



# The role of information in nudging Chinese consumers from choosing sugar to alternative sweeteners

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## ABSTRACT

This study investigates consumers' beliefs and valuations toward added sugar and sugar substitutes and assesses the impacts of information intervention in nudging individual healthy food choices, in the context of sugar-sweetened beverage consumption in China. Using a between-subject design, a discrete choice experiment, and a sample of 1800 urban Chinese consumers, we find a positive preference among Chinese consumers for sugar-sweetened beverages with low-sugar content, compared to zero-sugar and high-sugar alternatives. Chinese residents dislike sweeteners mainly due to concerns about their safety. However, individual valuations for sweeteners in both zero-sugar and low-sugar food products are significantly improved after providing information about the function and safety of the sweeteners. Policy implications for reducing sugar consumption in China are discussed in light of these findings.

## 1. Introduction

Global obesity rates have nearly tripled in the past four decades, affecting both high-income and low- to middle-income countries (Chen et al., 2019; Nie et al., 2019). It is well-established that excessive sugar consumption, especially from sugar-sweetened beverages (SSB), has been linked to an increased risk of obesity and various non-communicable diseases (Bentley et al., 2020; Hirahatake et al., 2019; Singh et al., 2015), which makes these beverages a clear target for policy and regulatory actions (Malik & Hu, 2022; Zhang et al., 2019). In China, SSB consumption is increasing rapidly, with a per capita annual intake of approximately 30 l (Zhai et al., 2022), and SSBs have become an important source of sugar intake for Chinese residents (Chinese Nutrition Society, 2021). Thus, the health authorities have accelerated the development of interventions and programs, such as the National Nutrition Plan (2017–2030) (State Council of China, 2017) and Healthy China Action (2019–2030) (State Council of China, 2019). These interventions all emphasize the importance of a healthy diet and recommend replacing sugary beverages with low-sugar or sugar-free beverages to reduce health problems such as obesity.

To reduce sugar consumption, policymakers worldwide have already taken actions or are considering interventions including taxation, the reduction of sugary product availability, public educational campaigns, and front-of-package nutrition labels. However, their effectiveness in cutting sugar intake among consumers remains inconclusive (An et al., 2021; Drugova et al., 2020; Hagmann et al., 2018; Neuhofer et al., 2020). In recent years, more restrictive interventions such as taxation on the consumption of SSBs have been implemented mainly in developed countries such as France, Britain, and part of America. However, existing studies have different

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conclusions about the impact of taxation on making consumers change their choice from SSBs to healthier diet drinks (Hagmann et al., 2018; Doble et al., 2020; Powell et al., 2020).

In response to these sugar reduction policies as well as consumer demand for lower-sugar foods, another tool that can be considered is to encourage the use of low-calorie sweeteners (LCS) as a substitution for sugars (Silva et al., 2021). Low-calorie sweeteners (LCS) provide a sweet taste but with substantially fewer calories, therefore, they are popular alternatives to sugar for food manufacturers to use in food and drink reformulation (Hovhannisyan & Bastian, 2022). A substantial body of evidence attested to the safety of LCS (Ashwell et al., 2020; Farag et al., 2022) and reported favorable effects on energy intake and weight management when LCS is substituted for sugars (Abo Elnaga et al., 2016; Harrold et al., 2023; Laviada-Molina et al., 2020; Rogers & Appleton, 2021). Several organizations such as the American Heart Association, the American Diabetes Association, and the British Dietetic Association issued statements advocating the safety of LCS<sup>1</sup> (Gardner et al., 2012). However, some studies carried out in developed countries reported significant public distrust in the safety of LCS, in America (Gardner et al., 2012) and UK (Farhat et al., 2021).

In China, according to the National Food Safety Standard for Prepackaged Food Nutrition Labeling Regulation issued by the National Health Commission<sup>2</sup> (GB 28050–2011), sweeteners are allowed to be added to food or beverages if their sugar content is no >5 g/100 ml. The National Food Safety Standard for the Use of Food Additives (GB 2760–2014) specified the principles for the use of sweeteners and confirmed the safety of adding sweeteners to food or drinks according to the requirements. An important prerequisite for carefully constructing a LCS encouraging policy is a theory-based understanding of whether and how consumers perceive sugar alternatives. The intention behind replacing added sugar with alternatives requires consumers recognition of the safety and benefits of LCS. However, little has been known about the public beliefs and valuations toward added sugar and sweeteners in emerging markets like China. To fill this void, this study explored Chinese consumers' beliefs and willingness to pay toward sweeteners. Consumers' beliefs about sweeteners were elicited from the aspects of acceptance, risks, benefits, and trust in regulation perceptions, to delve into the underlying mechanisms.

Different from most previous studies exploring consumer choice in settings of providing front-of-package or back-of-package nutritional information indicating the content of nutrients (Guan et al., 2022; da Silva et al., 2022; Zhu et al., 2023), this paper contributes to the literature by evaluating how providing functional and safety information of LCS nudges healthy food consumption. A discrete choice experiment and a between-subject design approach are applied in this study to explore the impact of information interventions on increasing consumers' evaluation of products with low-caloric sweeteners in the choice tasks. Moreover, we contribute to a broad literature that studies how governments can help consumers reduce sugar intake. This paper focused on information intervention and showed that it can be an effective tool to improve diet quality. Understanding information effects offers important policy insights when designing educational campaigns or effective labeling policy to more cost-effectively target the public, and to make treatments more responsive. Up to now, the main policy tool the Chinese government is using to combat obesity is the back-of-package Nutrition Facts Panel, which was found little effect in promoting healthier food choices (Guan et al., 2021). Other increasingly popular policy tools such as information intervention can be considered to combat the negative health consequences associated with excessive sugar consumption. This paper has the potential to inform public policy interventions and provide valuable insights for policymakers and food marketers when designing effective intervention policies by Chinese consumers' beliefs and preferences for reducing sugar consumption.

The remainder of this paper is organized as follows. Section 2 introduces the between-subject treatments and online choice experiment study design. Section 3 is the empirical methods followed by data used in this study in Section 4. Section 5 presents the results. The last section presents the conclusion, discussion, and policy implications of this study.

## 2. Study design

### 2.1. Between-subject treatments

This study employs an online survey incorporating a between-subject design and a discrete choice experiment (DCE) to assess the effect of sweetener information on consumer WTP for added sugar and low-calorie sweeteners. The survey consists of three parts. The first part includes questions related to participants' socio-demographic characteristics, SSB consumption patterns, sugar preferences, and beliefs about sweeteners. In the second part, participants were randomly assigned to one of the two treatment groups. Each treatment group was provided with simplified or detailed sweetener information before the DCE questions. The final part consists of a choice experiment to assess consumers' preferences for sugar-sweetened beverages. The target population for this study comprises Chinese urban consumers aged 18 years and above, who have purchased SSB products within the past three months.

