOMA-IR) for the full sample and for lean and overweight and obese study participants, before and after the SSB sales ban, with *P* values for *t* tests comparing values before and after the sales ban for each group. Employees reported a reduced SSB intake from a mean (SD) of 1050.0 (804.0) mL (35.0 [26.8] fl oz) at baseline to 540.0 (591.0) mL (18.0 [19.7] fl oz) per day 6 months after the sales ban, a reduction of 48.6% (510.0 mL [17.0 fl oz]; $t = 8.24$; $P < .001$). These reductions remained stable at 12 months across groups (**Figure 2**).

Reductions in SSB consumption were statistically significant in both the lean and overweight and obese groups (Table). Low-BMI participants reported reductions of 186.0 mL (6.2 fl oz) per day ($P = .05$), whereas high-BMI participants reported reductions of 588.0 mL (19.6 fl oz) per day ($P < .001$); a greater change was seen in the high-BMI group ($t = -2.86$; $P = .01$).

There was no mean change in HOMA-IR or BMI, although there were reductions in 2 of 3 measures of abdominal adiposity: mean (SE) waist circumference decreased by 2.1 (2.8) cm ($t = 5.61$; $P < .001$) and sagittal diameter decreased by 0.4 (2.2) cm ($t = 2.36$; $P = .01$). Body mass index and waist circumference, although highly correlated ($r = 0.91$ at baseline), did not consistently change together. Approximately half the sample lost weight and half gained weight, leading to no significant change. In contrast, 117 of 170 participants (68.8%) lost waist girth, leading to a mean (SE) loss of 2.1 (2.8) cm; these study participants tended to be the ones who also lost weight (75 of 117 [64.1%] lost weight).

We next conducted correlations and regressions for the primary analysis of SSB intake and HOMA-IR. Pearson correlations showed that change in SSB intake was associated with change in HOMA-IR ($r$ = 0.16; $P$ = .03) and insulin ($r$ = 0.16; $P$ = .04), with more pronounced associations in exploratory analyses of the high-BMI group ($r$ = 0.24; $P$ = .01 for HOMA-IR; and $r$ = 0.21; $P$ = .03 for insulin). In multivariate regressions controlling for sex, baseline BMI, and baseline HOMA-IR, reductions in SSB intake were still associated with lower HOMA-IR after exposure to the intervention (β = 0.02; $P$ = .02) (eTable 2 in Supplement 2). Change in SSB intake was not associated with change in waist circumference ($r$ = −0.01; $P$ = .94; in multivariate regression, β = −0.13; $P$ = .07) (eTable 2 in Supplement 2).

## Brief Motivational Intervention

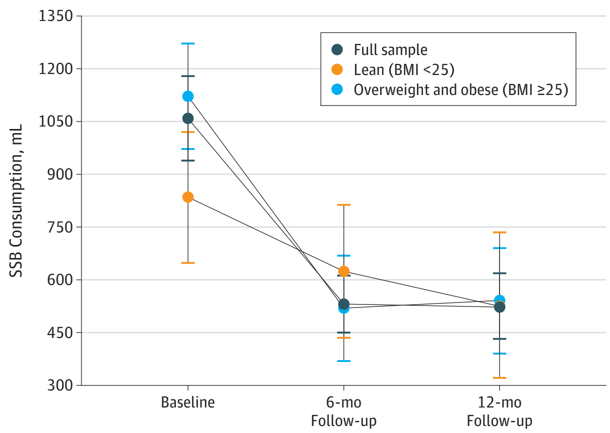
Employees exposed to the SSB sales ban plus the brief intervention reduced mean (SD) daily SSB intake by 762.0 (84.0) mL (25.4 [2.8] fl oz), vs a reduction of 246.0 (84.0) mL (8.2 [2.8] fl oz) among those exposed to the SSB sales ban alone ($t$ = −4.37; $P$ < .001). This added association of the intervention with SSB intake was significantly greater in the high-BMI group (n = 136) (840-mL [28-fl oz] vs 300-mL [10-fl oz] reduction; $P$ < .001) and not significant in the low-BMI group (n = 47) (69.0 mL [2.3 fl oz] vs 327.0 mL [10.9 fl oz]; $P$ = .27), although this difference could be owing to low statistical power in the latter. **Figure 3** shows the total reduction for low-BMI and high-BMI groups, including the additional reduction resulting from assignment to the brief intervention.

