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Author/s:
Morley, BC;Niven, PH;Dixon, HG;Swanson, MG;McAleese, AB;Wakefield, MA

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Controlled cohort evaluation of the *LiveLighter* mass media campaign's impact on adults' reported consumption of sugar-sweetened beverages

Belinda C Morley,[1] Philippa H Niven,[1] Helen G Dixon,[1] Maurice G Swanson,[2] Alison B McAleese,[3] Melanie A Wakefield[1]

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[1]Centre for Behavioural Research in Cancer, Cancer Council Victoria, Melbourne, Victoria, Australia
[2]Chief Executive, Heart Foundation (Western Australia), Subiaco, Western Australia, Australia
[3]Cancer Prevention Centre, Cancer Council Victoria, Melbourne, Victoria, Australia

Correspondence to
Dr Belinda C Morley;
Belinda.Morley@cancervic.org.au

ABSTRACT

Objective To evaluate the *LiveLighter* 'Sugary Drinks' campaign impact on awareness, knowledge and sugar-sweetened beverage (SSB) consumption.

Design Cohort study with population surveys undertaken in intervention and comparison states at baseline (n=900 each), with 78% retention at follow-up (intervention: n=673; comparison: n=730). Analyses tested interactions by state (intervention, comparison) and time (baseline, follow-up).

Setting and participants Adults aged 25–49 years residing in the Australian states of Victoria and South Australia.

Intervention The 6-week mass media campaign ran in Victoria in October/November 2015. It focused on the contribution of SSBs to the development of visceral 'toxic fat', graphically depicted around vital organs, and ultimately serious disease. Paid television advertising was complemented by radio, cinema, online and social media advertising, and stakeholder and community engagement.

Primary outcome measure Self-reported consumption of SSBs, artificially sweetened drinks and water.

Secondary outcome measures Campaign recall and recognition; knowledge of the health effects of overweight and SSB consumption; perceived impact of SSB consumption on body weight and of reduced consumption on health.

Results A significant reduction in frequent SSB consumption was observed in the intervention state (intervention: 31% compared with 22%, comparison: 30% compared with 29%; interaction p<0.01). This was accompanied by evidence of increased water consumption (intervention: 66% compared with 73%; comparison: 68% compared with 67%; interaction p=0.09) among overweight/obese SSB consumers. This group also showed increased knowledge of the health effects of SSB consumption (intervention: 60% compared with 71%, comparison: 63% compared with 59%; interaction p<0.05) and some evidence of increased prevalence of self-referent thoughts about SSB's relationship to weight gain (intervention: 39% compared with 45%, comparison: 43% compared with 38%; interaction p=0.06).

Conclusions The findings provide evidence of reduced SSB consumption among adults in the target age range following the *LiveLighter* campaign. This is notable in a context where public health campaigns occur against a backdrop of heavy commercial product advertising promoting increased SSB consumption.

Strengths and limitations of this study

- A cohort study design allowed comparisons longitudinally in self-reported outcomes at baseline and follow-up in the exposed and unexposed populations.
- Given the reliance on self-report rather than an objective measure of behaviour, the risk of socially desirable responses is a potential source of bias.
- In the absence of random allocation, it is not possible to definitively determine whether impacts on the main outcomes can be attributed to the campaign.
- A longer-term follow-up is needed to determine whether impacts on the main outcomes are maintained.

INTRODUCTION

Consumption of sugar-sweetened beverages (SSBs) increases the risk of overweight and obesity[1–4] and a reduction in intake can help prevent weight gain.[2 4 5] WHO has identified reducing SSB consumption as a critical target for obesity prevention.[6] In the developed world, sugar-sweetened drinks constitute the largest source of added sugar in the diet.[7–11] WHO also identified mass media as a particularly effective tool for dissemination of public education aimed at obesity prevention[12 13] and social marketing campaigns have been shown to be effective in influencing environmental and policy changes.[14] Available evidence suggests some nutrition-related mass communication interventions have successfully impacted selected dietary behaviours.[12 15] Experimental research testing adults' initial responses to public health advertisements addressing weight and lifestyle found the most persuasive ads contained messages about the health consequences of

excess body weight accompanied by graphic imagery.[16] These findings concerning advertising content align with those found for campaigns designed to reduce smoking prevalence.[17]