Before answering the DCE questions, participants were randomly assigned to one of two groups: simple information group (Control) and detailed information group (Treatment). Simple information is an introduction as follows "Sweeteners are food additives that sweeten foods. They include natural sweeteners such as sweeteners and artificial sweeteners such as sugar alcohols.". Detailed information added function and safety confirmation about sweeteners "Sweeteners are food additives that sweeten foods. They include natural sweeteners such as sweeteners and artificial sweeteners such as sugar alcohols. It provides sweetness with no or minimal calories. And it is safe to use reasonably according to national food safety standards.". These groups were designed to explore if and

<sup>1</sup> British Dietetic Association. Available online: [https://www.bda.uk.com/improvinghealth/healthprofessionals/policy\\_statements/sweeteners](https://www.bda.uk.com/improvinghealth/healthprofessionals/policy_statements/sweeteners). (accessed on 6 January 2020).

<sup>2</sup> See the website: [https://members.wto.org/crnattachments/2021/SPS/CHN/21\\_6717\\_00\\_x.pdf](https://members.wto.org/crnattachments/2021/SPS/CHN/21_6717_00_x.pdf)

how consumer willing to pay (WTP) for added sugar and low-caloric sweeteners varies when provided with detailed or simplified sweetener information. To enable respondents to read the information, they were not able to continue with the questionnaire until 30 s had elapsed.

## 2.2. Discrete choice experiment

During the online DCE experiment, respondents were asked to select the most preferred alternative between two options of packaged beverages and a no-purchase option. Beverages were chosen in this study because they are in general viewed as a promising application field for reducing sugar intake as they are a key source of added sugars in the diet (Lakkakula & Schmitz, 2019; Malik & Hu, 2022). A large body of evidence has linked sugar-sweetened beverages with weight gain and health risks (Bentley et al., 2020; Farag et al., 2022). Importantly, bottled black tea is chosen as the product of interest for this study as they are one of the most frequently purchased beverages among Chinese urban consumers and there is a broad range of health-level bottled black tea in the market.

The attributes and attribute levels of the product in question were selected based on relevant literature (Christiansen et al., 2023; Tang et al., 2021), and a focus group discussion was conducted before the experiment. We include three attributes: added sugar, sweetener, and price, as shown in Table 2. Four attribute levels are included for added sugar: zero sugar, low sugar, high sugar, and excessive sugar. According to the National Food Safety Standard for Prepackaged Food Nutrition Labeling Regulation issued by the National Health Commission of China,<sup>3</sup> a beverage can be labeled as zero-sugar if its sugar content is no >0.5 g/100 ml, and it can be labeled as low sugar if the sugar content is <5 g/100 ml. However, there is no specific regulation for the high sugar category. After examining the sugar content of soft drinks in the Chinese market, this study defined “high sugar” as “5 g/100ml ≤ sugar content < 10 g/100ml” and “excessive sugar” as “≥10 g/100 ml”. Low-caloric sweeteners, which provide sweetness without adding energy to the diet, are considered important substitutes for added sugar. The sweetener attribute was included in the choice set and applied to zero-sugar and low-sugar products. Finally, three price levels were selected to represent actual market price ranges, namely 3.3 RMB/bottle, 5.0 RMB/bottle, and 6.7 RMB/bottle, which were also validated through a pretest. (See Table 1.)

To minimize the respondent burden and ensure efficient data collection, a full factorial design with 576 different choice questions ( $4^1 \times 2^1 \times 3^1$ )<sup>2</sup> was initially considered given the selected attributes and attribute levels. However, following the approach of Street et al. (2005), the design was reduced to 20 choice questions with a D-efficiency of over 85%, considering only the main effects. These 20 choice questions were then divided into two blocks of 10 choice questions each to be presented to the participants during the survey. To prevent any potential ordering effects, the order of the choice tasks within each block was randomized. An example of a choice set is provided in Fig. 1. Before the choice questions, respondents were given instructions about the DCE and asked to read a scripted cheap talk statement to ensure their careful attention (see Appendix A). To ensure respondents had adequately reviewed the instructions and cheap talk, they were unable to proceed with the questionnaire until at least 40 s had elapsed.

## 3. Empirical methods

To model consumers' purchasing decisions for tea drinks, we specify an indirect utility function based on Lancaster's theory of consumer demand (Lancaster, 1966). Following random utility theory (McFadden, 1974), choice experiments rely on the assumption that the utility of individual  $n$  choosing alternative  $j$  in choice situation  $t$  can be expressed as:

$$U_{njt} = V_{njt} + \varepsilon_{njt} \quad (1)$$

$$= \alpha Price_{njt} + \beta_{n1} ZeroSugar_{njt} + \beta_{n2} LowSugar_{njt} + \beta_{n3} HighSugar_{njt} + \beta_{n4} Sweeten_{njt} * ZeroSugar_{njt} \\ + \beta_{n5} Sweeten_{njt} * LowSugar_{njt} + ASC_{Opt-out} + \varepsilon_{njt}$$

where  $V_{njt}$  is the systematic portion of the utility function, depending on the experimentally designed product attributes of alternative  $j$ .  $Price_{njt}$  is a continuous variable populated with the three price levels in the design;  $ZeroSugar_{njt}$ ,  $LowSugar_{njt}$  and  $HighSugar_{njt}$  are dummy variables for the levels of zero sugar, low sugar and high sugar content in tea beverages, and  $Sweeten_{njt}$  is also a dummy variable that indicates whether sweetener is included in the production of tea beverages.

If the product exhibits a particular attribute, then all corresponding values are set to 1; otherwise, they are set to 0.  $ASC_{Opt-out}$  is the alternative specific constant of the opt-out option;  $\alpha$  is price preference and the  $\beta$ s are the non-price taste coefficients.  $\varepsilon_{njt}$  is the stochastic and unobservable (to researchers) component.

We estimate a mixed logit model in which consumer tastes vary concerning unobserved variables, which captures the variability in consumer preferences and provides a more accurate representation of real-world decision-making processes. The model's high degree of flexibility allows it to approximate a wide range of random utility models, making it a suitable tool for modeling consumer behavior in various settings (McFadden & Train, 2000). Accordingly,  $\varepsilon_{njt}$  is the random error term that follows a Type I Extreme Value distribution. To account for the fact that individuals may assign either positive or negative values to non-price product attributes, the model assumes that the coefficients associated with these attributes follow a normal distribution. We specify a fixed price coefficient to obtain reasonable and finite distributions of WTPs (Bliemer & Rose, 2013; Hensher & Greene, 2005; Matthews & Matthews, 2017). To estimate these model parameters, we employ a simulated maximum likelihood estimation technique using 1000 Halton draws.