Multivariate regression analysis found that those exposed to the SSB sales ban plus the brief intervention experienced an additional 369.0-mL (12.3-fl oz) decline in daily SSB intake ($F_{4,177}$ = 71.37; $P$ < .001), explaining 6% of the total variance (eTable 3 in Supplement 2). The interaction term did not reach statistical significance, but given the greater reduction in SSB intake observed in those with a higher BMI, this finding warrants additional investigation.

## Exploratory Biomarkers

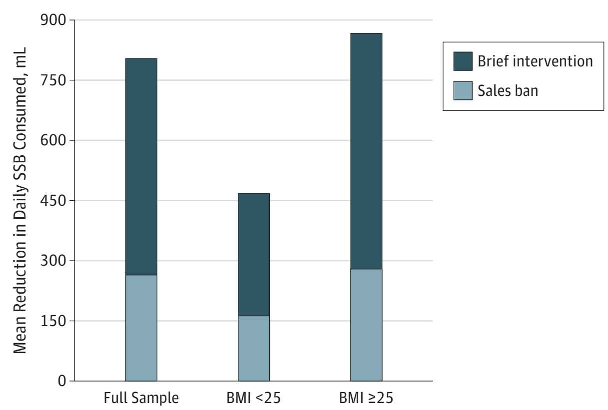
Across the sample, uric acid and high-density lipoprotein cholesterol levels improved over time, but total cholesterol and low-density lipoprotein cholesterol levels also increased in the lean group (BMI <25) (eTable 4 in Supplement 2). Comparisons by intervention group found that those in the lean group experienced increases in lipids, regardless of condition. However, those with overweight and obesity (BMI ≥25) who were assigned to the brief intervention showed statistically significant improvements in lipids (total cholesterol, low-density lipoprotein cholesterol, and apolipoprotein B levels) compared with those exposed to the sales ban only (eTable 5 in Supplement 2). Exploratory analyses found small associations between changes in SSB intake and changes in total cholesterol ($r$ = 0.22; $P$ = .004), but no association with triglycerides ($r$ = 0.14; $P$ = .08), high-density lipoprotein cholesterol ($r$ = 0.13; $P$ = .10), low-density lipoprotein cholesterol ($r$ = 0.15; $P$ = .06), apolipoprotein B ($r$ = 0.11; $P$ = .17), or liver enzymes (alanine transaminase: $r$ = 0.08; $P$ = .31).

Figure 2. Mean Sugar-Sweetened Beverage (SSB) Intake Under an SSB Sales Ban Intervention




All follow-up time points are significantly different from baseline at $P$ < .01 or less. BMI indicates body mass index (calculated as weight in kilograms divided by height in meters squared). Vertical lines indicate 95% CIs. To convert milliliters to fluid ounces, divide by 30.

Figure 3. Mean Reduction in Daily Sugar-Sweetened Beverage (SSB) Consumption Attributed to Sales Ban Only vs Added Association of a Brief Intervention 12 Months After Baseline




Light blue bars show the self-reported reduction in SSB intake in those exposed to the sales ban only, and dark blue bars show the additional reduction reported by those exposed to the brief intervention plus sales ban. The total height of the bar shows the total amount reduced for those in the brief intervention plus sales ban. The pattern for change in SSB at 12 months is similar, as shown in eTable 5 in Supplement 2. BMI indicates body mass index (calculated as weight in kilograms divided by height in meters squared). To convert milliliters to fluid ounces, divide by 30.

