





# Developing sugar-sweetened beverage warning labels for young adults

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## Abstract

**Objective:** There is a lack of qualitative research developing sugar-sweetened beverage (SSB) warning labels with their intended end users. We sought to identify promising SSB warning elements for improving label effectiveness and for future testing in policy and institutional settings.

**Design:** Mixed methods design using ten focus groups, a design task and a survey. The design task was used to generate ideas for an icon that would dissuade SSB consumption. The survey and focus group guide assessed participant perceptions of SSB warning label mock-ups of text (loss frame, gain frame and loss frame with attribution), colour and icon options.

**Setting:** Three large public universities in California from February to March 2018.

**Participants:** Young adult SSB consumers ( $n$  86) enrolled in one of three diverse California public universities.

**Results:** Participants perceived the following elements as most effective for reducing SSB consumption: loss-frame text with attribution to a credible source, yellow and red colour for label background and an image or icon to accompany the text. Preferred images included sugar near or inside of an SSB, intuitive shapes like a triangle with exclamation mark or octagon and a visual indicator of SSB sugar content compared with recommended limits. Support was high for using SSB warning labels in university cafeterias and on bottles/cans.

**Conclusions:** Loss-frame text with a credible source, yellow or red label colour and icons could potentially enhance effectiveness of SSB warning labels and warrant further testing.

## Keywords

Sugar-sweetened beverages  
Warning label  
Qualitative  
Policy  
Young adult  
Communication

Reducing sugar-sweetened beverage (SSB) consumption is a global priority for obesity prevention<sup>(1,2)</sup>. Based on tobacco control successes, excise taxes<sup>(2)</sup> and warning labels<sup>(3,4)</sup> have been identified as transferrable policies for SSB reduction. Evaluations of SSB taxes demonstrate reductions in SSB consumption, sales and/or purchasing<sup>(5–7)</sup>. Because SSB warning labels have not been widely implemented, there is comparatively less evidence of effectiveness. Online experiments<sup>(8–11)</sup> and a small number of laboratory<sup>(12)</sup> and field studies<sup>(13,14)</sup> indicate that warning labels reduce SSB purchasing or selection<sup>(15)</sup>. Furthermore, a Chilean law that mandates front-of-package warning labels on products high in added sugars, among other measures, reduced SSB purchasing<sup>(16)</sup>.

Although US SSB labelling laws have not yet been implemented, interest is growing. Nine US jurisdictions have introduced twenty-eight SSB labelling bills<sup>(17)</sup>. Polling data show high bipartisan support for SSB warning labels<sup>(4)</sup>, indicating political feasibility despite potential legal challenges<sup>(17)</sup>. Furthermore, institutions like workplaces and universities could voluntarily place SSB warning labels at point-of-purchase. Higher education may be a particularly impactful venue for SSB warning labels since 41 % of young adults enrol in college<sup>(18)</sup>, young adults consume high amounts of SSB<sup>(19)</sup>, and emerging adulthood is a developmental period important for establishing lasting dietary habits<sup>(20)</sup>. There is currently an opportunity to identify warning designs most likely to be effective before such

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policies are implemented more widely, either by law or by institutions.

Lessons from warning label development for other products suggest enhanced efficacy with images and symbols<sup>(21–23)</sup>, bright and contrasting colours<sup>(23,24)</sup> and attribution to trusted sources<sup>(25)</sup>. Evidence is more mixed regarding loss- *v.* gain-frame messaging<sup>(21)</sup>. Despite the potential for these elements to improve SSB warning labels, there is a dearth of formative qualitative or mixed methods research developing SSB warning labels with their intended end users. The importance of such studies is underscored by a qualitative study that was used to develop Chile's 'high-in' nutrient warning label<sup>(26)</sup>. Research on the design of SSB warning labels has consisted of quantitative studies testing a limited number of design variations<sup>(8,9,27,28)</sup>. Although prior quantitative research has been instrumental in designing SSB warning labels, the lack of formative research exploring a wide range of designs with end users means that important design variations could be overlooked.

We conducted a mixed methods study using focus groups and a survey of a diverse sample of young adults enrolled in public universities to identify promising SSB warning elements for improving label effectiveness and for future testing. The warning label elements assessed included variations on message framing, attribution to a source, icons and images, and marker words. We examined designs that could be used in policy and institutional settings and assessed support for using SSB warnings in college settings.

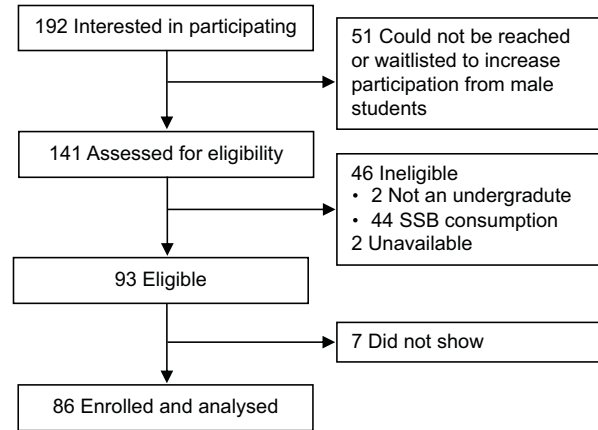
## Methods

### Participants and recruitment

We conducted ten focus groups from February to March 2018 with eighty-six participants enrolled in one of three California public universities. The universities were racially/ethnically and socio-economically diverse, reflected in 2018 total undergraduate enrolment at universities 1, 2 and 3: 34%, 42% and 26% non-Hispanic Asian/Pacific Islander; 28%, 18% and 39% Hispanic and 3%, 2% and 11% non-Hispanic Black, respectively, with 19–54% receiving Federal Pell grants<sup>(29)</sup>. Pell grants are an indicator of low socio-economic status because they are awarded to students of 'exceptional financial need'<sup>(30)</sup>.

