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Public health strategies to reduce sugar intake in the UK: An exploration of public perceptions using digital spaces

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Abstract

Objective: To explore UK public perceptions of children's sugar consumption, Public Health England's *Change4Life* Sugar Smart app and the Soft Drinks Industry Levy, using solicited and unsolicited digital data.

Methods: Data from three digital spaces were used as follows: (1) an online questionnaire advertised on parenting forums; (2) posts to UK online parenting forums; and (3) English language Tweets from Twitter. Quantitative data were analysed using descriptive statistics and qualitative data using content and inductive thematic analysis.

Results: Data were (study 1) 184 questionnaire participants; (study 2) 412 forum posts; and (study 3) 618 Tweets. In study 1, 94.0% (n = 173) agreed that children in the UK consumed too much sugar and this had a negative health effect (98.4%, n = 181). Environments (n = 135, 73.4%), media/advertising (n = 112, 60.9%) and parents (n = 107, 58.2%) were all reported as barriers to changing children's sugar intake. In study 2, more posts were negative towards the Soft Drinks Industry Levy (n = 189, 45.9%) than positive (n = 145, 35.2%), and themes about the inability of the Levy to affect sugar consumption in children and childhood obesity emerged. Other themes related to distrust of the government, food industry and retailers. In study 3, the Sugar Smart app was viewed positively (n = 474, 76.7%) with its function associated solely with identification of sugar content.

Conclusions: Participants accepted the necessity of sugar reduction in children, but recognised the complexity of behaviour change. Public health activities were not always perceived as effective strategies for health promotion. There was some distrust in government, public health officials and the food industry. A less simplistic approach to sugar reduction and more credible sources of information may, therefore, be welcomed by the public.

Keywords: childhood obesity, parenting forums, public health, social media, sugar, sugar tax

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Introduction

Sugar is widely believed to be a contributing factor to overweight and obesity, by promoting positive energy balance (SACN 2015). The World Health Organization (WHO) recently published guidelines for

policymakers to reduce sugar intake in both adults and children, aiming for an overall reduction in the prevalence of obesity, dental caries and non-communicable diseases (NCDs) (WHO 2015). In 2015, in the UK, the Scientific Advisory Committee on Nutrition (SACN) recommended a reduction in the intake of free sugars to no more than 5% of daily energy intake in those aged 2 years and over (SACN 2015). However, the most recent national survey in the UK revealed children aged 4–10 years are consuming far in excess of recommendations, with an average of 13.6% of their daily energy intake in the form of free sugars (PHE 2018).

In the UK, sugar intake has emerged as a key target for intervention to tackle childhood obesity. In response, several policies which aim to reduce the intake of sugar amongst children, including fiscal measures, regulation of marketing, reformulation and education, have been proposed (Tedstone *et al.* 2015). Public Health England's (PHE) *Change4Life* campaign launched a free smartphone application – the 'Sugar Smart app' – as part of their 2016 'Sugar Smart' campaign. The app is targeted directly at families and enables users to scan the barcode of a product (at home or while shopping) to identify the sugar content (PHE 2016a). A recent evaluation found that the Sugar Smart app reduced purchases of sugar-sweetened beverages (SSB) in favour of lower sugar products [32% of the intervention group had purchased a lower sugar drink compared with 19% of the comparison group ($P = 0.01$)] but, to date, no research has investigated public views about the app (Wrieden & Levy 2016).

A Soft Drinks Industry Levy, announced as part of the 2016 Childhood Obesity Strategy (HM UK Government 2016), became effective in April 2018 (HMRC 2016). Studies investigating the effect of levies on obesity (in France, Denmark, Finland, Mexico and Hungary) have not shown an effect, although one systematic review suggested levies lowered sales of SSB and reduced population energy intake from SSB by 5%–48% (Tedstone *et al.* 2015; Afshin *et al.* 2017) with a second review revealing negative price elasticity leads to a reduced demand for SSB (Cabrera-Escobar *et al.* 2013; Thow *et al.* 2014; Afshin *et al.* 2017). Between 45% and 47% of adults (depending on the survey) supported a levy on SSB but, to date, no studies have explored awareness, attitudes or perceptions of the Levy in the UK (OnePoll 2015; BMG Research 2016).