Between 2009 and 2011, New York City aired a number of high profile mass media campaigns aimed at educating the public about the added sugars in SSBs and their health impact. These campaigns included graphic portrayal of the health consequences of excess SSB consumption as well as implementation of nutrition standards limiting serving of SSBs in city agencies. Evaluation revealed a 35% decrease in the number of adults consuming one or more sugary drinks per day.[18] Another, similarly comprehensive campaign combined mass media advertising with policies to encourage healthy beverage consumption in various settings and found evidence of decreased sales of SSBs.[19] Mass media campaigns that have not been accompanied by policy or regulatory change have yielded mixed evidence as to their impact on SSB consumption. Oregon's 2011 *It Starts Here* mass media campaign on the sugar content and health impacts of consuming SSBs showed no significant change in consumption following the campaign.[20] Postintervention survey results for Los Angeles County's 2011–2012 *Sugar Pack* campaign found evidence of greater knowledge and intentions to reduce SSB consumption among those who had seen the campaign but did not report consumption data.[21] A recent, rigorous evaluation of the *Live Sugarfreed* mass media campaign employed a prepost cohort design and found evidence of changes in beliefs about the health effects of consuming SSBs and a decrease in SSB sales in the intervention area relative to the comparison area.[22] However, self-report data showed SSB consumption unexpectedly increased following the campaign. Given these mixed findings, there is need for further rigorous evaluations of mass media campaigns addressing SSBs to improve our understanding of their capacity to effect population-level reductions in consumption.

The present study reports evaluation results for an Australian mass media campaign aimed at reducing SSB consumption, which graphically communicated the health effects of excess sugary drink consumption. The *LiveLighter* 'Sugary Drinks' campaign was developed as part of the theoretically based, evidence-driven, *LiveLighter* healthy weight and lifestyle campaign, which targets adults aged 25–49 years.[23] The 'Sugary Drinks' campaign[24] consisted primarily of mass media education and stakeholder engagement, but was not accompanied by any of the institutional, policy or regulatory changes seen in some other jurisdictions. The evaluation consisted of a more rigorous study design than some previously published evaluations of mass media-only SSB interventions, allowing for more precise assessment of potential campaign impact.

The main objective of the evaluation was to determine whether the *LiveLighter* 'Sugary Drinks' campaign achieved its aim of promoting reduced SSB consumption among adults in the Australian state of Victoria, and to examine what consequences, if any, a reduction in SSBs might have for consumption of other beverages. In addition, the study aimed to determine whether the campaign increased knowledge of the health consequences of excessive SSB consumption, and changed beliefs about excessive SSB consumption. The study is novel for reporting on a public health mass media campaign targeting SSBs in a setting outside the USA and using an evaluation design featuring a cohort study with baseline and follow-up surveys in both an intervention state and a control state, thus helping to build the international evidence base surrounding population-level impacts of such campaigns.

METHODS

Intervention

The *LiveLighter* public health mass media campaign was developed in Western Australia where the first phase was launched in June 2012.[23] The 'Sugary Drinks' phase of the campaign was subsequently launched in Western Australia in July 2013 and later aired in the eastern Australian state of Victoria (population 6.2 million)[25] via paid television advertising over 6 weeks from 11 October 2015. For the Victorian campaign, the subject of this evaluation, 723 target audience rating points (TARPs) were achieved. TARPs measure the potential amount of advertising exposure, calculated by multiplying reach (percentage of target audience exposed) by frequency (number of times each was exposed) of advertising.[26] Therefore, 700 TARPs might represent 100% of the audience seeing the campaign seven times, or 50% seeing it 14 times.

The first phase of the campaign, aired in Victoria in 2014, graphically depicted visceral fat around the organs of an overweight person and how such 'toxic fat' increases risk of serious diseases, to communicate increased urgency to start pursuing a healthier lifestyle. The subsequent 'Sugary Drinks' campaign reminded viewers of this visceral imagery and focused on the contribution of SSBs (soft drink, energy drink, sports drinks, cordial and fruit drinks) to the development of 'toxic fat' around vital organs. Their superfluous nature within the diet was emphasised, along with the message that the simple lifestyle change of eliminating their habitual consumption will reduce 'toxic fat' and the associated increased risk of disease.

Paid television advertising was complemented by radio (reach 1 190 000 people aged 25–49 years), cinema (reach 203 652 admissions aged 25–54 years), online and social media advertising. The online advertising comprised of a suite of banner ads, preroll video, content seeding, Facebook and Google Search. Overall, the online advertising generated a total of 204 568 clicks to the website (www.livelighter.com.au). This website housed the television advertisements, as well as supporting information, healthy recipes, personal stories, and a meal and activity planner. The media elements of the campaign were supported by stakeholder and community engagement and resources.