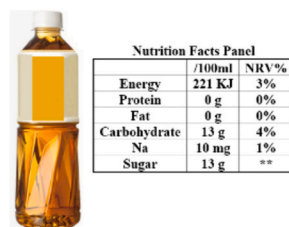
<sup>3</sup> See the website: [https://members.wto.org/crnattachments/2021/SPS/CHN/21\\_6717\\_00\\_x.pdf](https://members.wto.org/crnattachments/2021/SPS/CHN/21_6717_00_x.pdf)

**Table 1**  
Attributes and attribute levels in the choice set design.

Attribute	Attribute level	Sugar content (g/100 ml)
Added sugar	Zero sugar	≤0.5
	Low sugar	(0.5, 5)
	High sugar	[5, 10)
	Excessive sugar	≥10
Sweetener	Yes, No	
Price (RMB/bottle, 500 ml)	3.3, 5.0, 6.7	

**Please select the option you would choose in the store.**

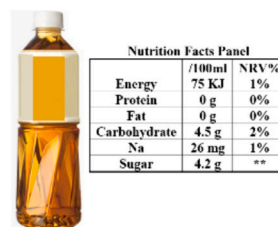
**Alternative 1:**



Sweetener: **No**

Price: **3.3 ¥**

**Alternative 2:**



Sweetener: **No**

Price: **5.0 ¥**

**Alternative 3:**

None of these

**Fig. 1.** An example of the choice tasks.

In our study, we evaluate the impact of sweetener information on consumer valuation of tea beverages by comparing WTPs between the control and treatment groups. We first employ a Monte Carlo simulation technique (Krinsky & Robb, 1986) using the variance-covariance matrix obtained from estimating eq. (1), and then we use a non-parametric complete combinatorial test as suggested by Poe et al. (2005). Further, we match demographic variables with individual-specific or conditional WTPs, as outlined in Train (2003), to identify potential demographic factors that may influence WTPs.

#### 4. Data

Data for this study was collected via an online survey in December 2022. Participants were recruited by the professional survey company “PowerCX”<sup>4</sup> in China. They were screened to ensure they were >18 years old and had purchased the bottled black tea within the last three months. Several trap questions were included in the survey, and participants who failed to answer the trap questions were excluded automatically. Five cities were chosen including Beijing, Guangzhou, Shanghai, Chengdu, and Wuhan, representing the north, south, east, west, and middle China. Finally, a total of 1800 respondents (900 for each group) were employed for the analysis.

Table 2 reports the balance test across different treatment groups. *P*-values from F-tests/chi-square tests suggest that the null hypothesis of equality in demographic variables between any two treatment groups cannot be rejected at the 10% significance level. Our sample was roughly consistent with the Chinese population in terms of gender, and marital status. The average age of our sample is 35 years old, which is younger than the population mean (42.51). This is somewhat expected because we screened the respondents to ensure that they had purchased the bottled black tea within the last three months. Bottled drinks are more popular among young consumers than in their older counterparts. Additionally, it’s important to note that our sample consists of individuals with higher education levels and income compared to the general Chinese population. This is due to the recruitment of respondents from five major cities, which are characterized by more advanced economic development and represent significant markets for bottled drinks in China.

Overall, the survey results indicate that soft drinks are frequently purchased by respondents, with 34% purchasing them >3 times per week. Additionally, 26% purchase soft drinks 1–2 times per week, 11% purchase them 1–3 times per month, and 3% purchase them <1 time per month. Among soft drinks, tea drinks are the most popular choice, preferred by 76% of the respondents, while only 4% dislike tea drinks. Furthermore, the majority of respondents spend >10 RMB on soft drinks. And 59.78% of the respondents reported that they have a sweet diet or a sweet tooth. The results of the chi-square tests suggest that there is no statistically significant difference

<sup>4</sup> Official website: [www.powercx.com](http://www.powercx.com).

**Table 2**

Balance tests between the control and information groups.

	Control	Information	P-value	Population
<b>Demographics</b>				
Age	34.866 (9.803)	35.190 (9.501)	0.476	42.509
Female	0.511 (0.500)	0.496 (0.500)	0.510	0.489
Married	0.607 (0.489)	0.638 (0.481)	0.174	0.721
Education			0.981	
Middle school and below	0.67	0.67		64.17
High school	5.22	4.89		16.35
College	83.11	83.00		18.53
Graduate	11.00	11.44		0.95
Annual individual after-tax income			0.954	
Below 20,000RMB	9.22	9.00		
20,000–49,999 RMB	10.67	10.89		
50, 000–999,999RMB	25.22	23.67		
100,000–199,999 RMB	31.56	31.56		
200,000–299,999 RMB	12.89	14.22		
300,000 RMB and above	10.44	10.67		
Household size	3.350 (1.070)	3.369 (1.110)	0.713	
BMI	21.697 (3.018)	21.863 (2.896)	0.233	
<b>Bottled beverage consumption</b>				
Bottled beverage purchasing frequency			0.836	
Daily	8.89	10.11		
5–6 times per week	16.33	15.89		
3–4 times per week	34.22	34.33		
1–2 times per week	26.33	26.56		
1–3 times per month	11.56	10.00		
Less than monthly	2.67	3.11		
Weekly bottled beverage expenditure			0.406	
<5 RMB	6.33	6.00		
5–9.99 RMB	17.33	19.22		
10–29.99 RMB	39.33	36.00		
30–49.99 RMB	27.44	27.22		
> 50 RMB	9.56	11.56		
Zero-sugar beverage purchasing frequency			0.572	
Never	0.89	1.56		
Seldom	51.67	52.67		
Often	43.78	42.33		
Always	3.67	3.44		

Note: P-values from t-tests/chi-square tests the null hypothesis of equality of means/frequencies in variables between two groups. Population statistics is from the 2023 China Statistical Yearbook.

observed among the treatment groups regarding bottled beverage purchasing frequency and expenditure information. This implies that any variations observed in SSB choices across treatments cannot be attributed to differences in demographic factors, SSB purchasing behavior, or consumption characteristics.

## 5. Results

### 5.1. Impacts of sweetener information on consumer WTPs for SSBs

To assess the impacts of sweetener information on consumer choices of SSBs, we employ mixed logit models to estimate eq. (1) for each treatment. We then generate willingness-to-pay (WTP) values through simulations based on the estimated parameters and variance-covariance matrix derived from eq. (1). The estimation results for the control, treatment, and pooled mixed logit models are summarized in Table A1. As expected, most product attributes exhibit significant effects on individual choices of black tea beverages, with coefficients displaying the anticipated signs. In the control group, respondents, on average, show a positive preference for black tea with low sugar content compared to other sugar levels, and they have a significant dislike for sweeteners. In the information treatment group, individual preferences for sugar levels and sweeteners exhibit heterogeneity.