## Discussion

There is substantial literature on tobacco and alcohol sales bans demonstrating reduced intake and improved health outcomes.[16] Workplace bans on tobacco sales have led to reductions in tobacco use as well as normative shifts in the popularity of smoking.[17,18] Despite the increased use of workplace SSB sales bans, to our knowledge, there have been no prior peer-reviewed studies documenting the association of such sales bans with health. School-based SSB sales bans have successfully reduced the in-school purchasing of SSBs, although student intake of SSBs brought from home and consumed outside of school may reduce these positive associations.[19,20]

There is growing interest in workplace SSB sales bans as a nongovernmental strategy for reducing SSB intake, thus mitigating associated cardiometabolic disease risks. This study examined whether a workplace SSB sales ban could decrease employee SSB intake, and whether such decreases would result in improved cardiometabolic health.

As hypothesized, a workplace SSB sales ban was followed by a significant decrease in employee-reported SSB intake. After the sales ban's implementation, frequent SSB consumers (≥360 mL [≥12 fl oz] of SSBs per day) reported a mean decline in consumption of 510 mL [17 fl oz], with significantly greater reductions in SSB intake among employees with overweight and obesity. Decreased SSB intake was associated with small beneficial changes in insulin resistance (primary outcome), along with a meaningful decrease in waist circumference (secondary outcome). Population-based studies have found that sugar intake is associated with abdominal adiposity, HOMA-IR, and lipid levels.[21] An experimental study controlling for food intake showed that reductions in added sugar are associated with improvements in visceral fat, HOMA-IR, and lipid levels.[22] Consistent with these findings, we found associations over time between reductions in SSB intake and reductions in HOMA-IR (our primary outcome), and, in exploratory analyses, with total cholesterol but not other lipid levels.

At the outset, we expected changes in waist circumference but not BMI, which was confirmed, with approximately half the sample losing weight and half gaining weight. Meanwhile, 69% lost waist girth; these study participants tended to be the ones who also lost weight. Body mass index and waist circumference represent fat depots that are differentially regulated, with abdominal adiposity specifically linked to myocardial infarctions in population-attributable risks.[23] Short-term isocaloric reductions in sugar consumption have been shown to lead to reductions in lipids[24] and HOMA-IR.[22] In this controlled feeding trial that substituted starch for sugar while keeping total calories constant, researchers found a 22% reduction in liver fat and 7% reduction in visceral fat, with essentially no change in BMI.[22]

This study added a randomized clinical trial of a brief employer-based motivational intervention. Employees who received the brief intervention as an adjunct to the SSB sales ban reported the largest decreases in SSB intake and experienced the greatest benefits for cardiometabolic health risk. Employers have efficiently and effectively implemented brief interventions to address employee alcohol intake for many years,[25] and similar approaches could be used to target SSBs. This study suggests that combining changes in the food environment with a targeted intervention can bolster health benefits beyond those achieved by a workplace sales ban alone. Future studies should examine longer-term associations of workplace SSB interventions and assess the potential cost savings to employers, who currently face rising employee health care costs owing to metabolic syndrome (obesity, type 2 diabetes, heart disease, and fatty liver disease).[26]

### Limitations

This study has some limitations. This additional randomized trial controlled for the SSB sales ban plus brief intervention group but not for the sales ban only group. Due to time constraints pertaining to UCSF's implementation of the SSB sales ban, we were unable to enroll a contemporaneous external control institution without an SSB sales ban. However, exploratory analyses found more pronounced associations in overweight and obese employees and in the controlled brief intervention condition, suggesting that the changes observed in this study may not be completely attributable to secular factors.

We also note limitations in the accuracy of self-reported SSB intake. Although it is possible that the observed declines in SSB intake are indicative of regression to the mean, the 2 follow-up time points at 6 and 12 months are both lower and are correlated with each other ($r = 0.60$; $P < .001$), suggesting a stable change. Although social desirability bias could explain reporting lower values, the correlation of SSB changes with expected changes in blood-based biomarkers (HOMA-IR and lipid levels) suggests true improvement for those who reported lowering their SSB intake. Observed declines in SSB consumption are unlikely due to seasonal changes, as they were sustained for 12 months (Figure 2).

