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Original Research

Sugar-sweetened beverage consumption in Thailand: Determinants and variation across socioeconomic status

Kittiphong Thiboonboon *, Richard De Abreu Lourenco, Jody Church, Stephen Goodall

Centre for Health Economics Research and Evaluation, University of Technology Sydney, Sydney, Australia, Level 5, Building 20, 100 Broadway, Chippendale, NSW, 2008, Australia

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ABSTRACT

Objectives: Reducing consumption of sugar-sweetened beverages (SSBs) is a primary public health goal in Thailand, but information on the characteristics of SSB consumers remains limited. This study aims to gain knowledge about the characteristics of SSB consumers in Thailand.
Study design: Secondary analysis of survey data.
Methods: The study used data from the Health Behaviour of Population Survey conducted by Thailand's National Statistics Office between February and May 2021. SSB consumption was sourced from a survey question about the consumption of prepackaged sugar-sweetened non-alcoholic beverages. The influence of demographic, socioeconomic, behavioural, habitual, and health factors on mean daily intake and daily consumption was assessed using a two-part model and logistic regression analysis, respectively. Decomposition analysis was conducted to understand how the impact of these factors affecting SSB consumption varied across socioeconomic groups.
Results: Frequent SSB consumers exhibited various unhealthy behaviours, including smoking, unhealthy food consumption, low physical activity, and making food selections driven by appetitive motivations. Although higher socioeconomic status was associated with greater consumption of SSBs, it stabilised at elevated income levels. Increased SSB consumption in higher socioeconomic groups was linked to mixed eating habits, being overweight, and occasional drinking, while in lower socioeconomic groups, it was associated with unhealthy behaviours like smoking, regular alcohol drinking, appetitive food choices, and low physical activity.
Conclusions: SSB consumption in Thailand is multifactorial, varying by socioeconomic status. These insights are crucial for policy formation aimed at reducing SSB consumption in the country. Policymakers should explore interventions that address overall unhealthy behaviours alongside those targeting overconsumption of SSBs.

Introduction

Reducing high sugar intake has been strongly recommended by the World Health Organization (WHO) due to its adverse effects on health.[1] Among the dietary sources of high sugar content, sugar-sweetened beverages (SSBs) stand out as a primary concern, as they represent the largest source of free sugars in the diet, contributing to a significant portion of daily caloric intake for many individuals.[2] Overconsumption of SSBs is a public health concern, as growing evidence indicates that high SSB consumption increases the risk of obesity, as well as many health conditions such as type 2 diabetes, cardiovascular disease, dental caries, and specific types of cancer.[3–6]

Thailand is often referred to as a country with high SSB consumption.[7,8] Between 1990 and 2018, SSB consumption in the country increased considerably, from an average of less than one serving per week in 1990 to more than four servings per week in 2018. Among Asian countries, Thailand has the highest per capita daily calorie intake from SSBs, at nearly 60 calories, which is twice as many calories as in other countries, notably China.[8] It is now estimated that 40–70 % of the Thai population consumes SSBs daily.[9,10] SSBs are a large source of sugar consumed in Thailand, and contribute significantly to the daily intake of sugar among the population, exceeding the recommended level of less than 50 g per capita per day.[11,12] This situation has become worrisome as many studies suggest that the trend of increasing SSB consumption will continue.[8,13,14]

International research has highlighted the broad factors that

* Corresponding author.
E-mail addresses: Kittiphong.Thiboonboon@uts.edu.au (K. Thiboonboon), Richard.DeAbreuLourenco@uts.edu.au (R.D.A. Lourenco), Jody.Church@uts.edu.au (J. Church), Stephen.Goodall@uts.edu.au (S. Goodall).