Table 3 shows the mean simulated values and 95% confidence intervals for willingness-to-pay (WTP) estimates, as well as the results of the Poe test assessing the equality of WTP distributions across treatments. The table displays the variations in consumer valuations between treatment and control groups and provides a statistical test to evaluate the significance of these differences. Several

key findings emerge from our analysis.

Firstly, we find that consumers in the control group exhibit a preference for sugar content in descending order: low sugar without sweetener, zero sugar without sweetener, high sugar, and excessive sugar. On average, respondents are willing to pay an additional 6.04 RMB per bottle to switch from excessive sugar to low sugar without sweetener tea beverages. For an excessive-sugar black tea priced at 5 RMB, the price premium percentage for the low-sugar and sweetener-free level is 120.8%. However, when the sugar content originates from an artificial sweetener, consumers in the control group devalue the low-sugar product, assigning a negative valuation of −3.08 RMB per bottle for low-sugar tea beverages with artificial sweeteners. That is, respondents are willing to pay an additional 2.96 RMB per bottle to switch from excessive-sugar to low-sugar with sweetener tea beverages. For an excessive-sugar black tea priced at 5 RMB, the price premium percentage for the low-sugar level with sweetener is 59.2%.

Secondly, consumers have a significant dislike for sweeteners. They value zero sugar without sweetener more than high sugar level products. But when there are sweeteners on the zero-sugar level products, they would prefer high-sugar products. On average, respondents in the control are willing to pay an additional 2.19 RMB per bottle to switch from excessive sugar to zero sugar without sweetener tea beverages. However, when the sugar content originates from an artificial sweetener, consumers in the control group devalue the zero-sugar product, assigning a negative valuation of −0.96 RMB per bottle for zero-sugar tea beverages with artificial sweeteners. That is, respondents in the control are willing to pay an additional 1.23 RMB per bottle to switch from excessive-sugar to zero-sugar with sweetener tea beverages, which is 0.69 RMB lower than that for high-sugar level tea beverages (1.92 RMB).

Thirdly, detailed sweetener information proves effective in increasing consumer valuations of sweeteners on both zero-sugar and low-sugar levels in tea SSBs. Respondents in the treatment exhibit mean WTP values of 0.20 RMB and −1.99 RMB per bottle for the sweetener on zero-sugar and low-sugar levels, respectively, which is 1.16 RMB and 1.10 RMB higher than those in the control group. On average, respondents in the treatment are willing to pay an additional 5.39 RMB per bottle to switch from excessive-sugar to low-sugar without sweetener tea beverages, and 3.4 RMB per bottle to switch from excessive-sugar to low-sugar with sweetener tea beverages. For zero-sugar tea beverages, they are willing to pay an additional 2.16 RMB per bottle to switch from excessive-sugar to zero-sugar without sweetener beverages, but 2.36 RMB per bottle to switch from excessive-sugar to zero-sugar with sweetener tea beverages. This indicates that sweetener information makes consumers value zero-sugar with sweetener more than zero-sugar without sweetener tea beverages.

Last, to validate the robustness of our findings, we conducted estimations using a pooled sample in the preference space (Table A1). Consistent with our previous results, we find that the interaction term between the sweetener dummy and zero-sugar or low-sugar dummy is statistically significant and negatively signed, indicating that consumers devalue sweetener content for both zero-sugar and low-sugar tea beverages. However, the interaction term between the treatment dummy and the sweetener dummy is statistically significant and positively signed for both zero-sugar and low-sugar tea beverages. This suggests that sweetener information intervention effectively increases consumers' WTP for sweetener content in tea beverages.

## 5.2. Consumers' beliefs about sweeteners

To shed light on mechanisms, we surveyed respondents and elicited their beliefs about low-calorie sweeteners. Before the information intervention and the discrete choice experiment (DCE), participants were asked to report their beliefs about the acceptance, risk, benefit, and trust in the regulations of sweeteners (Table 4). The results of the chi-square tests (all  $p$ -values > 0.15) suggest that there is no statistically significant difference observed among the treatment group and control group indicating a balanced sample regarding beliefs about sweeteners.

Consumer attitudes toward sweeteners and their trust in regulations are generally positive. Specifically, 60.50% of consumers are open to the idea of certain foods using sweeteners instead of added sugar, while 13.83% hold an unsupportive view, and 25.67% express neutrality. When it comes to taste perception, 40.72% of consumers believe sweeteners taste worse than added sugar, 17.17% hold the opposite view, and 42.11% remain neutral. In terms of regulatory trust, 74.77% of consumers trust the government in regulating sweetener use in food production, with only 3.94% expressing distrust and 21.29% maintaining a neutral stance.

However, consumer beliefs about the risks and benefits of sweeteners are complex, with negative evaluations outweighing positive

**Table 3**  
Simulated WTP between the control and information groups.

	Control	Information
Zero sugar without sweetener	2.192 <sup>a</sup> [1.586, 2.797] <sup>b</sup>	2.157 [1.572, 2.740]
Low sugar without sweetener	6.040 [5.081, 7.024]	5.386 [4.451, 6.362]
High Sugar	1.915 [1.162, 2.719]	2.372 [1.600, 3.213]
Sweetener on zero sugar	−0.964 [−1.828, −0.082]	0.197 [−0.679, 1.098]
Sweetener on low sugar	−3.084 [−3.554, −2.610]	−1.986 [−2.437, −1.535]

<sup>a</sup> Indicates the mean of the simulated WTP values using the Krinsky-Robb method.

<sup>b</sup> Is 95% confidence interval of the WTP values.



**Table 4**  
Consumers' beliefs about sweeteners.

Beliefs	Description	Control	Information	P-value
Acceptance	I am open to having some foods using sweeteners instead of added sugar	3.556 (0.943)	3.589 (0.925)	0.449
	Sweeteners taste worse than added sugar	3.330 (0.905)	3.303 (0.905)	0.532
Risk	I am concerned about the potential impact of sweeteners on human	3.822 (0.862)	3.789 (0.830)	0.404
	The consumption of sweeteners is harmful to health	3.647 (0.895)	3.612 (0.878)	0.410
Benefit	Sweeteners are necessary to produce diet products	3.17 (1.056)	3.200 (1.002)	0.507
	The use of sweeteners in food can benefit consumers by reducing calorie intake.	3.417 (0.922)	3.478 (0.917)	0.152
Trust in regulations	Government can regulate the use of sweeteners in food production	3.931 (0.803)	3.949 (0.796)	0.637

Note: 1 = totally disagree, 5 = totally agree. P-values from t-tests/chi-square tests the null hypothesis of equality of means/frequencies in variables between two groups.

ones. Regarding risk perception, 70.33% of consumers are concerned about the potential impact of sweeteners on humans, while only 6.94% hold a positive view, and 22.73% remain neutral. Additionally, 61.28% of consumers believe that sweetener consumption is harmful to health, with 10.72% holding the opposite view, and 28.00% expressing neutrality. In terms of benefit perception, 39.83% of consumers think sweeteners are necessary for producing diet products, 25.83% hold the opposite view, and 34.34% remain neutral. Moreover, 51.56% of consumers believe the use of sweeteners can benefit them by reducing calorie intake, while 15.28% hold an opposite view, and 33.16% remain neutral.