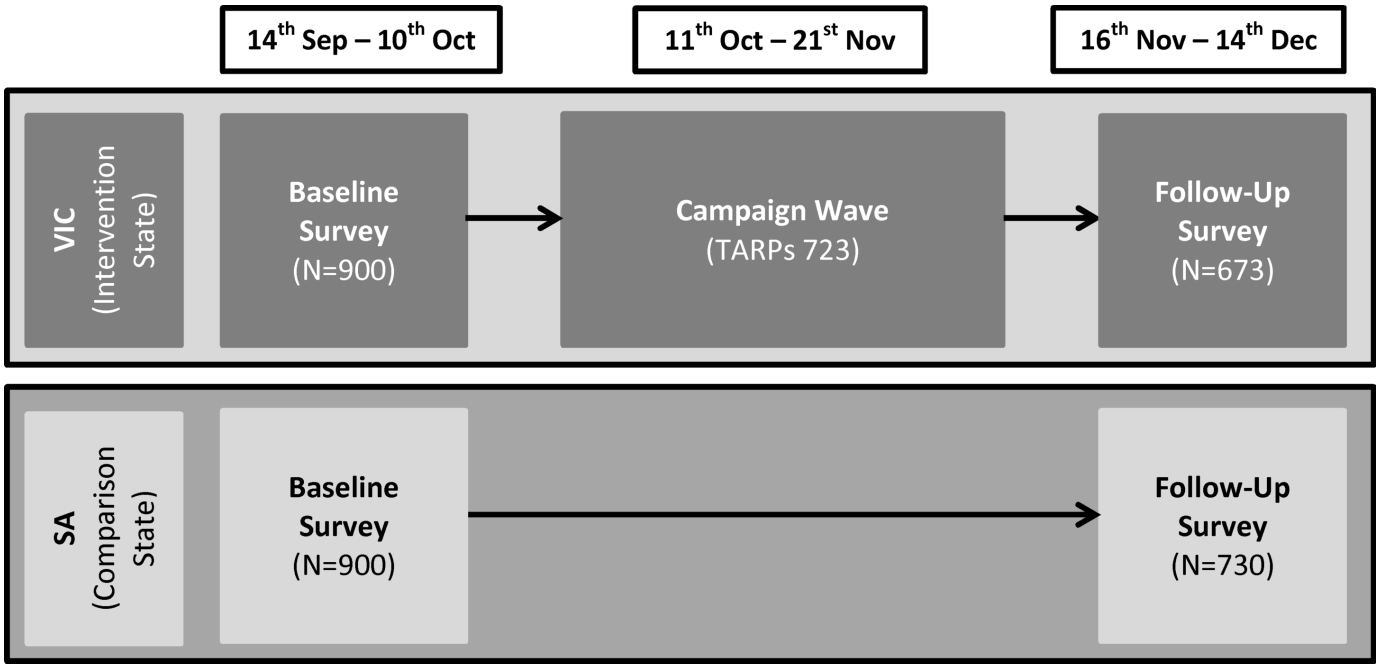


Figure 1 *LiveLighter* Victoria 'Sugary Drinks' campaign evaluation timeline. SA, South Australia; TAPRs, target audience rating points; VIC, Victoria.

Patient and public involvement

Members of the public participated in qualitative, formative research which informed the development of the *LiveLighter* campaign.

Evaluation design and sample

A baseline telephone population survey, using random digit dialling to landline telephones, of 900 adults from the primary target group of 25–49-year olds was undertaken in each of Victoria (intervention state) and South Australia (SA: comparison state) (see figure 1) prior to the campaign. The person who identified as the youngest man aged 25–49 years (or youngest woman if no men) in the household was selected for interview. At baseline, quotas for region (79% metropolitan/21% rural) were achieved in both states. The cooperation rate at baseline (completed interviews/completed interviews+refusals) was 31% (intervention: 30%; comparison: 31%), and 78% (intervention: 75%; comparison: 81%) (n=1403) participated in the follow-up survey. The follow-up survey commenced during the final week of the campaign, just over 5 weeks after completion of baseline (see figure 1). A subsample of n=761 overweight/obese adults (based on body mass index (BMI) (weight (kg)/height (m^2)=25+), self-reported height and weight) was obtained.[27]

MEASURES

Primary outcomes

The primary outcome is behaviour. Respondents' reported their frequency and quantity of SSB consumption over the past 7 days. 'Sugary drink consumers' were those who reported they consumed 1+ cups per week (≥250 mL) and comprised 55% of the sample. Following Rehm *et al*[28] and Scully *et al*,[29] 'frequent sugary drink consumers' were those who consumed 4+ cups per week (≥1 L), comprising 27% of the sample. Consumption of artificially sweetened drinks and water were also assessed. 'Artificially sweetened drink consumers' were those who drank one or more artificially sweetened drinks in the past week and comprised 23% of respondents. While no formal test of validity has been undertaken on the consumption questions, they are very similar to others which have been validated.[30 31]

Secondary outcomes

At both baseline and follow-up, respondents were asked about their knowledge and beliefs about the health effects of overweight and SSB consumption. The knowledge and beliefs questions were developed by the authors and used in the published evaluation of the earlier phase of the campaign with some adaptations for the focus of the present campaign on SSBs.[23] To control for order effects, the sequence of presentation of response options was randomised. To check for potential unintended effects of the campaign on weight-based stereotypes, respondents were asked whether they agreed or disagreed with the six overweight stereotypes detailed in table 1. Respondents who agreed with two or more of these statements were classified as endorsing weight-based stereotypes.[23] Campaign recall and recognition were assessed at the end of the follow-up survey (see table 1) and summed to provide total awareness.