Evaluating food-related programmes and policies has been identified as one of the top ten priority actions required to improve the UK food environment (Watson *et al.* 2018) but, despite this, public perceptions are often ignored. To complement more traditional forms of collecting solicited responses, research is beginning to explore how digital spaces can offer novel insight into public perceptions using unsolicited data; for example, see Arden *et al.* (2014). Therefore, this study investigates a novel method of exploring: (1) awareness, perception and attitudes of parents and caregivers towards children's sugar consumption and policies aimed at reducing sugar in children's diets; (2) perception and attitudes towards the Soft Drinks Industry Levy in particular; and (3) perceptions and attitudes of the general public towards PHE's Sugar Smart app. Three separate approaches help to build a picture of public response, providing a perspective across platforms, using data from three digital spaces. Due to the novelty of the methods employed and the exploratory nature of the enquiry, it does not aim to provide a comprehensive overview of public response to sugar reduction via digital spaces.

Methods

Data were posted on social media or collected via survey between July 2015 and September 2016 (study 1: 17 July 2016 – 24 Sept 2016; study 2: 17 July 2015 – 31 Aug 2016; and study 3: 4 Jan 2016 – 29 July 2016). Key dates included: 17 July 2015 SACN's *Carbohydrates and Health* report published (SACN 2015), 22 October 2015 PHE's *Sugar reduction: the evidence for action* report published (Tedstone *et al.* 2015); 4 January 2016 launch date of PHE's Sugar Smart app (PHE 2016a); 18 August 2016 Soft Drinks Industry Levy proposed as part of *Childhood Obesity: A Plan for Action* (HM Government 2016). The Levy was not introduced at the time of data collection.

Study 1

An anonymous, online questionnaire was developed to collect data on perceptions and attitudes around children's sugar consumption and the health consequences of excess sugar consumption, barriers to sugar reduction, the proposed Soft Drinks Industry Levy and PHE's *Change4Life* and Sugar Smart app. In addition, age (18–24, 25–29, 30–39, 40–49, 50–59, 60+ years); gender (male, female, non-binary, prefer not to say); self-described ethnicity [White (White British, Irish, other), Black and Black British (Black Caribbean, Black African, other Black), Mixed (White and Black Caribbean, White and Black African, White and

Asian, other mixed), Asian and Asian British (Indian, Pakistani, Bangladeshi, Gujarati, Tamil, other Asian), Chinese and other ethnic groups (Chinese, Korean, other ethnic group), prefer not to say, other (please specify)]; education [no formal qualifications, GCSE or equivalent, A-Level or equivalent, undergraduate degree or equivalent (*e.g.* BSc, BA), postgraduate degree or equivalent (*e.g.* PGCert, MSc, PhD)] and whether they were parents or grandparents to children aged 10 or younger were recorded. Those participants indicating that they were 17 years or younger were redirected and unable to access the survey. A URL for the questionnaire (hosted by SurveyMonkey) was posted on four popular parenting forums who did not charge for hosting: Netmums.com, bounty.com, cgbabyclub.co.uk (Cow & Gate Baby Club) and singlewithkids.co.uk. Participants were able to view an information sheet before entering their details. Two hundred and twenty responses were obtained of which 184 were useable: exclusions related to <18 years (n = 15), no data entered beyond basic demographics (n = 20), and purposefully void (n = 1). Data analysis was conducted in IBM SPSS for Mac Version 23.