### 5.3. Heterogeneity on the impacts of sweetener information

To examine how consumers' WTPs vary with consumers' beliefs about added sugar and low-caloric sweeteners, and whether the effectiveness of information intervention on consumers' WTPs varies across respondents' beliefs, we conducted heterogeneity analyses by adding cross terms of information intervention and respondents' beliefs including acceptance, risk and benefit perception, and trust in regulations about sweeteners (Table 5A). Results consistently showed that consumers prefer low-sugar without-sweetener tea beverages most, followed by zero-sugar without-sweetener, high sugar, and excessive sugar (control group). They have a significant dislike for sweeteners both on zero-sugar and low-sugar products.

We found that information effects varied between consumers with different beliefs, especially acceptance of and risk perception about the sweetener. Higher acceptance for LCS makes information intervention more effective in evaluating products with lower sugar level content in comparison to excessive sugar options, and makes consumers willing to pay higher for sweeteners in both zero-sugar and low-sugar products. Specifically, consumers exhibit a positive valuation of 0.941 RMB and 0.349 RMB per bottle for sweeteners in zero-sugar and low-sugar products respectively if they have a higher acceptance of using sweeteners as a substitution for added sugar. In comparison, higher risk perception for LCS makes information intervention less effective in evaluating products with lower sugar level content in comparison to excessive sugar options, and makes consumers willing to pay lower for sweeteners in both zero-sugar and low-sugar products. Specifically, consumers display discounts of −0.526 RMB and −0.422 RMB per bottle for sweeteners in zero-sugar and low-sugar products respectively if they have a higher concern about LCS on their health. Respondents

**Table 5A**  
Heterogeneity on the impacts of information on WTPs.

	Zero sugar without sweetener	Low sugar without sweetener	High Sugar	Sweetener on zero sugar	Sweetener on low sugar
Constant	2.213*** (0.206)	6.083*** (0.196)	1.936*** (0.114)	−0.951*** (0.148)	−3.098*** (0.095)
Information	0.687 (1.710)	−2.889* (1.625)	−1.070 (0.946)	−1.166 (1.225)	0.762 (0.785)
Information* Acceptance	0.614** (0.243)	0.792*** (0.231)	0.615*** (0.135)	0.941*** (0.174)	0.349*** (0.112)
Information*Risk	−0.489** (0.240)	−0.315 (0.229)	−0.304** (0.133)	−0.526*** (0.172)	−0.422*** (0.111)
Information*Benefit	0.259 (0.247)	0.118 (0.235)	0.114 (0.137)	0.188 (0.177)	0.235** (0.113)
Information*Trust	−0.542** (0.268)	0.016 (0.254)	−0.001 (0.148)	0.048 (0.192)	−0.052 (0.123)
R <sup>2</sup>	0.011	0.015	0.025	0.048	0.059
Observations	1800	1800	1800	1800	1800

Note: Numbers in parentheses are standard deviations. \*, \*\*, \*\*\* indicates statistical significance at the 10%, 5%, and at 1% levels.

with higher benefit perception for LCS show a higher valuation (0.235 RMB per bottle) for low-sugar SSBs with sweetener content in comparison to excessive sugar options.

To examine whether the effectiveness of information intervention on consumers' WTPs varies across respondents' demographic characteristics, we conducted heterogeneity analyses by adding cross terms of information intervention and respondents' characteristics including age, education, income, and BMI (Table 5B). Above\_age, Above\_edu, Above\_inc are all dummy variables, taking the value of 1 if an individual score is over the sample median and 0 otherwise. Above\_bmi is a dummy and it equals 1 if BMI is >25 and zero otherwise. Results showed that information intervention is more effective for younger and higher income group respondents. Specifically, consumers exhibit discounts of −0.974 RMB and −0.418 RMB per bottle for sweeteners in zero-sugar and low-sugar products respectively if they are over the median age of the sample. In comparison, a higher income level makes information intervention more effective and makes consumers willing to pay higher (0.862 RMB per bottle) for sweeteners in zero-sugar products in comparison to excessive sugar options.

## 6. Conclusion and discussion

The global effort to reduce free sugar intake faces a critical challenge rooted in consumer beliefs toward sugar and its alternatives. The success of initiatives promoting sugar reduction, whether through encouraging the consumption of low-caloric sweeteners or implementing taxation, hinges on consumer acceptance of these alternatives. If there is resistance to LCS, which is a key component in most diet products, the effectiveness of sugar reduction strategies is compromised. To effectively address and overcome barriers to LCS consumption, a thorough understanding of consumer perceptions and attitudes is essential. Developing communication strategies that resonate with the public is crucial for successful education. This paper aims to delve into consumers' beliefs about added sugar and non-caloric sweeteners, exploring associations between these attitudes and willingness to pay (WTP), using a nationwide Chinese sample. Additionally, the study seeks to evaluate the impact of providing information on altering WTPs of LCS.

Our research reveals a notable inclination among Chinese consumers toward sugar-sweetened beverages (SSBs) with low-sugar content, as opposed to zero-sugar and high-sugar alternatives. This preference is likely rooted in the widespread understanding among Chinese consumers of the health benefits associated with limiting sugar intake. However, it's essential to acknowledge that the innate human preference for sweetness persists from before birth (Mennella & Beauchamp, 1998), and dietary habits are deeply ingrained and resistant to change (Shepherd, 2002). Consequently, despite the potential health advantages of zero-sugar products, the inherent preference for sweetness makes low-sugar content products more appealing. This insight suggests that in the urban Chinese market, low-sugar products may be more effective substitutes for high-sugar items, contributing to an overall reduction in sugar consumption among residents.

Introducing sweeteners into zero-sugar products to replicate the taste of their high-sugar counterparts is a potential strategy. However, our findings reveal a noteworthy aversion among Chinese consumers to sweeteners. They favor zero sugar without sweeteners over high-sugar products. When sweeteners are present in zero-sugar products, consumers switch to high-sugar alternatives. This preference may stem from consumer concerns about the potential health impact of sweeteners. This aligns with previous studies examining the public attitudes toward sweeteners in the UK and the US (Farhat et al., 2021; Gardner et al., 2012; Sylvestsky et al., 2014). For instance, Farhat et al. (2021) surveyed 1589 UK-based adults and found that 25% of the sample considered low-caloric sweeteners harmful. Notably, the percentage of Chinese consumers perceiving sweetener consumption as harmful to health is even larger (61.28% in our case).