Participants were recruited through paper and electronic fliers and class announcements across multiple disciplines, inviting participants to share 'opinions on beverages and health messages.' Eligibility was assessed by phone and included: undergraduate, age  $\geq 18$  years and regular SSB consumption ( $\geq 1$  time/d). Participants received a \$25 incentive.

Following pragmatic recommendations on sample size for focus groups<sup>(31)</sup>, we aimed to conduct at least three focus groups per university with 8–12 participants per focus group to adequately capture the range of perspectives across sites.



**Fig. 1** Participant flow

Because the number of participants who could attend the first two focus groups at University 2 ( $n$  5 and 7) was lower than planned, a fourth focus group was conducted at this site. Data saturation from focus groups was monitored and used as the ultimate criterion for ending new enrolment of participants. Figure 1 shows participant flow. Focus group sizes ranged from 5 to 13 participants (mean:  $8.6 \pm 2.4$ ). All procedures were approved by the universities' institutional review boards.

### Procedures

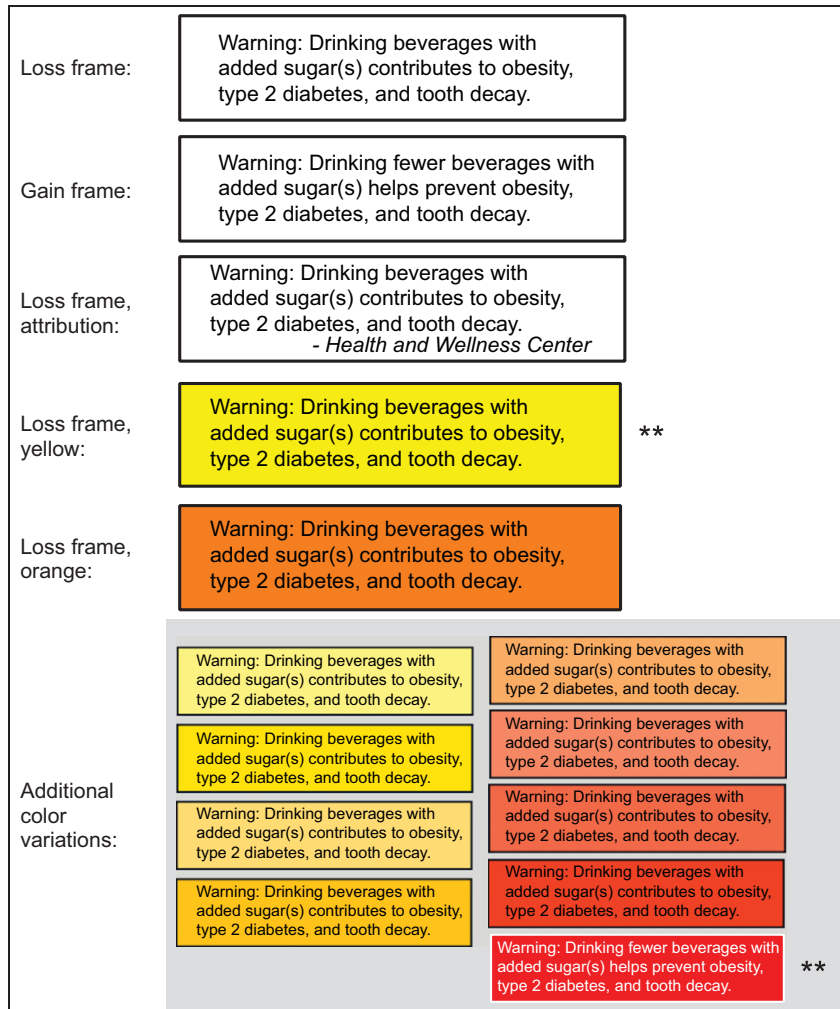
Before focus group discussions, participants completed independent tasks – a background questionnaire, design task and warning label questionnaire, all completed on paper.

#### Design task

The moderator asked, 'What if you were tasked to design an icon or graphic that would be posted on or near sugary beverages in college cafeterias. . . to get people to drink fewer sugary beverages?' Warnings were not referenced. Participants were provided paper, markers and 10 min to independently generate ideas.