Study 2

Based upon a Google search using the term 'UK parenting forum' on 10 July 2016, the top three forums were identified: Netmums.com, Babycentre.com and Mumsnet.com. Forum posts between 17 July 2015 and 31 August 2016 were identified with the keywords 'sugar tax' and 'sugar levy' and were manually searched to select those that referred to the proposed Soft Drinks Industry Levy (n = 462). A further 50 posts were excluded as they contained personal anecdotes or opinions not associated with the study aim (*e.g.* tax credits). In total, 412 posts in 18 threads were included in the analysis. Posts ranged from a few words to several paragraphs in length. All identifying information, such as avatar pictures and usernames, was removed. The data were analysed using a directed content analysis approach (Hsieh & Shannon 2005) whereby each post was coded using predetermined codes relating to the general sentiment expressed; namely positive, negative and neutral. Inductive, interpretative thematic analysis was then employed to describe emergent themes relating to the study aim (Fade & Swift 2011). Each post was read by AM and information that helped answer the research question 'How do users of parenting forums describe the proposed Soft Drinks Industry Levy?' was coded. These codes were developed into themes following discussion with JAS over several meetings until a descriptive analysis was agreed upon. Verbatim quotes are presented to illustrate the findings. In terms of reflexivity, the first author believes that current levels of sugar consumption in the UK are detrimental to health and that action from public health bodies is needed. She is skeptical of the UK's Soft Drinks Industry Levy and concerned about unintended psychological and sociological consequences of problematising any food group, product or ingredient that is a central part of the diet. Other members of the research team are more supportive of the Levy.

Study 3

English language Tweets between 4 January 2016 and 29 July 2016 were identified with the term words 'Sugar Smart app' and manually searched to select those that referred to PHE's *Change4Life* and Sugar Smart app (n = 618). In addition to the text of the Tweet, user profiles for each Twitter handle were inspected to determine nationality and whether they were personal accounts of individuals, a health organisation or some other public organisation or an educational institution. The data were analysed in a similar manner to study 2, first using directed content analysis (Hsieh & Shannon 2005) to determine the frequency of positive, negative and neutral posts, then with inductive, interpretative thematic analysis (Fade & Swift 2011). Each post was read by YC and information that helped answer the research question 'How do users of Twitter describe the PHE's *Change4Life* and Sugar Smart app?' was coded. Codes were developed into themes following discussion with JAS over several meetings until a descriptive analysis was agreed upon. Verbatim quotes are presented to illustrate the findings.

Ethics

Study 1 received approval from the School of Bioscience Research Ethics Committee of the University of Nottingham (Ref. SBREC150128A). Due to the public nature of the data in studies 2 and 3, no ethical approval was required. However, any information that might be used to identify members was removed prior to data analysis.

Results

Study 1

The majority of the 184 participants were aged 30-39 years (n = 95, 51.6%) with 15 participants (8.2%)

aged 18–24 years, 36 (19.6%) aged 25–29 years, 34 (18.5%) aged 40–49 years and four (2.2%) aged 50–59 years. The sample was predominately female (n = 179, 97.3%) with three males (1.6%) and two preferring not to say (1.1%). The majority of the sample described their ethnicity as White (n = 177, 96.2%) with one Black and two mixed, two 'other' and two preferring not to say. More than half of participants had an undergraduate degree (n = 72, 39.1%) or postgraduate degree (n = 41, 22.3%). One hundred and seventy-three participants were parents or grandparents to children aged 10 years or younger (94.0%).

Most participants (n = 173, 94.0%) agreed that children in the UK consumed too much sugar and 98.4% (n = 181) that this had a negative effect on their health, citing dental caries, overweight and obesity, diabetes type 2 and hyperactivity (all >50% agreement) (Table 1). Although participants did not overwhelmingly rate dietary sugar reduction as difficult (n = 53, 28.8%), numerous individual and structural barriers were endorsed: environments, media and advertising of high-sugar foods and drinks, parents' lack of willingness to change and a lack of knowledge around selecting low-sugar alternatives, along with children's taste preferences (all >50% agreement) (Table 2).

In response to the question 'The government has proposed introducing a sugar tax (levy). What effect do you think it will have on children's health in the UK?', half of the participants reported that it would have no effect on children's health (n = 93, 50.5%) while a quarter reported that it would improve children's health (n = 47, 25.5%) and two endorsed the notion that it will have a negative effect on children's health (1.1%). Thirty-one participants reported using the *Change4Life* Sugar Smart app (16.8%) and, of these participants, 45.2% rated their experience as good or excellent (n = 14), while 19.4% (n = 6) reported a significant reduction in sugar intake as a result of using the app. (N.B. data relating to other questions concerning use of the Sugar Smart app are not reported due to very low response rates. Further information is available from the corresponding author upon request).