Information intervention yielded success in this study, with consumers' demographic characteristics emerging as a pivotal factor influencing the effectiveness of the provided information. Detailed sweetener information indicating the function and safety of the sweeteners proved impactful in enhancing consumer valuations of sweeteners, particularly for both zero-sugar and low-sugar levels in sugar-sweetened beverages. Specifically, the provision of sweetener information led consumers to value zero-sugar beverages with

**Table 5B**  
Heterogeneity on the impacts of information on WTPs.

	Zero sugar without sweetener	Low sugar without sweetener	High Sugar	Sweetener on zero sugar	Sweetener on low sugar
Constant	2.213*** (0.207)	6.083*** (0.196)	1.936*** (0.115)	−0.951*** (0.149)	−3.098*** (0.096)
Information	−0.260 (0.379)	−0.615* (0.359)	0.523 (0.497)	1.353*** (0.273)	1.222*** (0.175)
Information* Above_age	0.064 (0.418)	−0.822** (0.396)	−0.608*** (0.232)	−0.974*** (0.302)	−0.418** (0.193)
Information* Above_edu	1.321* (0.677)	1.764*** (0.642)	−0.812** (0.375)	0.388 (0.489)	−0.488 (0.313)
Information* Above_inc	−0.480 (0.499)	0.538 (0.472)	0.453 (0.277)	0.862** (0.360)	0.262 (0.230)
Information* Above_bmi	0.684 (0.645)	−0.225 (0.612)	−0.002 (0.358)	0.155 (0.465)	0.219 (0.298)
R <sup>2</sup>	0.007	0.012	0.013	0.026	0.041
Observations	1800	1800	1800	1800	1800

Note: Numbers in parentheses are standard deviations. \*, \*\*, \*\*\* indicates statistical significance at the 10%, 5%, and at 1% levels.



sweeteners more than those without sweeteners. Chinese consumers' preference for sweeteners saw a substantial improvement following information exposure regarding the function and safety of these sweeteners. The improvement will be further enhanced for consumers with higher incomes but will be significantly diminished for elderly consumers.

To delve into the underlying mechanisms, we conducted surveys before the experiment to understand respondents' beliefs about sugar substitutes. In the self-reported acceptance of sweeteners, the reviewer is right in that nearly 60% of our respondents support sweeteners over added sugar, 26% are neutral, and 14% oppose. However, in the discrete choice experiment of bottled tea, when consumers are asked to choose between products with/without sweeteners, they express a strongly negative valuation of sweeteners in the control group. This implies that our respondents are less favorable toward sweeteners as they had self-reported. On the other hand, while 51.56% believe that the use of sweeteners can be beneficial in reducing calorie intake, 70.33% of consumers express concerns about the potential impact of sweeteners on human health. Chinese consumers reported greater concerns about the use of sweeteners than their counterparts in developed countries. Farhat et al. (2021) surveyed 1589 UK adults and found that 25% of the sample considered low-caloric sweeteners harmful. People with higher concern about the safety of sweeteners are less receptive to sweetener information intervention (Table 5A). Hence, it is possible that safety concerns about sweeteners play a more significant role than perceived benefits in shaping tea beverage choices.

Our findings may hold implications for the efficacy of sugar taxes, a policy garnering widespread attention from worldwide governments and scholars. Numerous studies have explored the impact of taxes on sugar-sweetened beverage consumption. Some suggest a positive influence of taxes on reducing SSB consumption (Zhai et al., 2022; Zhong et al., 2018), while others argue that the policy has not yielded the desired outcomes (Doble et al., 2020; Powell & Leider, 2020). The crux of our insights lies in the potential ramifications for the effectiveness of sugar taxation policies, especially considering that diet drinks, the primary alternatives to SSBs, often contain low-calorie sweeteners. Beliefs over nutritional content are a primary driver of consumer behavior (Barahona et al., 2023). The effectiveness of the sugar taxation policy may be reduced if consumers strongly resist LCS in the alternatives of SSBs making them choose SSBs anyway despite the tax. Chinese consumers in this sample exhibited a significantly higher level of perceived concern and risk beliefs about sweeteners compared to those in developed countries, further studies can be conducted to explore if the impact of sugar taxation in China will be less effective than in more developed counterparts.

Our findings give important implications for policymakers to design other effective sugar reduction policies. Firstly, consumers' beliefs about sugar substitutes are the primary drivers of consumer behavior. Chinese consumers are more concerned about the safety of sweeteners compared with those in Western countries. This could be due to miscommunication of information, or a lack of knowledge of the benefits and risks surrounding the use of LCS (Williams et al., 2023). There is a need to develop communications, especially by governments to foster more informed public attitudes toward sweeteners, for example by emphasizing the potential health gains associated with sugar intake reduction and the role of sweeteners in achieving this. The media or other organizations could be provided, for example, with simple explanations and the safety of sweeteners. Secondly, the main policy tool the Chinese government is using now to combat obesity is the back-of-package Nutrition Facts Panel which displays energy, fat, carbohydrate, and sodium content while excluding sugar information (Guan et al., 2021). To restrain sugar intake, some new policy tools can be considered such as promoting sugar substitutes. Information intervention is a promising policy tool to help consumers choose products with lower sugar levels and to increase consumers' evaluation of sugar substitutes. Effective intervention strategies such as simplified front-of-package food labels with sugar information and sugar substitute functional claims should be developed to educate the public about the characteristics and healthiness of sweeteners. Finally, a caveat on our findings is that they could be contingent on the setting being studied, such as hypothetical DCEs and the tea product. Future research should test the robustness of our findings to variations in these contexts, especially using non-hypothetical choice experiments and experimental auctions.

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## Declaration of competing interest

The authors declare no conflict of interest.

## Data availability

The data is available upon request through the corresponding author.

## Appendix A. Choice experiment instruction and cheap talk script

Next, you will be presented with a hypothetical choice involving money. No one will actually be paid money based on the decision you make, but you are asked to make the decision as though it would result in the actual payment. Studies show that people tend to act differently when they face hypothetical decisions. In other words, they say one thing and do something different. We call this a 'hypothetical bias.' For example, in a recent study, several different groups of people made decisions just like the one you are about to make. Payment was real for one group and hypothetical for the other group, as it will be for you. The results of these studies were that

on average, more people expressed a willingness to pay money in the hypothetical group than in the real group.

How can we get people to think about their decisions in a hypothetical situation like they think in a real situation? I think that when we hear about a situation that involves doing something that is basically good, for example helping people in need, improving environmental quality, or anything else, our basic reaction in a hypothetical situation is to think: sure, I would do this. I really would spend the money; I really, really, think I would. But when the situation is real, and we would actually have to spend our money, we think a different way. We basically still would like to see good things happen, but when we are faced with the possibility of having to spend money, we think about our options: If I spend money on this, that's money I cannot spend on other things. So, when the payment is real, we act in a way that takes into account the limited amount of money we have. We make the decision while realizing that we just don't have enough money to do everything we might like to do.