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influence SSB consumption.[15–21] In high-income countries, individuals of lower socioeconomic status tend to consume more SSBs.[19,20,22] A study also discovered that SSB consumption is multifactorial extending beyond observable external factors to internal factors such as habits, intentions and attitudes.[23] Moreover, as SSBs are regarded as palatable foods with instant gratification, literature from behavioural economics and psychology emphasises that deeper factors, such as cognitive susceptibility, might play a role in the consumption of such foods.[24,25] In terms of public health, because of their significant impact on health outcomes, differences in SSB consumption can also represent one of the pathways by which health inequalities are generated and sustained in the population, and therefore one potential focus for promoting health equity.[26,27] There has been little investigation of these aspects of SSB consumption in Thailand.[9,10,28]

In Thailand, various strategies to reduce SSB intake have been considered by policymakers.[29] Specifically, a tax on SSBs, introduced in the country in 2017, is set to increase progressively until 2025.[30] The tax is primarily structured to rise based on pre-defined tiers of sugar content, encouraging manufacturers to lower the sugar levels in their products. This aims to reduce the consumption of high sugar beverages by incentivising a shift toward lower-content sugar alternatives.[29,31] Conducting a thorough situational analysis of SSB consumers is vital to ensure these policies are well-targeted and effective in achieving their intended outcomes.[31] A previous study has provided valuable insight into certain key characteristics of SSB consumers, such as socioeconomic status, which help explain SSB consumption patterns in Thailand.[10] Further understanding the various characteristics across socioeconomic groups would deepen knowledge of how public health policies, including the SSB tax, might affect various population groups. This is particularly important since such policies have been advocated to improve the health of disadvantaged groups.[31] This study aims to provide a nuanced analysis of the complex interplay between the multiple determinants affecting SSB consumption in Thailand.

Methods

Data

The study used data from the Health Behaviour of Population Survey provided by the National Statistics Office in Thailand.[32] This nationally representative, self-reported survey, carried out from February to May 2021, collected information from Thais on demographics, socioeconomics, health status, and health behaviours. It was a household survey that included a total of 84,000 households, interviewing individuals aged 15 years and above, resulting in 207,192 participants. A summary of the original number of respondents and the number excluded from analysis is presented in Fig. 1. Responses provided on behalf of others, or proxy responses, were excluded because of potential inaccuracies, missing data (particularly on physical activity), and the risk of bias.[33] A total of 49,128 participants aged 25 to 59, who completed the survey themselves, were included in this study. To ensure the representativeness of the survey to the entire Thai population, existing weighting factors accounting for sampling design, nonresponse, and potential biases were applied.[34]

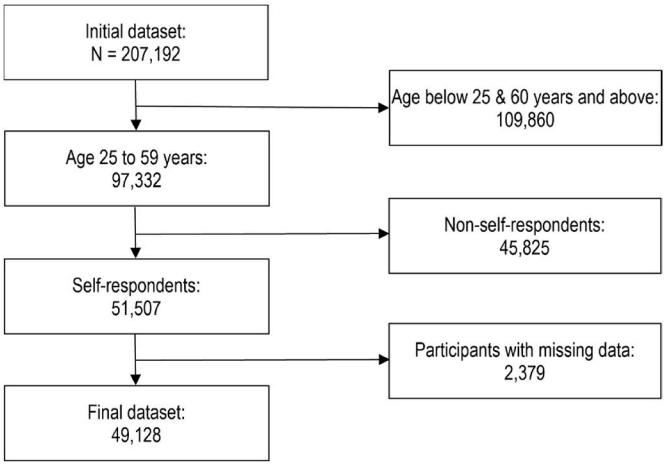

Fig. 1. Overview of sample sizes and exclusions by reason.

Outcomes of interest

Two outcomes related to SSB consumption (Table 1), including mean daily intake in mL and the likelihood of being a daily consumer of SSBs, were chosen as they are commonly used measurement in similar studies[10,35,36] and aligns with health guidelines assess sugar consumption risk based on daily intake.[37]

Information regarding SSBs was obtained from a survey question on the consumption of prepackaged sugar-sweetened non-alcoholic beverages. Participants were first asked how often they consumed prepackaged sugar-sweetened non-alcoholic beverages (examples provided included sweetened drinks, carbonated drinks, energy drinks, fruit juices, health and beauty drinks, tea and coffee) over the past 30 days. Response options included daily, 5–6 days a week, 3–4 days a week, 1–2 days a week, less than 1 day a week, or never. Those who reported consumption were then asked to specify the number of servings of prepacked non-alcoholic beverages per day, with one serving equivalent to 200–250 mL (mL).