A small minority of participants selected a maximum daily amount of free sugars in excess of the recommended five cubes (19 g) for children aged 4–6 years (n = 7, 3.8%) and six cubes (24 g) for children aged 7–10 years (n = 10, 5.4%). However, only 11.4% (n = 21) and 14.1% (n = 26), respectively, selected the correct recommendation while 11.4% (n = 21) and 6.5% (n = 12) selected no free sugars.

Table 1 Beliefs about children's sugar consumption and its consequences (study 1)

	n (%)
When thinking generally about children in the UK, how would you describe their sugar intake?	
Low	2 (1.1)
About the right amount	9 (4.9)
High	115 (62.5)
Very high	58 (31.5)
Generally what do you think is the effect of children's current sugar intake on their health?	
No negative effect	3 (1.6)
Some negative effect	39 (21.2)
Somewhat negative effect	57 (31.0)
Very negative effect	85 (46.2)
What do you think are significant issues for children caused by sugar? (Select all that apply)	
Dental caries (cavities)	175 (95.1)
Overweight	162 (88.0)
Obesity	152 (82.6)
Diabetes type 2 (often associated with higher weight and obesity)	139 (75.5)
Hyperactivity	133 (72.3)
Poor concentration	90 (48.9)
Low fitness levels	70 (38.0)
Diabetes type 1 (sometimes called juvenile, early onset, or insulin-dependent diabetes)	52 (28.3)
Heart disease	44 (23.9)
Poor mental health	40 (21.7)
High cholesterol	36 (19.6)
Cancer	29 (15.8)
Non-alcoholic Fatty Liver Disease	23 (12.6)
Underweight	16 (8.7)
There are no significant issues associated with sugar intake	0

Study 2

Due to the anonymous nature of participation in forums, no sociodemographic information could reliably be extracted from the username and avatars associated with the 412 posts included in this analysis. Content analysis demonstrated that just over a third of the posts could be categorised as positive towards the proposed Soft Drinks Industry Levy (Table 3). Notably, positivity was not consistently accompanied with strongly stated beliefs in efficacy, and likewise negativity did not always indicate disbelief; instead, seven themes emerged that cut across both positive and negative comments (Table 4).

The 'Necessity of sugar reduction' theme reports on the consensus that sugar intakes are currently problematic and that this has a significant impact on health. Reference was made to a range of specific

Table 2 Beliefs about the ease of sugar reduction and potential barriers to behaviour change (study 1)

Question/Response	Frequency (%)
How easy do you think it is to reduce the amount of sugar that children in general have in their diets?	
Very easy	23 (12.5)
Easy	64 (34.8)
Neither	40 (21.7)
Difficult	50 (27.2)
Very difficult	3 (1.6)
Missing data	4 (2.2)
What would you say are the barriers to reducing the amount of sugar that children in general have? (Select all that apply)	
Environments that encourage high sugar intakes (*e.g.* parties, play dates, social events)	135 (73.4)
Media and advertising of high-sugar foods	112 (60.9)
Parents' lack of willingness to change their own food/drink choices	107 (58.2)
Lack of knowledge about selecting low-sugar alternatives	97 (52.7)
Media and advertising of high-sugar drinks	96 (52.2)
Children's taste preferences	93 (50.5)
Lack of suitable alternatives that are easily available to buy	90 (48.9)
Parents' taste preferences	87 (47.3)
Childcare arrangements that provide high-sugar foods/drinks (*e.g.* childminders, other family members, after school club, *etc.*)	78 (42.4)
Pressure from children to buy high-sugar foods	70 (38.0)
Children's refusal to eat/drink low-sugar alternatives	66 (35.9)
Higher cost of low-sugar alternatives	58 (31.5)
Pressure from children to buy high-sugar drinks	58 (31.5)
Extra meal planning to incorporate low-sugar alternatives	33 (17.9)
There are no significant barriers	9 (4.9)

Table 3 Content analysis of forum posts describing reactions to the proposed Soft Drinks Industry Levy (study 2)