#### Warning label questionnaire

The questionnaire assessed ratings and rankings of warning label mock-ups. Participants viewed images of where labels could be placed – near SSB dispensers and on bottles/cans (see online supplementary material, Supplemental Figure 1). Participants viewed and rated print-outs of five randomly ordered mock-ups of rectangular warning labels (Fig. 2), including three text variations in black-and-white: loss frame, gain frame and loss frame with attribution to the 'Health and Wellness Center' – generic for the student health centre. Mock-ups also included two background colour variations: yellow and orange. The loss-frame text was based on SSB warnings shown to be efficacious<sup>(8,9)</sup>: 'Drinking beverages with added sugar(s) contributes to obesity, type 2 diabetes, and tooth decay.' We developed a gain-frame message in consultation with



**Fig. 2** (colour online) Five initial warning label mock-ups and additional colour variations rated and discussed by focus group participants. Note: The first five labels were shown to participants on a single page against a white background in random order. Participants were also shown an image of where labels would be placed (near blue and multi-coloured fountain drink dispensers and on red, yellow and green cans or bottles). Additional colours were displayed against a blue dispenser only. \*\*Colours ranked as most effective ( $P < 0.01$ )

four prominent SSB researchers: ‘Drinking fewer beverages with added sugar(s) helps prevent obesity, type 2 diabetes, and tooth decay.’

Second, as a result of feedback from the first focus group, we presented additional colour variations for all subsequent focus groups to assess: red and additional shades of orange and yellow (Fig. 2).

Third, participants provided rankings of icons/images that could appear on warnings (see online supplementary material, Supplemental Table 1). We used an evolving set of images based on design tasks and discussions, where new images were introduced and unpopular ones removed. We developed an initial set of nine image concepts based on existing warnings (e.g. Chile’s ‘high in’ octagon, triangle with exclamation mark), public health campaigns (e.g. sugar cubes) and health consequences (e.g. tooth decay). Because we sought to design a label that,

in addition to being policy relevant, could be acceptable for voluntary placement by institutions, we did not examine images intended to elicit disgust or that could stigmatise obesity<sup>(32)</sup>.

*Focus group*

Discussion questions (online appendix) assessed perceptions and recommendations for text, colours, attribution, icons/images and marker word. We audio-recorded and transcribed discussions.

The warning mock-ups, questionnaires and focus group guide were informed both by prior empirical research on tobacco and SSB warning labels as well by parts of the Message Impact Framework<sup>(33)</sup> used to explain how tobacco warning labels might impact consumption (e.g. attention, credibility, perceived effectiveness, knowledge and intention).



## Measures

### Background questionnaire

Questions assessed age, gender, race/ethnicity, height, weight, year in college, first generation status, food security<sup>(34)</sup>, Pell grant status, parental income, frequency of eating on campus and beverage consumption<sup>(35)</sup>.

### Warning label questionnaire

Items on perceived message effectiveness (PME) were adapted from a protocol by Hammond and Reid to pre-test tobacco warning labels<sup>(36)</sup>. Prior research has found that PME is predictive of message effectiveness and subsequent behavioural response, making PME a useful outcome in formative research<sup>(37)</sup>. PME ratings of the initial five mock-ups were assessed for text (loss frame, gain frame, loss + attribution) and colour (white, yellow, orange), separately, with: 'Think about the [text/color] of this message. Please rate the effectiveness of the [text/color] by circling one number on the scale below' (ten-point scale: LEAST effective – 1 to MOST effective – 10). Open-ended questions asked what participants liked/disliked about each label.

PME rankings of warning text were assessed with the item, 'Please put the warning messages in order from most to least effective overall, in your opinion.' Rankings of initial colours (white, yellow or orange) were assessed with: 'Consider the color of all messages. Which one is most effective?' Rankings of the additional colours (red and other shades of yellow/orange) and icons/image mock-ups were assessed with the items: 'Choose the three [colors/images/icons] you think would be most effective. Rank them below.' The questionnaire also assessed which icons were perceived as least effective. Finally, the questionnaire asked, 'Would you prefer a text-only message or a message that includes a picture or icon?' For rankings, we created a categorical variable for the highest ranked variation.

The questionnaires assessed support for SSB warnings in college dining commons and on bottles/cans with: 'Do you support the use of sugary drink warning' . . . 'messages in front of sugary drink dispensers in college dining commons?' and 'labels on bottles/cans of sugary drinks?' (ten-point scale: not at all – 1 to extremely support – 10). Last, the questionnaire assessed SSB intention<sup>(38)</sup> and perceived knowledge gain: 'As a result of seeing these warnings, I plan to reduce my intake of sugary drinks' (seven-point scale: strongly disagree to strongly agree), which was dichotomised as agree *v.* neutral/disagree; 'Did you learn anything new after seeing these warnings' (yes/no); and 'What did you learn?'

## Analysis

We used quantitative analysis to determine the extent to which a particular variation of a label element was perceived as more effective than others. We used qualitative analysis to elaborate on the participants' rationale for quantitative ratings and rankings, which could help reveal

mechanisms of potential effectiveness. Qualitative analysis was also used to generate additional ideas for quantitative testing (e.g. additional colours and icons/images) and to corroborate quantitative findings.

### Quantitative

We examined within-subjects differences in mock-up ratings using Friedman and Wilcoxon signed-rank tests.  $\chi^2$  goodness-of-fit tests were used to examine statistical significance of top-ranked variation, and an exact binomial test was used to determine if the proportion preferring a pictorial warnings exceeded 50%. All statistical tests were two-sided ( $\alpha = 0.05$ ) and were conducted using Stata15MP (College Station, TX). Because an evolving set of icons/images were used, we present only percentages for rankings. Also, the sample size was based on considerations for the qualitative component of this study and not on a formal power calculation for rating and ranking outcomes, so some analyses may be underpowered.