To calculate the mean daily intake, categorical data on frequency of consumption were transformed into continuous values based on midpoints (e.g., 5.5 days per week for those reporting 5–6 days a week). These weekly values were divided by seven to obtain the proportion of days with consumption (e.g., $5.5/7 = 0.786$). The daily proportion was then multiplied by the reported number of servings per day and by 225 mL (the midpoint of a 200–250 mL serving) to obtain the mean daily intake in mL.

The likelihood of being a daily consumer of SSBs was a binary outcome. Participants reporting a consumption frequency of less than one serving a week were reclassified as “non-consumers”, along with those who never consumed SSBs. This reclassification was based on the assumption that such infrequent consumption is unlikely to contribute adverse health effects (e.g., unlikely to lead to sugar intake exceeding WHO recommendations[12]), and an exploratory analysis of the data suggested that the characteristics of these low-frequency consumers (8.42 %) were similar to those who reported never consuming SSBs.

Explanatory variables

An extensive literature review was conducted to investigate factors previously identified as influencing SSB consumption.[9,10,15–18,21,22,28,35,38–41] This revealed a range of demographic, socioeconomic, behavioural, habitual and health factors influencing SSB consumption (Table 1). Demographic factors included sex, age and marital status, while socioeconomic factors included education, income quintiles, levels of work-related physical activity, and area of residence.[10] The inclusion of work-related physical activity was important since Thailand has a significant manual labour work force that might depend on SSBs for energy.[10] Behavioural factors included in this study were smoking status, alcohol consumption, intake of other unhealthy foods (such as fatty foods, fast foods, or snacks), vegetable and fruit consumption, the number of main meals consumed daily, the source of foods, consideration of food labels, and leisure-time physical activity.[9,10,38] Previous studies also indicate that SSB consumption is associated with other unhealthy behaviours, such as smoking and alcohol consumption.[10,16,38] Furthermore, evidence suggests that SSB consumption might partly offset individuals’ primary meals.[41] Weight status, determined by BMI, and health conditions based on non-communicable disease (NCD) status

Table 1
Definition of SSB variables and explanatory variables.

Variable	Definition and statistical coding
Dependent variables	
Mean daily intake	Mean daily intake of SSBs (mL)
Daily consumption	1 if consume at least one serving of SSB per day, 0 otherwise
Explanatory variables	
Sex	1 if male, 0 otherwise
Age	Age in years
Marital status	1 if ever married, 0 otherwise
Socioeconomic quintiles	Socioeconomic status was based on income quintiles, which were constructed by ranking participants based on their total monthly equivalised household income[45] (including all sources of financial income reported by individuals within the household) and then dividing them into five equal groups.
Education	Total years of education
Work-related physical activity	1 if involved in daily tasks that require moderate work-related physical effort, 2 if involved in daily tasks that require high work-related physical effort, 0 otherwise
Area of residence	1 if living in an urban area, 0 otherwise
Smoking status	1 if a current smoker, 2 if ex-smoker, 0 otherwise
Alcohol drinking status	1 if a former drinker, 2 if consume 1–4 days a week (occasionally), 3 if consume ≥5 days a week (usually), 0 otherwise
Unhealthy foods [a]	1 if consume either fatty foods, junk foods, or snacks ≥5 days a week, 0 otherwise
Vegetable	1 if consume vegetables ≥5 days a week, 0 otherwise
Fruit	1 if consume fruit ≥5 days a week, 0 otherwise
Main meal	Number of main meals per day
Source of food	1 if the most frequent source of food is non-home cooked, 0 otherwise
Food choice	Participants self-reported their most important reason for purchasing foods: 1 taste, 2 -nutrition, 3 -price, 4 - conveniences, 5 - liking, 6 - wanting, 0 otherwise (cleanliness[b])
Food label consideration	1 if never seen or unsure, 2 if seen but no impact, 0 otherwise (seen and has impact)
Leisure-time physical activity	1 if self-reported insufficient leisure-time physical activity but willing to do more in 1 month, 2 if self-reported insufficient leisure-time physical activity but willing to do more in 6 months, 3 if self-reported insufficient leisure-time physical activity and have no plan or unclear to do more, 0 otherwise (sufficient)
Weight status	1 if underweight (BMI <18.5), 2 if overweight (BMI 25 to < 30), 3 if obese (BMI ≥30), 0 otherwise (normal weight)
Health problem	1 if have any non-communicable disease (high blood pressure, diabetes/high blood sugar, high blood lipids/high cholesterol, stroke/paralysis, heart disease/coronary artery disease, chronic lung disease/emphysema/asthma, cancer/tumour, depression, and osteoarthritis/degenerative arthritis), 0 otherwise
Control variables	
Region of residence	
Bangkok	1 if living in Bangkok, 0 otherwise
Central	1 if living in the Central region, 0 otherwise
North	1 if living in the North region, 0 otherwise
Northeast	1 if living in the Northeast region, 0 otherwise
South	Reference