Codes (with example verbatim quotes)	Frequency (%)
Positive	
. . .I think increasing the price of sugary drinks is a great idea. If you are skint then buying sugary drinks seems an odd choice to treat your kids. I think something needs to be done but I am not entirely sure what.	145 (35.2%)
Negative	
Making sugar eeeeeevil will just make people feel they have failed if a grain of it crosses their lips, and dieting is much better served by positive emotions - guilt and failure lead to comfort eating and the 'I failed, so I might as well stuff my face with it' reaction.	189 (45.9%)
whether they tax people 7p or £1 will make no real difference in my view..	78 (18.9%)
Neutral	
Define sugar.	

health conditions, namely dental caries, obesity and type 2 diabetes, and sometimes accompanied by biomedical explanations, which indicates that sugar poses more than an anonymous, general threat to health for these participants.

The 'Efficacy of Levy to affect sugar consumption in children' theme describes how participants framed a positive outcome of the Levy as, at best, possible but not guaranteed. At worst, it was considered harmful to healthy eating, in a psychological sense. Interestingly there was little mention of, or comparison with, similar schemes in other countries, either favourably or unfavourably. While the Levy received some lukewarm support in terms of its potential to support dietary behaviour change, these benefits were not automatically translated into perceived improvements in obesity. Instead, the 'Inability of the Levy to affect obesity' theme demonstrates that participants were aware that obesity has a multifactorial aetiology and that obesity management is highly complex. The positioning of the Levy in the Childhood Obesity Strategy by the government was considered overly simplistic.

Furthermore, in the 'Distrust over government intentions' theme participants identified the Levy as a government scheme to generate revenue and participants were concerned that this income would be generated by those who could least afford it: 'The concerns regarding equality' theme. Participants, therefore, were not only concerned with the outcome but also by the morality of the actions required to achieve the outcome; a rejection of pure utilitarianism.

Not only was the food industry implicated in the pervasiveness of sugar in products, the 'Distrust of the food industry and retailers' theme describes how it was framed, along with retailers, as actively facilitating high consumption of sugar for monetary gain and, consequently, distrusted. Concerns about ingredients were not limited to hidden sugar but extended to 'Concerns regarding artificial sweeteners'. These were not perceived as desirable alternatives but instead were characterised as a less healthy choice than sugar.

Study 3

Twitter handles were inspected for sociodemographic information but gender could not reliably be extracted from the accounts associated with the 618 Tweets included in this analysis. Approximately a third of accounts were presented as personal accounts of

Table 4 Thematic analysis of the forum posts describing framing of the Soft Drinks Industry Levy (study 2)

Themes (with example verbatim quotes)
Necessity of sugar reduction
'These highly sugary drinks and foods do not need breaking down - they just flood your system with a sugar hit which requires your body to release a mass of insulin to deal with it and this is what eventually caused diabetes.'
'As a nation we do eat too much sugar… We simply don't need this.'
Efficacy of Levy to effect sugar consumption in children
'…I bet there are more grownups than kids drinking it so how is the tax going to improve children's health or tackle childhood obesity I don't know.'
'So if increasing the price of a completely non-essential drink with no nutritional value can have a potentially positive impact for many people I don't see why you wouldn't do it.'
Inability of Levy to effect obesity
'…It is ridiculously simplistic to blame sugar for the obesity crisis (presuming that's his angle). Stupid, band-aid suggestion.'
'(Username) I really agree, sugar is in itself way more worrying than the larger problem Of obesity…'
Distrust over government intentions
'…as others have said a tax on sugary drinks is just a government money generating scheme and not addressing the real issues …'
'The sugar tax is a travesty overall anyway.'
Concerns regarding equality
'…the demography that is affected the most statistically will be the poorest yet again - have they not been victimised enough and had enough of a financial kick in the teeth already!'
'I think the only way to truly deal with this is to stop putting people against each other (often based on socioeconomic groups) and start holding the corporations who produce and sell this shite responsible.'
Distrust of food industry and retailers
'…advertising and the food industry has created the 'Western Diet' of processed food and liquid sugars in order to make a lot of money out of making us fat and ill…'
'when I go to get petrol at our local garage you have to walk through a 'sugar tunnel' to get to the till.'
Concerns regarding artificial sweeteners
'And if you're fool enough to think sugar is the bad guy and food producers are going to make it go away and not sub in more and more fake sweeteners which are far worse than sugar, guess again.'
'I'd rather sugar than artificial sweeteners…'