Statistical analysis

Data were analysed using Stata SE V.14.0[32] during 2016. In light of effect sizes reported in previous reviews of the impact of mass media campaigns on behaviour,[12 33] a sample size of 1216 (n=608 per group—intervention and comparison) should have been sufficient to detect a difference between

Table 1 Outcome measures

Construct	Question	Response options	Binary aggregation for analysis
Behaviour			
Sugar-sweetened beverage consumption	(A) During the past 7 days, on how many days did you drink a can, bottle or glass of a sugar-sweetened drink such as soft drinks, energy drinks, fruit drink, sports drinks and cordial? Do not include diet drinks. (Interviewer note: fruit drink does not include 100% fruit juice). If 1 to 7: (B) Over the past 7 days, on a typical day when you did consume these types of drinks, how many cups did you consume each day? If necessary: one average can=1½ cups, one 600 mL bottle=2½ cups, 1 L bottle=4 cups.	(A) Days in the past 7 days drank sugary drink (range 0–7); (don't know); (refused). (B) Cups per day (range 1–20); (don't know); (refused).	One or more cups per week (≥250 mL) classified as 'sugary drink consumers'; three or more cups per week; four or more cups per week (≥1 L) classified as 'frequent sugary drink consumers'.
Artificially sweetened drink consumption	During the past 7 days, on how many days did you drink a can, bottle or glass of a diet drink such as diet soft drinks, diet energy drinks or diet cordial?	Days in the past 7 days drank diet drink (range 0–7); (don't know); (refused).	Drank diet drink on one or more days in past week classified as 'artificially sweetened drink consumers' compared with did not drink a diet drink in the past week.
Water consumption	How many cups of water do you usually drink each day? This can be plain tap water, mineral water or bottled water. If necessary: one average bottle=2 cups, 1 L bottle=4 cups.	I don't drink water; less than one cup a day; about one cup a day; about two cups a day; about three cups a day; about four cups a day; about five cups or more a day; (don't know); (refused).	4+ cups per day compared with less than four cups per day.
Knowledge			
Knowledge of overweight and toxic fat link	Thinking about what goes on inside the body of an overweight or obese person. Based on what you know or believe, which one of these health effects does being overweight or obese cause….?	(Randomise) Toxic fat to build up; the blood to thicken; the heart and lungs to contract; (none); (don't know); (refused).	Toxic fat to build up compared with all other responses.
Knowledge of sugary drink and toxic fat link	Based on what you know or believe, which one of these health effects does drinking too many sugary drinks like soft drink cause…?	(Randomise) Toxic fat to build up; the blood to thicken; the heart and lungs to contract; (none); (don't know); (refused).	Toxic fat to build up compared with all other responses.
Beliefs			
Thought about how sugary drinks lead to weight gain	In the last 7 days how often, if at all, did you think about how sugary drinks can make you put on weight?	Several times a day; once a day; once every few days; once in the past week; not at all; (don't know); (refused).	At least once in the past week compared with not at all.

Continued

Table 1 Continued

Construct	Question	Response options	Binary aggregation for analysis
Believe health would improve if reduced sugary drinks	If you cut down on sugary drinks, do you think your health would improve?	Not change; improve a little; improve a lot; (don't know); (refused); (I don't drink sugary drinks so can't cut down).	Improve a little or a lot compared with not change.
Overweight stereotypes	I'm now going to read out some statements that other people have made about overweight people, please tell me the extent to which you agree or disagree with the following statements. Compared with 'healthy' weight people, overweight people are more likely to: (randomise) be happier; lack will power; have fewer friends; be outgoing; have less energy; be less successful. Probe: Strongly agree/disagree or somewhat agree/disagree?	Strongly disagree; somewhat disagree; neither agree nor disagree; somewhat agree; strongly agree; (don't know); (refused).	Agree compared with disagree, neither or don't know/refused. A composite scale combined ratings of 'agreed' for two or more.
Campaign awareness			
Recall	(A) In the past month or so, have you seen any advertisements on television about being overweight? (B) Which ad about being overweight do you most remember? Can you describe what happened in this ad?(C) Which other ads about being overweight do you remember seeing in the past month or so?	(A) Yes; no; (don't know); (refused). (B and C) Code mentions of the 'Sugary Drink' ad.	Recall of 'Sugary Drink' advertisement compared with no recall of 'Sugary Drink' advertisement.
Recognition	A moderately overweight man in a convenience store buys a can of soft drink. The man grabs his gut and the camera zooms in to show his insides. The voice-over says 'the sugar in any sugary drink is sugar your body doesn't need. So it gets turned into fat, including toxic fat around your vital organs, which can lead to cancer, type 2 diabetes and heart disease.'	Yes; no; (don't know); (refused).	Recognition of 'Sugary Drink' advertisement compared with no recognition of 'Sugary Drink' advertisement.