### Qualitative

We developed a codebook with structural codes based on question theme and used NVivo11 (QSRInternational, Melbourne) to double-code transcripts. We developed a codebook for classifying each drawing/design idea by topic (e.g. health consequences, warning icon). Disagreements were resolved by the first and second authors. Data saturation was examined throughout the course of the study and was defined as there being no new topics depicted in the design tasks and no new perspectives during focus group discussions. Because data saturation was reached prior to the final focus group, no additional focus groups were conducted beyond the initial ten.

## Results

Most participants (76%) were Hispanic or non-white, and 59% were female (Table 1). Almost half reported low food security, 31% were first generation students and 31% were Pell grant recipients. The racial/ethnic and Pell grant distribution of participants in our sample were within the range of the lowest and highest proportions across the three universities. Participants consumed a  $2.5 \pm 2.1$  cans, bottles or glasses of SSB per day.

### Design task

The most common topics in participant designs were health consequences of SSB (e.g. obesity, oral health, amputation, death, tombstone) – 49%; SSB sugar content (e.g. soda can near sugar pile, sugar content warning) – 47%; warning icons/symbols/labels – 24% and water promotion (e.g. health and aesthetic benefits of drinking water) – 17%. Other topics appearing repeatedly but less frequently were emojis, slogans (e.g. 'save calories for food'), addictiveness, portrayals of SSB as chemicals or toxic, short-term effects of SSB (e.g. mood)

**Table 1** Characteristics of eighty-six focus group participants

	<i>n</i>	%
Age (years)		
Mean	20.0	
SD	2.2	
Female	49	59
Race/ethnicity		
Hispanic or Latino/a, any race	20	24
NH Asian	35	41
NH White	20	24
NH Multiracial	6	7
NH Black	2	2
NH Pacific Islander	2	2
BMI (kg/m <sup>2</sup> ) category		
BMI < 25	59	70
25 ≤ BMI < 30	17	20
BMI ≥ 30	8	10
Year in college		
First	37	43
Second or later	49	57
First generation undergraduate student*	26	31
Food security (six-item USDA) <sup>(34)</sup>		
High/Marginal food security	42	51
Low food security	24	29
Very low security	17	20
Pell grant recipient	24	31
Parents' total household income		
<\$20 000 a year	5	7
\$20 000–<\$65 000 a year	23	34
\$65 000–\$110 000 a year	15	22
> \$110 000	24	36
Frequency eating in dining commons		
Never	18	21
≤2 times/week	21	24
3+ times/week	47	55
Daily self-reported beverage intake, drinks/d		
Total sugar-sweetened beverages (SSB)		
Mean	2.5	
SD	2.1	
Sweetened coffee or tea, including boba		
Mean	0.8	
SD	0.8	
Fruit drinks (not 100 % juice)		
Mean	0.5	
SD	0.6	
Regular soda		
Mean	0.4	
SD	0.6	
Sports drinks		
Mean	0.3	
SD	0.4	
Energy drinks		
Mean	0.2	
SD	0.3	
Total Non-SSB		
Mean	5.5	
SD	2.5	
Water (bottled or tap)		
Mean	3.4	
SD	1.5	
Other non-SSB		
Mean	2.1	
SD	1.6	
Sample distribution among universities		
University 1 (3 focus groups)	30	35
University 2 (4 focus groups)	34	40
University 3 (3 focus groups)	22	26

NH, non-Hispanic; SSB, sugar-sweetened beverage.

Observations with missing data were excluded from calculations of means, SD, and percentages.

\*Neither parent completed 4-year college degree.

and physical activity equivalents of SSB energies (see online supplementary material, Supplemental Figure 2). The mock-ups of icons/images we developed to elicit feedback contained examples of participants' most frequently depicted topics (except obesity, graphic/morbid images and water promotion) and some less frequently depicted topics: emojis, portrayals of SSB as chemicals and slogans.

### Warning questionnaire and focus group discussions

Quantitative results below for each theme are followed by quantitative findings that explain the rationale behind participants' ratings and rankings of PME. Table 2 and Supplemental Table 1 contain additional quotes.

#### Text

When participants rated PME of mock-ups one-by-one (on a ten-point scale from least – 1 to most effective – 10), PME ratings differed significantly by mock-up text (gain = 5.3, loss = 5.6 and loss + attribution = 6.2;  $P < 0.01$ ). Loss + attribution was rated significantly more effective than loss frame ( $P = 0.01$ ) and gain frame ( $P < 0.01$ ), but there was no significant difference between loss- and gain-frame ratings ( $P = 0.14$ ). When ranking all mock-ups side-by-side, participants ranked loss + attribution as most effective (52%;  $P < 0.001$ ), followed by a similar proportion for gain (27%) and loss frame (20%). However, gain frame was ranked least effective (49%;  $P < 0.01$ ) compared with loss frame (35%) and loss + attribution (16%).

In focus group discussions, the most common reason favouring attribution was credibility. However, many felt that the attribution reduced readability by adding text and was unnecessary. Regarding source, although some favoured the university health and wellness centre (e.g. 'who doesn't like them?'; 'it makes me feel like [my university] is looking out for me'), many felt it lacked authority: 'It's not like the American Heart Association or a surgeon's warning. It doesn't have authority.' The American Heart Association and FDA were mentioned most frequently as preferred sources, followed by research universities.

Participants who favoured the loss-frame text preferred its brevity, clarity and directness: 'Concise, easy for most people to understand.' Others perceived the loss-frame text as more effective because it sounded 'stronger' and more 'concerning' than gain frame: 'If I see a warning, I really want it to warn me... instead of being soft...'