Table 5 Content analysis of Tweets describing information about Twitter handles and reaction to the Sugar Smart app (study 3)

Codes	Frequency (%)
Account type	
Individual	213 (34.5)
Health organisation	206 (33.3)
Non-health public organisation	171 (27.7)
Educational institution	28 (4.5)
Nationality	
UK	499 (80.7)
Non-UK	55 (8.9)
Unknown	64 (10.4)
Reaction to the Sugar Smart app	
Positive	474 (76.7)
Neutral	132 (21.4)
Negative	12 (1.9)

Table 6 Thematic analysis of Tweets describing framing of the Sugar Smart app (study 3)

Themes (with example verbatim quotes)
Reports and promotes use of the app
Read about a new app called 'Sugar Smart' that can help parents see the sugar content of products quickly and easily
Sugar smart app downloaded by 2 million people. That's 2 million sugar detectives! #healtheuropeeu
App supports identification of sugar content
How much hidden sugar is lurking in your kitchen? Download @Change4Life's Sugar Smart app to find out
Just scanned my first barcode using the @PHE_uk Sugar Smart App. Lipton peach ice tea if you were wondering. 5.6 out 7 sugar cube daily max
Mentions information on health effects of sugar/reduction
Swapping sugar can really help reduce the risk of #childhoodobesity get the Sugar Smart App today!
Most of us eat too much sugar, which can lead to serious diseases in the future. Let's get #sugarsmart

individuals (n = 213, 34.5%), health-related organisations (n = 206, 33.3%), non-health-related organisations (n = 171, 27.7%) and educational organisations (n = 28, 4.5%). Furthermore, the majority of the accounts were identified as originating in the UK (n = 499, 80.7%) (Table 5). Content analysis demonstrated that the majority of posts could be categorised as positive towards the *Change4Life* Sugar Smart app (n = 474, 76.7%) (Table 5).

Three themes emerged which related to content that 'Reports and promotes use of the app', 'App supports identification of sugar content' and 'Mentions information on health effects of sugar/reduction' (Table 6). Aspects of the app that were particularly promoted were its free and easy availability, and a note of pride and pleasant surprise was evident in reports of download figures. The app itself was framed as empowering, arming the individual against hidden sugar. Shock was described at uncovering information about the sugar content of products, which implied that it was otherwise inaccessible. Promotion of the app was

accompanied by recognition of the importance of sugar reduction for health, particularly childhood obesity. Missing, however, was any direct account of behaviour change resulting from use of the app.

Discussion

This study is the first of its kind to utilise unsolicited digital data to characterise public perceptions of UK children's sugar consumption and public health efforts to reduce intakes. It is perhaps surprising that there has been so little research into public opinions of these costly and controversial initiatives, especially considering their centrality to the UK Childhood Obesity Strategy (HM Government 2016). Novel methods have allowed for a deeper understanding of public sentiment and dialogue about public health activities and provided much needed evaluation of acceptability and engagement.

Digital spaces are widely used by the public as sources of health information and are used by health providers as a means to educate and support behaviour change (Fox & Duggan 2012). Online surveys are strengthened by internet penetration (ONS 2015) and large numbers of people use social media, with 77% of mothers accessing parenting forums weekly and over 313 million people actively using Twitter each month (Roberts 2015; Twitter 2016). Digital spaces offer a novel source of unsolicited data, via the emerging field of netnography (use of online communications, participation and observation, with new forms of digital and network data collection, analysis and research representation) (Hill *et al.* 2013; Murphy *et al.* 2014; Kozinets 2015).