BMI = body mass index (estimated as weight in kilograms divided by squared height in metres); mL = millilitre; SSBs = sugar-sweetened beverages.
[a] Participants were provided with examples of foods as follow: fatty foods include foods cooked by frying, stir-frying with oil, curries with coconut milk, foods with cream, bakery items (such as cakes, doughnuts, bread with butter/jam and butter, snacks with coconut milk, cookies). Fast foods include fast food from Western-style restaurants with franchises, such as pizza, sandwiches, and fried chicken. Snacks include dried fish snacks, potato chips, popcorn, dried seaweed snacks, cookies, biscuits, and wafers.
[b] This study assumed that all beverages meet a basic standard of cleanliness or hygiene, thus, it can be posited that cleanliness does not directly impact SSB consumption. Therefore, this analysis focuses on how other factors influence the decision to consume sugary drinks relative to cleanliness.

were also integrated into the study.[10] Additionally, the study accounted for habitual factors influencing food choices obtained from one question from the survey that addressed the primary reasons for food choice, probing aspects like personal liking, wanting, taste, price, nutritional value, cleanliness, and convenience. Appetitive motivations for foods, such as 'liking' and 'wanting', are intrinsically linked to psychological processes connected to the brain's reward system, specifically dopamine.[42] 'Liking' pertains to positive feelings like pleasure or enjoyment derived from an experience, whereas 'wanting' is a more goal-oriented behaviour driven by reward anticipation. Those people especially responsive to these reward pathways might consume more palatable foods like SSBs as they provide immediate sweetness-induced gratification, appealing to taste and triggering the brain's reward system.[43,44]

Statistical analyses

The influence of explanatory factors on the mean daily intake of SSBs was examined using a two-part model.[46] This regression method is specifically developed to handle a significant proportion of zeros in outcome data (i.e., in this study, those who had no consumption of SSBs). In the first part of the model a logistic regression was used to model the probability of being an SSB consumer (>1 serving a week), influenced by underlying explanatory factors. In the second part of the model, frequent SSB consumers were identified from those who are SSB consumers using an ordinary least squares (OLS) regression. Finally, incremental consumption by different characteristics of consumers was calculated using marginal effects. The likelihood of being a daily consumer of SSBs (versus less than daily) outcome was analysed using a logistic regression model. In this model, odds ratios were reported as indicators of the strength and direction of the relationship between the explanatory variables and the likelihood of daily SSB consumption.[47] To account for the variation of economic and food culture across Thailand's five region, which could influence SSB consumption pattern,[28,48] regional dummy variables were incorporated into the model.[49]

To further explore whether the patterns of SSB consumption differ across socioeconomic domain in the population, a decomposition analysis was conducted.[50] This approach is commonly used in public health research to understand inequalities in various health behaviours in the population.[51–53] For example, it has been used to assess socioeconomic-driven inequalities in tobacco use, highlighting influences like wealth, area of residence and sex.[51] This approach can provide a deeper understanding of how various factors combined with socioeconomic status, influences SSB consumption, potentially impacting health and health equity. This study used the standard version of the decomposition analysis, which is based on an additive regression model.[54,55] The decomposition analysis is a function of the outcome (i.