**Table A1**

Mixed logit models in preference-space for each group.

	Control		Information		Pooled	
	Estimate	Z-value	Estimate	Z-value	Estimate	Z-value
Mean						
Price	−0.317***	−26.04	−0.319***	−26.27	−0.317***	−26.82
Opt-out	−4.682***	−39.37	−4.487***	−39.94	−4.690***	−40.76
Zero sugar	0.696***	7.11	0.647***	6.87	0.713***	7.49
Low Sugar	1.917***	12.13	1.691***	10.70	1.953***	12.78
High Sugar	0.608***	4.84	0.777***	6.04	0.618***	5.09
Zero sugar*Sweetener	−0.306**	−2.16	0.098	0.67	−0.305**	−2.20
Low Sugar* Sweetener	−0.979***	−13.01	−0.646***	−8.79	−0.996***	−13.21
Price*Information					−0.002	−0.15
Opt-out*Information					0.204	1.32
Zero sugar*Information					−0.043	−0.33
Low Sugar*Information					−0.322	−1.62
High Sugar*Information					0.131	0.81
Zero sugar*Sweetener*Information					0.376**	1.98
Low Sugar* Sweetener*Information					0.360***	3.46
Standard deviation						
Zero sugar	2.334***	19.64	2.210***	19.84	2.281***	27.85
Low Sugar	1.865***	13.18	2.120***	15.45	2.031***	20.51
High Sugar	0.547***	3.83	0.707***	3.90	0.695***	5.81
Zero sugar*Sweetener	0.453*	1.73	0.591**	2.48	0.489**	2.11
Low Sugar* Sweetener	0.136	0.28	0.226	0.56	0.219	0.43
<b>Model statistics</b>						
Log-likelihood	−6089.890		−6283.374		−12,384.846	
Number of Observations	27,000		27,000		5400	
Number of Individuals	900		900		1800	

Note: all models are estimated via simulation maximum likelihood estimation based on 500 Halton draws. \*, \*\*, \*\*\* indicates statistical significance at the 10%, 5%, and at 1% levels, respectively.

## References

- Abu Elnaga, N. I. E., Massoud, M. I., Yousef, M. I., & Mohamed, H. H. A. (2016). Effect of stevia sweetener consumption as non-caloric sweetening on body weight gain and biochemical's parameters in overweight female rats. *Annals of Agricultural Sciences*, 61(1), 155–163.
- An, R., Shi, Y., Shen, J., Bullard, T., Liu, G., Yang, Q., ... Cao, L. (2021). Effect of front-of-package nutrition labeling on food purchases: A systematic review. *Public Health*, 191, 59–67.
- Ashwell, M., Gibson, S., Bellisle, F., Buttriss, J., Drewnowski, A., Fantino, M., ... la Vecchia, C. (2020). Expert consensus on low-calorie sweeteners: Facts, research gaps and suggested actions. *Nutrition Research Reviews*, 33(1), 145–154.
- Barahona, N., Otero, C., & Otero, S. (2023). Equilibrium effects of food labeling policies. *Econometrica*, 91(3), 839–868.
- Bentley, R. A., Ruck, D. J., & Fouts, H. N. (2020). US obesity as delayed effect of excess sugar. *Economics and Human Biology*, 36, Article 100818.
- Bliemer, M. C., & Rose, J. M. (2013). Confidence intervals of willingness-to-pay for random coefficient logit models. *Transportation Research Part B: Methodological*, 58, 199–214.
- Chen, Y. J., Peng, Q., Yang, Y., Zheng, S. S., Wang, Y., & Lu, W. L. (2019). The prevalence and increasing trends of overweight, general obesity, and abdominal obesity among Chinese adults: A repeated cross-sectional study. *BMC Public Health*, 19(1), 1293.
- Chinese Nutrition Society. (2021). *Scientific Research Report on Dietary Guidelines for Chinese Residents*. Beijing: Chinese Nutrition Society.
- Christiansen, P., Roberts, C., Radu, C., & Hardman, C. (2023). A validation of a questionnaire to assess consumer attitudes towards artificial sweeteners. *Food Quality and Preference*, 103, Article 104707.
- Doble, B., Ang Jia Ler, F., & Finkelstein, E. A. (2020). The effect of implicit and explicit taxes on the purchasing of 'high-in-calorie' products: A randomized controlled trial. *Economics and Human Biology*, 37, Article 100860.
- Drugova, T., Curtis, K. R., & Akhundjanov, S. B. (2020). Are multiple labels on food products beneficial or simply ignored? *Canadian Journal of Agricultural Economics*, 68(4), 411–427.
- Farag, M. A., Rezk, M. M., Hamdi Elashal, M., El-Araby, M., Khalifa, S. A. M., & El-Seedi, H. R. (2022). An updated multifaceted overview of sweet proteins and dipeptides as sugar substitutes; the chemistry, health benefits, gut interactions, and safety. *Food Research International*, 162(Pt A), Article 111853.
- Farhat, G., Dewison, F., & Stevenson, L. (2021). Knowledge and perceptions of non-nutritive sweeteners within the UK adult population. *Nutrients*, 13(2), 444.