The first finding of this research is that UK public health sugar reduction efforts are being discussed in digital spaces and that there was consistent agreement that currently children's sugar intakes in the UK are too high and harming health. Since its inception in 2009, *Change4Life* has focused its activities on a range of children's health behaviours, including saturated fat intake and 'me-sized' portions, but this study demonstrates that its recent focus on sugar has raised sugar consumption as a problem area for UK children, effectively 'problematising' current intakes. 'Problematisation' is necessary to initiate voluntary behaviour change (Polivy & Herman 2000) but concerns should be raised about very negative messages and the reinforcement of a good–bad food dichotomy. It is notable that the majority of participants in study 1 tended to overestimate recommended limits of free sugars. From a strictly nutritional perspective, this could be viewed as positive news, but high aspirations may be counterproductive if they result in a sense of failure and learned helplessness when not met (Polivy & Herman 2000).

Despite accepting the need for action, there was little consensus on parenting forums and Twitter about the effectiveness of the public health activities to actually reduce sugar intakes. For the Soft Drinks Industry Levy, only a quarter of participants in study 1 agreed that it would have a positive impact on children's health, and themes about the inability of the Levy to reduce sugar consumption and obesity emerged in study 2. This underlines the importance of understanding context as opposed to just sentiment (*The Grocer* 2016; OnePoll 2015). Further research is needed to address whether there has been any change in public opinion since the introduction of the Levy. It is also important to recognise that taxation on foods and beverages is a global debate, and WHO recently published cautious support for taxes on SSBs (WHO 2018) but stopped short of recommending them. Taxation is, therefore, likely to remain a controversial and widely discussed topic.

The function of the *Change4Life* Sugar Smart app was described (positively) in terms of knowledge provision in study 3, which is important as knowledge was indicated as a barrier to change in over half the participants in study 1. The terminology used in the study 3 Tweets – 'lurking' and 'hidden' – mimics that employed by the Sugar Swap campaign, and implies that the consumer is a 'victim' of a deception and that information on sugar content has previously been concealed (despite labelling of nutritional information being mandatory). In study 2, some consumers also believed that the food industry was 'hiding' sugar in food, while retailers were 'pushing' high-sugar products, again in the name of profit. Blame for current bad choices is, therefore, positioned away from the unwitting consumer ('us') and onto, presumably, the food industry ('them'). This attitude is unsurprising when public health campaigns position the consumer as the victim (both harmed by the situation and helpless to change it), but seems at odds with the goal of working with industry to bring about voluntary reformulation. It is also important to recognise that innovations from industry may not be as welcomed as anticipated; in this study, sweeteners were considered by some as less healthy than sugar. The positioning of natural sugar above artificial sweeteners in terms of health, in spite of its higher calorific value, is perhaps an example of the wisdom of nature heuristic (the assumption that due to evolutionary adaption, natural products are superior for the human body than anything 'man-made') (Bostrom & Sandberg 2009).

Although ~20% of those who had used the app in study 1 reported a significant reduction in sugar intake as a result, there was little dialogue around behaviour change in study 2. Despite the emphasis on providing the public with information as part of PHE's work (PHE 2016b), it is widely accepted that education alone is unlikely to initiate and maintain behaviour change (Boles *et al.* 2014). Participants appear aware both that multiple barriers to behaviour change exist (as evidenced by the responses in study 1) and that obesity has a multifactorial aetiology (theme 'Inability of Levy to effect obesity' in study 2). It might, therefore, be possible that parents perceive the responsibility for child health as shared between themselves and the government. Despite this, some disrespect for government and its public health officials was evident in the language used on social media, along with cynicism towards the Levy as a 'money-making scheme'. The implication being that the government is intentionally using a scheme that it does not believe will change people's purchasing habits to generate revenue, due to people continuing to purchase SSBs, albeit at a higher price. There were also some negative comments towards the government's positioning of the Levy as central to the Childhood Obesity Strategy although, interestingly, there were no issues raised as to the significant cost of the Sugar Smart app (£5 million), which was financed through central government.