It appears that future research should use more rigorous dietary assessments to more precisely determine the association between health improvements and changes or reductions in all sources of sugar intake. Finally, the generalizability of these findings is limited to an urban environment of frequent SSB drinkers and a disproportionately ethnic minority sample.

## Conclusions and Public Health Implications

As rates of cardiometabolic diseases continue to rise, private employers are likely to face greater productivity losses and private health expenditures. The results of this study suggest that workplace SSB sales bans, if widely adopted, could add another layer of efficacy to existing SSB reduction strategies. At the societal level, private sector–driven change through workplace sales bans seems to offer a strategy that complements existing governmental reform efforts. Although effective, governmental reform policies, such as SSB taxation and warning labels, face significant political obstacles that private-sector sales bans do not.

Contractual arrangements with beverage companies may pose obstacles to implementing workplace SSB sales bans, although beverage companies are increasingly reformulating and diversifying product lines to offer healthier alternatives to SSBs. Some public and nonprofit sector employers, including many schools and universities, face challenges resulting from beverage company subsidies of sports teams and other activities—so-called pouring rights contracts—that require on-campus marketing, promotion, and sales. Finally, some employers may face challenges in a workplace culture in which SSB sales bans are perceived as paternalistic. Despite these barriers, there is a growing movement to ban the workplace sale of SSBs, particularly in the health sector, where this strategy proves consistent with the organizational mission. Our data appear to support the health benefits of this approach.

ARTICLE INFORMATION

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**Author Affiliations:** Department of Psychiatry, University of California, San Francisco (Epel, Mason); Center for Health and Community, University of California, San Francisco (Epel, Hartman, Wojcicki); Philip R. Lee Institute for Health Policy Studies, University of California, San Francisco (Jacobs, Lustig, Schmidt); Department of Nutritional Sciences, School of Public Health, University of Michigan, Ann Arbor (Leung); Osher Center for Integrative Medicine, University of California, San Francisco (Cohn, Mason); Campus Life Services, UCSF Wellness Program, University of California, San Francisco (Jensen, Ishkanian); Department of Pediatrics, University of California, San Francisco (Wojcicki, Lustig); Department of Molecular Biosciences, University of California, Davis (Stanhope); Department of Anthropology, History and Social Medicine, University of California, San Francisco (Schmidt).

**Author Contributions:** Drs Epel and Schmidt had full access to all the data in the study, and take responsibility for the integrity of the data and the accuracy of the data analysis. Drs Epel and Schmidt are coprincipal investigators.
*Concept and design:* Epel, Cohn, Jensen, Ishkanian, Wojcicki, Lustig, Schmidt.
*Acquisition, analysis, or interpretation of data:* Epel, Hartman, Jacobs, Leung, Cohn, Wojcicki, Mason, Lustig, Stanhope, Schmidt.
*Drafting of the manuscript:* Epel, Hartman, Jacobs, Cohn, Jensen, Wojcicki, Mason, Lustig, Schmidt.
*Critical revision of the manuscript for important intellectual content:* Epel, Hartman, Jacobs, Leung, Ishkanian, Wojcicki, Mason, Lustig, Stanhope, Schmidt.
*Statistical analysis:* Epel, Jacobs, Leung, Wojcicki.
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*Supervision:* Epel, Cohn, Lustig, Schmidt.

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**Additional Contributions:** Casey Palmer, MS, RN, Philip R. Lee Institute for Health Policy Studies, University of California San Francisco; Daniel Henroid, MS, Department of Nutrition and Food Services, University of California San Francisco; Amanda Gilbert, BA, The Center for Health and Community, University of California San Francisco; and Pal Shah, MS, Philip R. Lee Institute for Health Policy Studies, University of California San Francisco, assisted in the data collection and technical execution of this manuscript. Mss Palmer, Gilbert, and Shah were compensated for their contributions; Mr Henroid was not compensated for his contribution.

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