- Gardner, C., Wylie-Rosett, J., Gidding, S. S., Steffen, L. M., Johnson, R. K., Reader, D., ... American Diabetes, A. (2012). Nonnutritive sweeteners: Current use and health perspectives: A scientific statement from the American Heart Association and the American Diabetes Association. *Diabetes Care*, 35(8), 1798–1808.
- Guan, L., Huang, Z., & Jin, S. (2022). Time preference and nutrition label use: Evidence from China. *Economics and Human Biology*, 47, Article 101184.
- Guan, L., Zhang, Y., Jin, S., & Zhou, L. (2021). Understanding the low use rate of food nutrition information in China. *International Food and Agribusiness Management Review*, 24(5), 863–876.
- Hagmann, D., Siegrist, M., & Hartmann, C. (2018). Taxes, labels, or nudges? Public acceptance of various interventions designed to reduce sugar intake. *Food Policy*, 79, 156–165.
- Harrold, J. A., Hill, S., Radu, C., Thomas, P., Thorp, P., Hardman, C. A., ... Halford, J. C. G. (2023). Effects of non-nutritive sweetened beverages versus water after a 12-week weight-loss program: A randomized controlled trial. *Obesity (Silver Spring)*, 31(8), 1996–2008.
- Hensher, D. A., & Greene, J. M. R. W. H. (2005). *Applied Choice Analysis: A Primer*, Cambridge. Cambridge University Press.
- Hirahatake, K. M., Jacobs, D. R., Shikany, J. M., Jiang, L., Wong, N. D., Steffen, L. M., & Odegaard, A. O. (2019). Cumulative intake of artificially sweetened and sugar-sweetened beverages and risk of incident type 2 diabetes in young adults: The coronary artery risk development in young adults (CARDIA) study. *The American Journal of Clinical Nutrition*, 110(3), 733–741.
- Hovhannisyan, V., & Bastian, C. T. (2022). New insights into the structure of consumer preferences for natural and artificial sweeteners. *American Journal of Agricultural Economics*, 105(5), 1491–1515.
- Krinsky, I., & Robb, A. L. (1986). On approximating the statistical properties of elasticities. *The Review of Economics and Statistics*, 715–719.
- Lakkakula, P., & Schmitz, A. (2019). US sweeteners: Combating excess consumption with an excise tax? *Agricultural Economics*, 50(5), 543–554.
- Lancaster, K. J. (1966). A new approach to consumer theory. *Journal of Political Economy*, 74, 132–157.
- Laviada-Molina, H., Molina-Segui, F., Perez-Gaxiola, G., Cuello-Garcia, C., Arjona-Villicana, R., Espinosa-Marron, A., & Martinez-Portilla, R. J. (2020). Effects of nonnutritive sweeteners on body weight and BMI in diverse clinical contexts: Systematic review and meta-analysis. *Obesity Reviews*, 21(7), Article e13020.
- Malik, V. S., & Hu, F. B. (2022). The role of sugar-sweetened beverages in the global epidemics of obesity and chronic diseases. *Nature Reviews. Endocrinology*, 18(4), 205–218.
- Matthews, R. W., & Matthews, J. R. (2017). The malaise trap: Its utility and potential for sampling insect populations. *The Great Lakes Entomologist*, 4(4).
- McFadden, D. (1974). The measurement of urban travel demand. *Journal of Public Economics*, 3(4), 303–328.
- McFadden, D., & Train, K. (2000). Mixed MNL models for discrete response. *Journal of Applied Econometrics*, 15(5), 447–470.
- Mennella, J. A., & Beauchamp, G. K. (1998). Early flavor experiences: Research update (reprinted from pediatric basics, vol 82). *Nutrition Reviews*, 56(7), 205–211.
- Neuhofer, Z., McFadden, B. R., Rihn, A., Wei, X., Khachatryan, H., & House, L. (2020). Can the updated nutrition facts label decrease sugar-sweetened beverage consumption? *Economics and Human Biology*, 37, Article 100867.
- Nie, P., Ding, L., & Sousa-Poza, A. (2019). Obesity inequality and the changing shape of the bodyweight distribution in China. *China Economic Review*, 58, Article 101348.
- Poe, G. L., Giraud, K. L., & Loomis, J. B. (2005). Computational methods for measuring the difference of empirical distributions. *American Journal of Agricultural Economics*, 87(2), 353–365.
- Powell, L. M., & Leider, J. (2020). The impact of Seattle's sweetened beverage tax on beverage prices and volume sold. *Economics and Human Biology*, 37, Article 100856.
- Powell, L. M., Leider, J., & Leger, P. T. (2020). The impact of the Cook County, IL, sweetened beverage tax on beverage prices. *Economics and Human Biology*, 37, Article 100855.
- Rogers, P. J., & Appleton, K. M. (2021). Correction: The effects of low-calorie sweeteners on energy intake and body weight: A systematic review and meta-analyses of sustained intervention studies. *International Journal of Obesity (Lond)*, 45(9), 2139–2140.
- Shepherd, R. (2002). Resistance to changes in diet. *Proceedings of the Nutrition Society*, 61(2), 267–272.
- da Silva, C. P., Bento, A. C., & Guaraldo, E. (2022). The impact of front-of-the-packaging nutrition labelling warnings on consumer habits: A scoping review exploring the case of the Chilean food law. *British Food Journal*, 124(13), 66–80.
- Silva, P. D., Cruz, R., & Casal, S. (2021). Sugars and artificial sweeteners in soft drinks: A decade of evolution in Portugal. *Food Control*, 120, Article 107481.
- Singh, G. M., Michia, R., Khatibzadeh, S., Shi, P., Lim, S., Andrews, K. G., & Mozaffarian, D. (2015). Global, regional, and National Consumption of sugar-sweetened beverages, fruit juices, and Milk: A systematic assessment of beverage intake in 187 countries. *PLoS ONE*, 14(3), Article e0214344.
- State Council of China. (2017). *National Nutrition Plan (2017–2030)*, Beijing. The State Council of China.
- State Council of China. (2019). *The healthy China initiative (2019–2030)*, Beijing. The State Council of China.
- Street, D. J., Burgess, L., & Louviere, J. J. (2005). Quick and easy choice sets: Constructing optimal and nearly optimal stated choice experiments. *International Journal of Research in Marketing*, 22(4), 459–470.
- Sylvetsky, A. C., Greenberg, M., Zhao, X., & Rother, K. I. (2014). What parents think about giving nonnutritive sweeteners to their children: A pilot study. *International Journal Of Pediatrics*, 2014, 819872.
- Tang, C. S., Mars, M., James, J., de Graaf, K., & Appleton, K. M. (2021). Sweet talk: A qualitative study exploring attitudes towards sugar, sweeteners and sweet-tasting foods in the United Kingdom. *Foods*, 10(6), 1172.
- Train, K. E. (2003). *Discrete Choice Methods With Simulation*, Cambridge. Cambridge University Press.
- Williams, R., Moazzem, M. S., Dees, J., Hayden, M., Traynor, M., & Cho, S. (2023). Consumer acceptability of no added sugar pound cakes under blind and informed testing conditions. *Journal of Food Science*, 88(11), 4677–4692.
- Zhai, T. C., Li, L., Wang, J. J., & Si, W. (2022). Will the consumption tax on sugar-sweetened beverages help promote healthy beverage consumption? Evidence from urban China. *China Economic Review*, 73, Article 101798.
- Zhang, X., Huang, X., Xiao, Y., Jing, D., Huang, Y., Chen, L., ... Shen, M. (2019). Daily intake of soft drinks is associated with symptoms of anxiety and depression in Chinese adolescents. *Public Health Nutrition*, 22(14), 2553–2560.
- Zhong, Y., Auchincloss, A. H., Lee, B. K., & Kanter, G. P. (2018). The short-term impacts of the Philadelphia beverage tax on beverage consumption. *American Journal of Preventive Medicine*, 55(1), 26–34.
- Zhu, C., Lopez, R. A., Zhen, C., & Zhao, Q. (2023). Consumer responses to nutrition labels in China. *Journal of Agricultural and Applied Economics Association*, 2(2), 278–294.