conditions for frequent sugary drink consumption using the full sample at α=0.05. However, this sample size may not have been sufficient to detect differences for subgroup analyses. Data were weighted to the population on sex, age, metropolitan/rural residence and highest educational attainment.[34] Participants with complete data sets across the two survey time points were included in analyses (Victoria: n=673 and SA: n=730).

Data analysis and checking of statistical assumptions was undertaken by BCM and PHN. χ^2 analysis assessed whether baseline characteristics differed between states at follow-up and whether study completers differed from non-completers. Responses were dichotomised and logistic regression analysis taking into account panel data using a population-averaged model, tested interactions by state (intervention vs comparison) and study phase (baseline vs follow-up) controlling for baseline characteristics: SSB consumption (4+ cups per week), socioeconomic position (SEP), BMI, time spent viewing commercial television and number of days between interviews. Given tests for interaction usually have low power and are therefore subject to type II error,[35 36] a significance level of p<0.10

was accepted for the interactions. All other analyses used p<0.05. No adjustments were made for multiple testing.

χ^2 tests further examined associations between changes in SSB consumption and consumption of artificially sweetened drinks within the intervention state.

RESULTS

Sample characteristics

Comparison of study completers (n=2806) with non-completers (n=397) showed those who participated in the follow-up survey were more likely to be older (35–49 years: 88% compared with 25–34 years: 85%; p=0.007), parents (88% compared with 86%; p=0.03), obese (obese 90% compared with not overweight 88%, overweight 86%; p=0.024) and reside in a rural area (90% compared with 87%; p=0.009). Sex, frequent SSB consumption at baseline, SEP and time spent viewing commercial television did not differ by completion status. Table 2 shows baseline characteristics of respondents surveyed in each state at follow-up. The two samples had similar profiles in terms of sex, age, location, parental status and baseline SSB consumption. However, a greater proportion of comparison state than intervention state respondents were of low SEP, classified as obese and watched two or more hours of commercial television per day (all p<0.05).

Table 2 Baseline demographic characteristics of final sample, by state

	Intervention state (n=673)	Comparison state (n=730)
Sex		
Male	41.9%	43.7%
Female	58.1%	56.3%
Age		
25–34 years	21.1%	20.0%
35–49 years	78.9%	80.0%
BMI category†*		
Not overweight or obese	43.8%	42.2%
Overweight	36.8%	32.3%
Obese	19.4%	25.6%
Location		
Rural	24.5%	20.4%
Socio-economic position‡*		
Low SEP	30.3%	36.4%
Mid SEP	42.4%	42.8%
High SEP	27.3%	20.9%
Parental status		
Parent	70.3%	68.1%
Commercial television viewing§*		
More than 2 hours	18.9%	24.8%

Unweighted percentages. Percentages are rounded so may not sum to 100%.
*Significant difference at p<0.05, by state (Victoria compared with SA)
†Weight status based on BMI (weight (kg)/height (m)^2) using self-reported height and weight. Missing data: Victoria n=23, SA n=45.
‡SEP was determined according to the Index of Relative Socio-Economic Disadvantage (IRSD) rankings for Victoria as described by the Australian Bureau of Statistics (2008),[12 13] based on respondent's home postcode. Low IRSD indicates greater disadvantage, high IRSD indicated least disadvantage. Missing data: SA n=1.
§Missing data: Victoria n=1, SA n=1.
BMI, body mass index; SA, South Australia; SEP, socioeconomic position.

Primary outcome

SSB consumption was analysed to look for differences between those who consumed 1+ cups per week compared with less than this, 3+ cups per week compared with less and 4+ cups per week compared with less. The interactions for the lower levels of consumption (1+ and 3+ cups per week) were not statistically significant. As shown in table 3, there was a significant interaction (p<0.01) between state and study phase for 4+ cups per week showing a reduction in the proportion of respondents who frequently consumed SSBs in the intervention state (31% (95% CI 27% to 36%) to 22% (95% CI 18% to 26%)), but not in the comparison state (30% (95% CI 26% to 35%) to 29% (95% CI 25% to 33%)). Among overweight SSB consumers, a reduction was recorded from baseline to follow-up in both the intervention (15%) and comparison (8%) states, but with no significant interaction (p>0.10). There was evidence of an increase in the proportion of overweight SSB consumers (1+ per week) drinking four or more cups of water per day (interaction p=0.09), in the intervention state and not in the comparison state. There were no significant interactions by state and study phase (p>0.10) for the proportion of respondents who consumed artificially sweetened drinks once a week or more for the sample as a whole, nor the subgroup of overweight SSB consumers.