Participants favouring gain frame noted its positivity: 'It uses a more proactive/positive angle.' Others thought the gain-frame text may increase self-efficacy: '[Drinking] "fewer" makes it seem... doable.' Critiques were that it was ineffective, confusing and did not quantify 'fewer': 'How much is fewer? Is it two sips less?; it's enabling.' Others noted the contradiction of gain-frame text for a warning: '... that wasn't really a warning.'

**Table 2** Exemplary quotes from focus group discussions and free-response questionnaire items evaluating sugar-sweetened beverage warning label designs

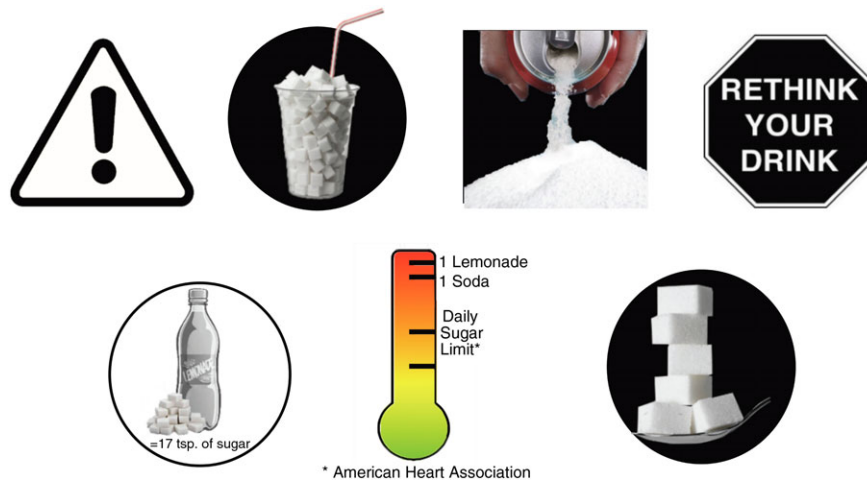
Design element	Quotes containing appraisals of SSB warning label design elements	
	Positive appraisals	Critical appraisals
Text: Loss frame	<ul style="list-style-type: none"> <li>– <b>Concise, easy for most people to understand.</b></li> <li>– <b>Informative.</b></li> <li>– <b>Warned of risks in a very straightforward way.</b></li> <li>– <b>It is believable and factual.</b></li> <li>– <b>[It lists] specific diseases that most teens care about.</b></li> <li>– It does not propose drinking less... but states that sugary drinks contribute to the negatives.</li> <li>– More alarming [than gain-frame].</li> </ul>	<ul style="list-style-type: none"> <li>– <b>Lengthy.</b></li> <li>– <b>It is information that everybody is supposed to know.</b></li> <li>– <b>Not catchy enough.</b></li> <li>– <b>They are only listing 3 unhealthy things that can happen.</b></li> <li>– Non-science majors may not understand the severity of this.</li> <li>– Not specific... how much added sugar?</li> <li>– It did not tell us why.</li> <li>– There is no emotional appeal.</li> <li>– <b>It makes the whole message more wordy... So, I'm inclined to ignore it.</b></li> <li>– <b>The citation does not help a whole lot because I feel like the warning says things that are widely agreed upon.</b></li> <li>– ... <b>makes it seem like it is not a universal claim.</b></li> <li>– It looks like a weird quote.</li> <li>– <b>If I see a warning, I really want it to warn me. I want it to say "don't do this," instead of being soft like "if you don't do it, then that's good for you."</b></li> <li>– <b>How much is fewer? Because people don't know how much less they have to drink, they'll probably still drink an amount that is still unhealthy.</b></li> <li>– <b>Too long to read.</b></li> <li>– <b>The "helping" part can be confusing...</b></li> <li>– <b>Doesn't show people the urgency of the message.</b></li> <li>– <b>Twisty-turny, wishy-washy, not direct.</b></li> <li>– <b>Does not exactly fit as a warning.</b></li> <li>– <b>Does not seem aggressive enough.</b></li> <li>– Double negative.</li> <li>– <b>The sign in white can be easily missed.</b></li> <li>– <b>Did not stand out, should have different background colour.</b></li> </ul>
Text: Attribution	<ul style="list-style-type: none"> <li>– ... <b>legitimises the statement.</b></li> <li>– <b>Adding a source of reference adds credibility to the statement, which would convince sceptical people that do not believe it.</b></li> <li>– ... makes the health effects less annoying/judgmental.</li> <li>– It's completely factual; no emotional bias.</li> </ul>	<ul style="list-style-type: none"> <li>– ... <b>makes it seem like it is not a universal claim.</b></li> <li>– It looks like a weird quote.</li> <li>– <b>If I see a warning, I really want it to warn me. I want it to say "don't do this," instead of being soft like "if you don't do it, then that's good for you."</b></li> <li>– <b>How much is fewer? Because people don't know how much less they have to drink, they'll probably still drink an amount that is still unhealthy.</b></li> <li>– <b>Too long to read.</b></li> <li>– <b>The "helping" part can be confusing...</b></li> <li>– <b>Doesn't show people the urgency of the message.</b></li> <li>– <b>Twisty-turny, wishy-washy, not direct.</b></li> <li>– <b>Does not exactly fit as a warning.</b></li> <li>– <b>Does not seem aggressive enough.</b></li> <li>– Double negative.</li> <li>– <b>The sign in white can be easily missed.</b></li> <li>– <b>Did not stand out, should have different background colour.</b></li> </ul>
Text: Gain frame	<ul style="list-style-type: none"> <li>– <b>It uses a more proactive, positive angle.</b></li> <li>– <b>Easy to understand.</b></li> <li>– <b>"Fewer" makes it seem like a doable thing.</b></li> <li>– <b>I liked how it talks about preventative measures, and it indirectly makes people a lot more self-conscious. They will pay attention to a problem if it's within their control.</b></li> <li>– <b>It's less aggressive, more of a kind suggestion than outright warning.</b></li> <li>– <b>It says to drink fewer, not stop completely.</b></li> <li>– I like that it is saying what it could prevent v. what it will cause. I think that is more palatable.</li> </ul>	<ul style="list-style-type: none"> <li>– <b>If I see a warning, I really want it to warn me. I want it to say "don't do this," instead of being soft like "if you don't do it, then that's good for you."</b></li> <li>– <b>How much is fewer? Because people don't know how much less they have to drink, they'll probably still drink an amount that is still unhealthy.</b></li> <li>– <b>Too long to read.</b></li> <li>– <b>The "helping" part can be confusing...</b></li> <li>– <b>Doesn't show people the urgency of the message.</b></li> <li>– <b>Twisty-turny, wishy-washy, not direct.</b></li> <li>– <b>Does not exactly fit as a warning.</b></li> <li>– <b>Does not seem aggressive enough.</b></li> <li>– Double negative.</li> <li>– <b>The sign in white can be easily missed.</b></li> <li>– <b>Did not stand out, should have different background colour.</b></li> </ul>
Colour: White	<ul style="list-style-type: none"> <li>– <b>White is better to read text.</b></li> <li>– <b>The black and white makes it seem serious.</b></li> <li>– I like the plainness... it gets to the point.</li> </ul>	<ul style="list-style-type: none"> <li>– <b>Maybe too much in your face to some.</b></li> <li>– <b>Ugly colour.</b></li> <li>– It could potentially be distracting.</li> <li>– Yellow is not as intimidating as, let's say, red.</li> </ul>
Colour: Yellow	<ul style="list-style-type: none"> <li>– <b>It catches your attention, makes the message appear very important.</b></li> <li>– <b>The yellow is eye-grabbing but bright enough to let the black text pop.</b></li> <li>– <b>Reminds me of the traffic signs that warn drivers of accident potentials.</b></li> <li>– I highlight everything; when I see a warning label that is a highlighter colour, I will want to read it</li> </ul>	<ul style="list-style-type: none"> <li>– <b>Maybe too much in your face to some.</b></li> <li>– <b>Ugly colour.</b></li> <li>– It could potentially be distracting.</li> <li>– Yellow is not as intimidating as, let's say, red.</li> </ul>
Colour: Orange	<ul style="list-style-type: none"> <li>– <b>Catches eyes more than white.</b></li> <li>– <b>Orange is better on the eye than yellow.</b></li> <li>– <b>The colour gives the idea of a construction zone which is associated with caution.</b></li> </ul>	<ul style="list-style-type: none"> <li>– <b>Orange does not help the black text "pop" like the yellow does.</b></li> <li>– It is not as bright as yellow.</li> </ul>
Colour: Red	<ul style="list-style-type: none"> <li>– <b>I really liked the red and white one. It looks like a stop sign so it made me stop and read it.</b></li> <li>– <b>Definitely the red is more dangerous and attention-grabbing.</b></li> </ul>	<ul style="list-style-type: none"> <li>– <b>I feel like the red background and white is really awful to me...the contrast is weird. it makes the colours blur and hard to read.</b></li> </ul>