e., SSB consumption)'s elasticity with respect to the explanatory variable (elasticity; E) and the degree of concentration of the explanatory variable across socioeconomic groups (C_k).[50] The socioeconomic status" of individuals was represented by an equivalised household income calculated using the square root scale method recommended by the Organisation for Economic Co-operation and Development (OECD).[45] Results from the decomposition analysis were reported in terms of elasticity (E), representing the change in the outcome (SSB consumption) associated with a one-unit change in the explanatory variable, with a positive sign on E indicating an increase, and a negative sign on E indicating a decrease in the outcome due to a positive change in the explanatory variable. A negative C_k indicates a higher prevalence of the respective variable among lower socioeconomic individuals, while a positive C_k suggests a higher prevalence among those of higher socioeconomic status. All analyses were performed using Stata 17 software.[56] To test for the presence of multicollinearity among the predictor variables, a correlation analysis was performed using Stata's correlate ('corr') command.

Results

A summary of the characteristics of the studied population is presented in Table 2. The sample of 49,128 participants consisted of 40.48 % males and 59.52 % females, with a mean age of 45.30 years (standard deviation; SD = 9.5). Of the participants, 15.8 % indicated daily consumption of SSBs and the mean daily intake was estimated at 85.2 mL (SD = 125.8). The test of the presence of multicollinearity suggests that most variables had weak or no correlation with one another, apart from

Table 2
Descriptive statistics of the included population.