Within the intervention state, reduced SSB consumption was not associated with increased consumption of artificially sweetened drinks among the sample overall or overweight SSB consumers (p>0.05).

Secondary outcomes

At follow-up, one in four adults in the intervention state could recall the *LiveLighter* 'Sugary Drinks' advertisement without prompting; an additional 23% recognised the advertisement when prompted with a brief description, yielding total campaign awareness of 48%. Campaign awareness showed no evidence of significant differentiation by sex, sugary drink consumption, SEP, weight status or parental status.

At baseline, a greater proportion of respondents in the intervention state compared with the comparison

Table 3 Campaign impacts on knowledge, beliefs and behaviour, interactions by state and study phase

	Overall							Overweight (BMI 25+) SSB consumers (1+ per week)						
	Intervention state n=1346			Comparison state n=1460				Intervention state n=416			Comparison state n=442			
	B % n=673	FU % n=673	OR (95% CIs)	B % n=730	FU % n=730	OR (95%CIs)	X^2 for interaction‡	B % n=208	FU % n=208	OR (95%CIs)	B % n=221	FU % n=221	OR (95%CIs)	X^2 for interaction‡
Behaviour														
SSB consumption (1+ per week)§	58.4	57.9		57.6	60.9		0.87	59.6	60.5		61.4	65.3		0.48
SSB consumption (3+ per week)	37.2	30.0		36.8	33.9		1.32	63.8	46.8		63.8	52.8		0.74
SSB consumption (4+ per week)	31.3	22.0	0.3 (0.2 to 0.5)**	30.2	28.8	0.8 (0.5 to 1.3)	6.83**	51.1	36.3		50.9	42.6		1.08
Water consumption	72.5	75.4		71.1	71.7		0.51	66.1	73.1	1.4 (1.0 to 2.0)†	68.2	67.2	0.9 (0.7 to 1.3)	2.88†
Artificially sweetened drink consumption	19.9	23.0		20.8	21.6		1.03	25.4	28.2		21.1	18.8		1.60
Knowledge														
Health effect of being overweight or obese	72.5	82.7		55.5	63.1		2.46	70.6	81.7		59.3	61.3		2.43
Health effect of drinking too many SSBs	65.9	70.1		63.2	64.0		1.40	60.5	71.1	1.6 (1.1 to 2.4)*	63.4	59.4	0.8 (0.6 to 1.2)	5.10*
Beliefs														
Thought about how SSBs can make you put on weight	30.8	32.6		30.4	29.1		1.02	39.0	45.0	1.3 (0.9 to 1.9)	43.2	38.3	0.8 (0.6 to 1.1)	3.54†
Health would improve with reduced SSB consumption	75.5	71.7		74.3	71.0		0.00	86.7	81.4		84.1	84.4		1.84
Overweight stereotypes	71.9	71.0		73.6	73.1		0.08	74.1	70.7		74.0	74.0		0.43

Baseline characteristics: SSB consumption, SEP, BMI, commercial television viewing, and days between interviews were included as covariates in the models.
*p<0.05, **p<0.01.
†p<0.10.
‡State × study phase.
§Subgroup analyses are among overweight (BMI 25+) respondents only as SSB consumption (1+ per week) is the outcome.
B, baseline survey; BMI, body mass index; FU, follow-up survey; SEP, socioeconomic position; SSB, sugar-sweetened beverage.

state, correctly identified the message introduced in the previous *LiveLighter* campaign in Victoria, that *toxic fat to build up* is a health effect caused by overweight or obesity (73% compared with 56%; p<0.001) with a similar trend seen among the subgroup of overweight SSB consumers (1+ per week) (71% compared with 59%; p=0.07). As shown in table 3, awareness of this message subsequently did not change at follow-up in response to the 'Sugary Drinks' *LiveLighter* campaign among the sample as a whole, nor the subgroup of overweight SSB consumers (1+ per week) (interactions p>0.10).

For knowledge of the new Victorian *LiveLighter* campaign message that too much *sugary drink leads to toxic fat*, there was no difference between states at baseline among the whole sample or among overweight SSB consumers (both p>0.05). However, as shown in table 3, at follow-up, there was an increase in the proportion of overweight SSB consumers (1+ per week) with knowledge of this new message (interaction p<0.05) in the intervention state and not in the comparison state. No such difference was evident for the overall sample.