The study has several limitations. While a key strength of this research is the use of unsolicited data, which is less burdensome and less intrusive for participants, and less likely to be influenced by the researcher's perspective (Hill *et al.* 2013), care must be taken when considering the data from Twitter and parenting forums as natural or organic. Response bias is a recognised but persistent issue for surveys, but on social media individuals are interacting with each other (Giles 2016) and produce content with the audience in mind. Meyer and Milestone (2016) discuss how parenting forums permit mothers to exhibit their mastery of intensive parenting and how anonymous platforms allow comment that is critical and injurious. When reflecting on the data used in this research, comments were sometimes impassioned, even scornful, of certain points of view but there was no direct criticism of individual comments or commentators. Furthermore, there was a clear theme around the importance of structural factors, which is at odds with a neoliberal intensive-parenting discourse (Meyer & Milestone 2016).

Compared to a French study (n = 1996) where perceptions of the SSB tax were assessed via self-administered questionnaires (Julia *et al.* 2015), the sample used in study 1 is small. Larger samples can be analysed using automated text mining algorithms but these have yet to prove reliable for sentiment analysis (Kim *et al.* 2012).

Although sample size has little impact on analytical power in this research, more serious concerns exist about the representativeness of data from social media (Murphy *et al.* 2014). Health consciousness has been linked to health information seeking and the use of health apps (Cho *et al.* 2014) and it is not unreasonable to assume that participants in the current research are likely to be particularly orientated towards taking care of their (and their family's) health. The perceived necessity of sugar reduction might, therefore, be overestimated but this research sought to derive qualitative insights, rather than test hypotheses.

Parent-focused social media networks are very popular. For example, in 2015, Mumsnet had 7.5 million users (Roberts 2015) and, in 2012, 73% of UK mothers went online and 51% of Internet-using mothers accessed a social network every day (77% weekly) (Internet Advertising Bureau 2013). However, parent-focused social media networks do not provide a representative sample of parents in the UK, which is illustrated by the sociodemographics of the sample in study 1, and care should be taken with unsubstantiated generalisation. Twitter differs from parenting forums as the microblog format supports the sharing of information in real time and is one of the most popular social media networks with over 313 million monthly active users worldwide (Twitter 2016).

The sampling frame for study 1 and study 2 purposefully targeted popular parenting forums as digital spaces used by parents in the UK, which were considered to be rich sources of data in relation to the research objectives (Draper & Swift 2011). In study 3, however, it was not possible to filter by parenting status or country of origin. This prompted the focus on the *Change4Life* Sugar Smart app, which is a distinctly UK activity (as opposed to the more international attention to sugar taxes and levies). Indeed, the resultant Tweets were overwhelming from accounts that presented as being from UK individuals and organisations.

Ethical approval was sought for study 1, but not for study 2 or 3. Many researchers work from the premise that no consent should be necessary to conduct research on publicly available information, particularly when the terms of service clearly state that content will be made public (Murphy *et al.* 2014).

Indeed, a recent systematic review of health research that used Twitter demonstrated that two-thirds of studies had not obtained ethical approval (Sinnenberg *et al.* 2017).

In conclusion, this study suggests that while sugar consumption is readily 'problematised' by health officials, the UK may be underserved by public health activities which aim to reduce sugar consumption. More behaviour change strategies are required, which are perceived by the public as both effective and morally justifiable. The results of this study should encourage public health officials to look beyond single-issue and reductionistic campaigns, and embrace the public's appreciation that behaviour change is complex. Of particular concern is the evidence of some public distrust of government, public health officials and the food industry. Public health should move away from perpetuating the 'them' and 'us' mentality discussed in this work and seek to work in productive and transparent partnerships with industry, complementing product reformulation with effective behaviour change strategies. Further research is also required to expand on the exploratory research presented here and would usefully include both traditional and non-traditional data sources.

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Conflict of interest

The authors JAS, LS, AM, YC and JP declare that they have no conflict of interests. TT is currently employed as a research associate on a Knowledge Transfer Partnership between The University of Nottingham and the British Beet Research Organisation but was not employed as such during data collection, data analysis or drafting of the manuscript. This research was funded by the School of Biosciences, The University of Nottingham. There are no other sources of funding to declare.

Transparency declaration

The lead author (JAS) affirms that this manuscript is an honest, accurate and transparent account of the study being reported. The lead author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned have been explained.

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