Bold font indicates sentiments voiced with greater frequency.

### Colour

PME ratings of the three initial background colours differed (yellow = 7.1, orange = 6.3 and white = 4.1;  $P < 0.001$ ). Participants perceived yellow ( $P < 0.001$ ) and orange ( $P < 0.001$ ) as more effective than white, and yellow as more effective than orange ( $P < 0.001$ ). When participants were asked to rank a larger selection of twelve colours, including red, the highest proportion of participants ranked the following as most effective (Fig. 2): yellow with black font (16%;  $P < 0.01$ ) and red with white font (16%;  $P < 0.01$ ).

Participants perceived yellow as 'attention-grabbing' and contrasting with black font. Participants likened yellow to traffic lights and signs. Another said, '... when I see... a highlighter color, I will want to read it.' Those favouring red with white font noted that red signified 'danger' and reminded them of traffic signals: 'it made me stop and read it.' However, several participants noted the poorer contrast of red and white font. Orange was also perceived as eye-catching and reminded participants of 'construction zones' and 'chemistry' warnings. Although black-and-white was perceived as 'official' and 'readable,' many thought it failed



**Fig. 3** (colour online) Top ranking icon or image concepts to accompany a sugar-sweetened beverage warning label  
 Note: Supplemental Figure 1 shows all icon and image concepts ranked by participants.

to grab attention. Participants emphasised the importance of the label colour contrasting with location placed.