There was also some evidence of an increase in the proportion of overweight SSB consumers (1+ per week) who thought about how too many sugary drinks can lead to weight gain more than once in the past week (interaction p=0.06). This pattern was not evident among the sample of all adults. For the belief that reducing consumption would lead to improved health, there were no significant interactions by state and study phase for adults overall or overweight SSB consumers. There was also no difference in the proportion of respondents who endorsed overweight stereotypes from before to after the campaign, in the intervention or the comparison state.

DISCUSSION

Summary of principal findings

The evaluation findings provide evidence that the *LiveLighter* 'Sugary Drinks' campaign achieved a significant reduction in the proportion of frequent SSB consumers among the target population of adults aged 25–49 years in Victoria, Australia. This was accompanied by some evidence of increased water intake with a somewhat greater proportion of overweight SSB consumers drinking four or more cups per day. Among this same respondent subgroup, we observed an increase in the proportion with knowledge of the health effects of SSB consumption and some evidence of an increase in the proportion with self-referent thoughts about its relationship to weight gain. Findings converge with previous evaluations of similar campaigns in the USA, which demonstrate that with an adequate media presence and rigorous evaluation design, changes in knowledge and impacts on SSB consumption may be achieved.[22]

Comparison with other studies

The ability of public health campaigns to increase population knowledge of a particular health effect has been reported previously.[20 37–39] It is notable that baseline knowledge of the original campaign message about the health effects of overweight was significantly higher in the intervention state, likely reflecting gains established in Victoria with the first more general *LiveLighter* campaign in 2014.[23] Gains in knowledge associated with the current campaign, reflect the specific message about the health effects of SSBs providing evidence this campaign is a likely driver. Consistent with evaluation of an earlier campaign phase,[23] our findings indicate the campaign did not promote negative social stereotypes of overweight individuals but did promote improvements in knowledge and behaviour. These findings run contrary to suggestions that campaigns focusing on body weight stigmatise overweight people and are associated with decreased self-efficacy and intentions for health behaviour change.[40–42] However, they are in line with recent research suggesting obesity-related health messages emphasising lifestyle change did not increase negative perceptions of obese persons[43] and may be more persuasive than other public health advertisements addressing weight and lifestyle.[16] This may be because the *LiveLighter* campaign combined advertising content about negative health consequences of overweight with a clear behavioural recommendation to help avert that risk (ie, quit SSBs).

We found that the campaign was associated with a 9% absolute percentage point reduction in the proportion of adults in the intervention state who reported they frequently consume SSBs, with only a 1% decline in the comparison state. This translates to around 200 000 fewer frequent SSB consumers aged 25–49 years in Victoria based on population data.[25] Notably the decline was among frequent SSB consumers (4+ cups per week) rather than less regular SSB consumers, suggesting an impact on those most likely to benefit. Though declines in SSB sales were reported in the broader Australian population prior to the *LiveLighter* 'Sugary Drinks' campaign,[44] this study adds to the literature which has demonstrated the potential for public health mass media campaigns to positively influence health behaviours.[14 15 45] Previous media-centred public health campaigns targeting SSB consumption demonstrated population-level impacts on awareness and intentions but no significant declines in self-reported SSB consumption.[20 21] However, one showed objective evidence of declines in SSB sales in response to the campaign.[22] Other campaigns targeting SSBs that have occurred in the context of major regulatory change have demonstrated impacts on SSB consumption.[18 46] However, it is impossible to isolate the unique contribution of the media component to effecting behaviour change. Findings for this study suggest an SSB intervention consisting primarily of mass media can promote population-level impact on SSB consumption. This pattern of results has been reported in both Western Australia[24] and Victoria, Australia. The magnitudes of the effects reported here are also in line with those associated with mass media campaigns on health behaviour which tend to be small to moderate,[47] but given their

reach they have the potential for significant impacts at the population level that surpass that of more targeted intensive interventions.[33]

It was also important to investigate what beverages Victorian adults may have replaced SSBs with in their diet. There was no evidence that the campaign promoted increased consumption of artificially sweetened drinks, or that those who reduced their SSB intake switched to artificially sweetened drinks. Evidence on the relationship between artificially sweetened beverage consumption and body weight remains equivocal.[48–50] On the other hand, replacing sugar-sweetened drinks with water is associated with reduced long-term weight gain.[49 51] The postintervention increase in the proportion of overweight SSB consumers who reported drinking four or more cups of water per day is encouraging (7% increase in Victoria compared with no change in comparison state). The television advertising did not suggest which beverages viewers should replace SSBs with, although other components of the campaign (eg, website) emphasised the benefits of drinking water along with the tagline 'Choose water first'. There was also a local-level campaign, the 'H_3O Challenge™' (VicHealth http://h30challenge.com.au/) which ran in Victoria 6–9 months before the 'Sugary Drinks' campaign using non- television media, and focused on replacing SSBs with water for 30 days. The low reach of this campaign seems unlikely to have prompted statewide changes in water consumption. Importantly, it ran well before the 'Sugary Drinks' campaign and did not appear to influence the water consumption at baseline, with no difference between states in the full sample nor the subgroup of overweight SSB consumers.