*Icon/image*

Most (81%;  $P < 0.001$ ) preferred a warning with a picture/icon over a text-only warning. Icon/image ideas ranked as most effective by  $>10\%$  of participants were (Fig. 3): sugar next to/inside an SSB can, bottle or cup (38%), a triangle-exclamation mark (15%) and an octagon with a slogan, ‘rethink your drink’ or nutrient warning ‘high in sugar’ (14%), and depiction of sugar content of SSB relative to daily limits (11%).

Reasons for preferring images of sugar were that they convey the high sugar content of SSB and reduced product appeal (e.g. ‘when I think of Coke or a lemonade, I think . . . that’s refreshing, not a liquid form of [sugar] cubes; that’s kind of disgusting’). However, some participants thought the sugar cubes were ice, underscoring the need for unambiguous icons.

Those in favour of the triangle-exclamation mark noted that it universally symbolised a warning, drew attention and motivated them to read the text. Those in favour of octagons noted they elicited attention, were catchy (‘rethink your drink’) and served as a concise reminder of the label’s message. However, a participant noted that if an icon also contains text, it creates ‘two information sources battling each other’ making it ‘hard to read.’

Icons depicting SSB sugar content *v.* daily limit were controversial. Although they can correct misperceptions about sugar content (e.g. ‘people probably think that amount of sugar is normal, but it shows you it isn’t’), others found them harder to quickly process and understand.

Icons perceived as least effective were emojis (34%) and health symbols (e.g. heart; 14%). Although emojis had proponents, others perceived them as removing ‘the weight of the problem.’ Participants noted that health symbols may send an unintended message, ‘like it was a doctor-approved soda.’ Last, some participants said certain image

concepts would be effective on a billboard (e.g. sugar packets) but would be hard to comprehend on a small label.

*Marker word*

Participants voiced their preference for the marker word, ‘warning,’ to be in all-caps, bold or larger font. Regarding other marker words, participants generally preferred ‘warning’ but noted that ‘caution’ or ‘attention’ fit better with gain-frame text.

*Support*

Support was high for using warnings in front of sugary drink dispensers in college dining commons and on bottles/cans of sugary drinks:  $8.1 \pm 1.7$  and  $8.1 \pm 2.0$ , respectively, on a ten-point scale (not at all – 1 to extremely support – 10). The proportion selecting a 6–10 on that scale was 92% for the ‘dining commons’ and 87% for ‘bottles/cans.’ Reasons for supporting warnings in dining commons were perceived effectiveness and to: increase knowledge about the health consequences of SSB, ‘remind’ those who already have this knowledge, increase risk perception and promote informed choice (e.g. ‘this is a low-cost way to promote health without infringing on students’ liberty . . .’). Those unsupportive expressed scepticism about effectiveness (e.g. ‘. . . college students would mostly ignore . . . the warnings . . . there is a low risk perception’).

*Perceived knowledge and intention*

Seventeen percentage reported learning something new from the warnings (e.g. specific disease consequences of SSB and that some ‘juice drinks’ contained added sugar), and 69% reported intending to reduce SSB intake after seeing the warnings.

**Discussion**

This formative mixed methods study found that young adults enrolled in one of three public universities had a

strong preference for warning labels in attention-grabbing colours, namely yellow and red, that evoke symbols of caution. Participants emphasised the importance of the warning colour contrasting with where it is placed and the need for enough contrast with font colour for readability. Of the text options, participants perceived the loss-frame text with attribution to a source as most effective, but some thought a source added unnecessary length. Although loss- and gain-frame text elicited similar rankings as 'most effective,' gain frame was also ranked 'least effective,' indicating ambivalence about gain-frame text. Reasons for preferring loss-frame text included brevity, clarity and directness. Consistent with a loss-frame text preference, participant-generated designs for images/icons were more likely to convey health consequences (disease, mortality) or nutrition consequences (excess sugar) of SSB than benefits of not consuming SSB or consuming water instead of SSB. Most participants preferred a warning that included an icon/image. Of the icon/image mock-ups, the following were perceived as the most effective: depiction of sugar near/inside SSB, a triangle-exclamation mark and octagon, and the sugar content of SSB relative to daily limits. Participants articulated a preference for the marker word to stand out (e.g. caps). Most participants reported intending to reduce SSB consumption as a result of seeing the warnings in the study. Last, participants indicated strong support for SSB warning labels in college dining commons and on SSB cans/bottles.

All warning designs tested in this study could be used in voluntary warning labels or in labels placed by institutions themselves. However, not all may be legally viable as part of government policies that require businesses to label products. The more factual and less controversial the warning content, the more legally viable it will be<sup>(17,39)</sup>. Regarding images tested in our study, a triangle icon (proposed in California SB347) may be less risky than others as it is commonly understood to signify a warning and has been implemented in voluntary and mandatory<sup>(40,41)</sup> warning labels for other products. Also, an image that depicts an amount of sugar not exceeding that in the product is more factual and therefore may be less risky than an image exaggerating sugar content. Likewise, for textual statements, the more factual it is (e.g. 'high in added sugar'), the more legally viable the label may be. Conversely, text or icons that convey an opinion (e.g. 'Rethink your drink') or that may be misleading or not factual (e.g. cup filled entirely with sugar) are unlikely to survive a legal challenge if required by government. The loss-frame text of mock-ups in this study has been written into bills and is similar to that in an enacted San Francisco ordinance that requires warning labels on ads for SSB (the difference being that the ordinance did not specify 'type 2' diabetes). A 2019 court decision blocked the implementation of San Francisco's ordinance because of the size of the required warning and also suggested, without ruling definitively, that words like 'may' and 'type 2' diabetes could

be needed in the text to make it factually accurate<sup>(17)</sup>. However, including 'can' or 'may' could attenuate label effectiveness<sup>(42)</sup>. San Francisco has since enacted a revised warning label ordinance, which has also been the subject of litigation, that requires the following text: '... Drinking beverages with added sugar(s) can cause weight gain, which increases the risk of obesity and type 2 diabetes'<sup>(43)</sup>.