To inform other mass media campaigns aimed at health behaviour change, an important question to ask is: why was the *LiveLighter* 'Sugary Drinks' campaign associated with behaviour change? First, the campaign employed graphic imagery coupled with a focus on the serious negative health consequences of SSB consumption, message elements identified as most persuasive in obesity prevention.[16] Second, it is probable the campaign focus on change to a single dietary behaviour played an important role, given reviews of the effectiveness of social marketing campaigns in achieving healthy eating behaviours recommend focusing on one behaviour at a time.[15 52] Further, SSBs are superfluous to the diet and their reduction involves much less deprivation than other dietary changes suggested for improved health. As a result, there are fewer barriers to change with the benefits of improved health more likely to outweigh the costs of deprivation.[52] Third, the campaign also incorporated stakeholder and community engagement as well as resources. There is evidence that including additional supporting campaign components on top of the mass media element increases effectiveness.[15 53] More peripherally, the timing of the campaign coincided with the negative impact of sugar on health. This message received much attention in popular media throughout Australia along with advocacy for policy changes such as a 'soda tax' and could have served to further reinforce the message of the campaign in the intervention state.

Strengths and limitations of the study

A study strength was our use of a controlled cohort evaluation design that supports the evidence for campaign effects by allowing comparisons longitudinally in outcomes of interest in exposed and unexposed populations, controlling for most threats to internal validity.[54 55] However, in the absence of random allocation, it is not possible to definitively attribute changes to the campaign. Further, without longer-term follow-up of respondents it remains undetermined whether the observed reduction in frequent SSB consumption was maintained. Research shows regular repeated exposures are needed to reinforce behaviour change including consumption of a healthy diet.[15 56] The study is limited by its reliance on self-report so that risk of socially desirable responses is a potential source of bias: it remains possible that the intervention changed the social acceptability of sugary drink consumption rather than consumption itself. While the study would have clearly benefited from the more objective measure of behaviour that sales data would have provided, our efforts to purchase beverage sales data in Australia have gone unrewarded. There may also have been unknown potential confounders unrelated to the campaign that were unique to the intervention state and may have affected SSB-related beliefs and behaviour and therefore external validity, with their influence not limited by the study design.[14] Possible sampling bias is shown by the proportion of Victorian adults (25–49 years) consuming 4+ cups of SSBs per week in the surveyed sample (31.3%) being slightly lower than that recorded by a large Victorian population survey in 2014 (25–54 years—34.6%).[57] Relatedly, the survey samples in both states were achieved via calls to landline telephones so may not represent mobile phone only households. The low cooperation rate for the baseline survey of 31% may also have introduced sampling bias, although this was equivalent across states. There is also some evidence of low power to detect the small effects recorded in mass media campaigns.[45] Finally, the two samples differed in baseline population characteristics (ie, SEP, obesity and commercial television viewing) and though included as covariates in the analyses, this may have incompletely corrected for pre-existing group differences. Importantly baseline SSB consumption did not differ between the two samples.

Campaign investment for the year of implementation was approximately $A2.2 million, including $A746 000 for the evaluated media buy plus $A160 000 for a second non-evaluated media buy and the remainder for licence and production fees, website, communications, evaluation and project management. An economic evaluation of the campaign would inform policy makers.

Conclusions and implications

These findings suggest the public are receptive to making the simple lifestyle change suggested by the campaign

and provide evidence that the *LiveLighter* 'Sugary Drinks' campaign may have contributed to the reduced proportion of adults in the intervention state frequently consuming SSBs. Although the study design does not permit confirmed impact, this is a notable outcome in a context where public health campaigns promoting reduced SSB consumption occur against a backdrop of heavy commercial product advertising promoting increased consumption.[58 59] It also adds evidence to the existing literature which suggests mass media public education can influence health behaviours in general and obesity prevention behaviour more specifically. The findings support continued adequate and sustained investment in *LiveLighter* with the aim of further improvements in public knowledge and behaviour, combined with complementary environmental and policy changes (eg, an SSBs tax[60 61]), to ultimately contribute to reducing obesity-related chronic disease in the longer term.

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