Similar to our findings for colour, Reyes *et al.*<sup>(26)</sup> used focus groups to develop Chile's nutrient warnings and found that red, yellow and orange were preferred over black-and-white. In a quantitative study, Grummon *et al.*<sup>(28)</sup> found that although most participants perceived red as most effective, few perceived yellow as most effective, perhaps because their study's yellow label lacked a black border, causing low contrast against light backgrounds. Prior research has shown consumer preference for a border<sup>(27)</sup>. Similar to our finding, Lempert *et al.*'s analysis<sup>(24)</sup> of tobacco industry research found that 'yellow most quickly and effectively seizes and holds consumers' attention and signals warning...' Acton *et al.*<sup>(27)</sup> found that yellow was rated as more noticeable than white but less readable. When tested against control conditions (e.g. no label), online experiments have found that black-and-white SSB warnings were efficacious<sup>(8,12,44)</sup>, whereas real-world experiments have only tested labels in colour, finding that a red octagon<sup>(12)</sup> and yellow warning with a triangle-exclamation icon<sup>(14)</sup> reduced SSB purchase or consumption. For other products, not all studies consistently showed greater efficacy for red and yellow *v.* black/white. For instance, Musicus *et al.*<sup>(45)</sup> found no significant difference between red and black sodium warnings.

There is a lack of studies testing gain- *v.* loss-frame text for SSB warning labels, and to our knowledge, experiments of SSB warnings have used loss frame<sup>(15)</sup>. However, a qualitative study eliciting opinions about a variety of SSB interventions (e.g. warning labels) among parents and providers of infants and pregnant women found that although gain-frame messages were well-received, loss-frame messages (e.g. risk of diabetes, heart disease) drew more attention, elicited stronger emotional responses and were perceived as particularly effective among parents for discouraging SSB consumption<sup>(46)</sup>. Also, an online experiment among Brazilian adults tested a loss-frame labelling scheme for unhealthy products against a gain-frame labelling scheme for healthy products; the authors found that the loss-frame scheme was more efficacious<sup>(47)</sup>. Similarly, tobacco literature suggests that although participants may voice preference for gain frame in some studies, loss-frame warnings are typically more effective<sup>(21,22)</sup>. However, the literature on health behaviours more broadly has demonstrated between-person variability in effectiveness of loss- and gain-frame messages<sup>(48)</sup>. Thus, using multiple variations of a warning by frame and other characteristics (e.g. colour) simultaneously or on a rotating basis may





be effective in a larger proportion of the population than using a single warning variation.

Similar to our findings that participants preferred intuitive icons, online studies indicated that triangle-exclamation mark, octagon and circle-exclamation mark were perceived as more effective than text-only labels<sup>(26–28)</sup>, and two real-world experiments using such icons on labels reduced SSB purchase<sup>(12)</sup> or consumption<sup>(14)</sup>.

Support for SSB warning labels on cans/bottles of SSB was high in this study, similar to prior findings<sup>(4)</sup>. However, our study also finds high support among college students for SSB warning labels in dining commons.

Limitations of this study include not eliciting feedback on gruesome/morbid imagery or depictions of obesity and the potential limited generalisability of results to other regions or age groups. However, young adults are among the highest SSB consumers<sup>(19)</sup>, making it critical to design effective warnings for this group. Further, because our sample consisted of SSB consumers who were disproportionately food insecure, a population at increased chronic disease risk<sup>(49,50)</sup>, our sample was well-suited for testing SSB warnings. Also, although we tested a comprehensive set of images/icons, the execution of mock-ups may have influenced perceptions. Since this study was designed, a validated brief scale of PME was developed and published<sup>(51)</sup>. Scales such as these should be used in future formative studies. We assessed only self-reported perceptions of labels and not actual effectiveness, so further quantitative testing with objective outcomes is needed to definitively identify the most effective design variations. Future testing of warning label variations would benefit from measures and procedures that not only test efficacy but also provide further evidence on the mechanisms<sup>(52,53)</sup> through which labels impact consumption. Last, our sample size may have been underpowered to detect some quantitative differences in perception of label design variations.

Interest in SSB warning label legislation is growing, but there has yet to be such a law implemented in the USA. To maximise public health impacts of such laws, it is important to thoroughly consider design elements that could enhance label effectiveness. This study identified promising SSB warning label variations for further testing and revealed reasons young adult SSB consumers preferred these variations. It will be important to quantitatively test the top designs against one another as existing research has already begun to do. These results could also be used to design SSB warning labels in institutions like hospitals, workplaces and universities. The feasibility of voluntary SSB warning labels is underscored by participant's strong support for SSB warning labels in dining commons.

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### Supplementary material

For supplementary material accompanying this paper visit <https://doi.org/10.1017/S1368980021002287>

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