Characteristics		All participants	Daily consumption (n)	p-value[a]	Mean daily intake in mL (SD)	p-value[b]
Total (N = 49,128)		49,128 (100.0 %)	7760 (15.8 %)	–	85.2 (125.8)	–
Sex	Male	19,887 (40.5 %)	4098 (52.8 %)		104.5 (135.7)	
	Female	29,241 (59.5 %)	3662 (47.2 %)	<0.01	72.1 (116.9)	<0.01
Age, mean (SD)	Age in years	45.30 (9.5)	7760 (15.8 %)	<0.01	85.2 (125.8)	<0.01
Marital status	Single	7830 (15.9 %)	1393 (18.0 %)		102.4 (148.4)	
	Ever-married	41,298 (84.1 %)	6367 (82.0 %)	<0.01	81.9 (120.8)	<0.01
Education, mean (SD)	Total years of education	9.15 (4.3)	7760 (15.8 %)	<0.01	85.2 (125.8)	<0.01
Socioeconomic quintiles	Quintile 1	9825 (20.0 %)	1103 (14.2 %)		62.8 (104.3)	
	Quintile 2	9827 (20.0 %)	1370 (17.7 %)		77.7 (117.9)	
	Quintile 3	9824 (20.0 %)	1681 (21.7 %)		90.4 (129.5)	
	Quintile 4	9826 (20.0 %)	1798 (23.2 %)		97.1 (138.9)	
	Quintile 5 (highest)	9825 (20.0 %)	1808 (23.3 %)	<0.01	97.9 (132.0)	<0.01
Work-related physical activity	Light	24,816 (50.5 %)	3282 (42.3 %)		77.2 (117.9)	
	Moderate	20,758 (42.3 %)	3688 (47.5 %)		91.6 (132.8)	
	High	3554 (7.2 %)	790 (10.2 %)	<0.01	103.3 (133.5)	<0.01
Area of residence	Non-urban	23,997 (48.8 %)	3560 (45.9 %)		80.5 (122.7)	
	Urban	25,131 (51.2 %)	4200 (54.1 %)	<0.01	89.7 (128.6)	<0.01
Smoking status	Never	36,906 (75.1 %)	5130 (66.1 %)		77.7 (119.5)	
	Current	8730 (17.8 %)	1956 (25.2 %)		110.6 (141.5)	
	Ex-smoker	3492 (7.1 %)	674 (8.7 %)	<0.01	101.2 (138.9)	<0.01
Alcohol drinking status	Never/rarely	34,537 (70.3 %)	4856 (62.6 %)		77.8 (117.4)	
	Former	7672 (15.6 %)	1309 (16.9 %)		92.6 (144.5)	
	Occasionally	2362 (4.8 %)	630 (8.1 %)		118.5 (146.5)	
	Usually	4557 (9.3 %)	965 (12.4 %)	<0.01	111.6 (134.9)	<0.01
Unhealthy foods	<5 d/w	44,993 (91.6 %)	6567 (84.6 %)		82.0 (121.9)	
	5–7 d/w	4135 (8.4 %)	1193 (15.4 %)	<0.01	119.9 (158.9)	<0.01
Vegetables	<5 d/w	22,676 (46.2 %)	2730 (35.2 %)		81.3 (123.6)	
	5–7 d/w	26,452 (53.8 %)	5030 (64.8 %)	<0.01	88.5 (127.6)	<0.01
Fruit	<5 d/w	36,462 (74.2 %)	4873 (62.8 %)		80.9 (118.3)	
	5–7 d/w	12,666 (25.8 %)	2887 (37.2 %)	<0.01	97.5 (144.8)	<0.01
Main meal, mean/d (SD)	Number of meals a day	2.89 (0.34)	7760 (15.8 %)	<0.01	85.2 (125.8)	<0.01
Source of foods	Home cooking	37,868 (77.1 %)	5462 (70.4 %)		77.4 (116.6)	
	Non-home cooked	11,260 (22.9 %)	2298 (29.6 %)		111.3 (149.8)	
Food choice	Cleanliness	9114 (18.6 %)	1374 (17.7 %)		77.6 (117.9)	
	Taste	9320 (19.0 %)	1343 (17.3 %)		86.1 (130.3)	
	Nutrition	5959 (12.1 %)	702 (9.0 %)		69.8 (123.5)	
	Price	2686 (5.5 %)	356 (4.6 %)		78.1 (136.3)	
	Convenience	2796 (5.7 %)	632 (8.1 %)		111.0 (146.9)	
	Liking	8339 (17.0 %)	1464 (18.9 %)		90.9 (122.1)	
	Wanting	10,914 (22.2 %)	1889 (24.3 %)	<0.01	89.9 (122.2)	<0.01
Food label consideration	Never or unsure	16,765 (34.1 %)	2611 (33.6 %)		80.4 (124.0)	
	Seen but no impact	13,350 (27.2 %)	2335 (30.1 %)		90.6 (123.7)	
	Seen and have impact	19,013 (38.7 %)	2814 (36.3 %)	<0.01	85.6 (128.8)	<0.01
Leisure-time physical activity	Sufficient	6466 (13.2 %)	1004 (12.9 %)		87.1 (126.3)	
	Insufficient, willing in 1 m	2969 (6.0 %)	447 (5.8 %)		83.7 (136.6)	
	Insufficient, willing in 6 m	4895 (10.0 %)	755 (9.7 %)		90.3 (124.4)	
	Insufficient, no/unclear willingness	34,798 (70.8 %)	5554 (71.6 %)	0.43	84.2 (125.0)	<0.01
Weight classification	Underweight	2163 (4.4 %)	366 (4.7 %)		90.2 (132.9)	
	Normal	30,943 (63.0 %)	4856 (62.6 %)		84.9 (125.7)	
	Overweight	12,478 (25.4 %)	1971 (25.4 %)		85.8 (124.9)	
	Obese	3544 (7.2 %)	567 (7.3 %)	0.49	82.7 (126.4)	0.15
Health problem (s)	No	39,440 (80.3 %)	6382 (82.2 %)		88.0 (127.7)	
	Yes	9688 (19.7 %)	1378 (17.8 %)	<0.01	73.7 (117.1)	<0.01

d = day; m = month; mL = millilitre; n = number of participants; SD = standard deviation; THB = Thai Baht; vs = versus; w = week.
[a] Pearson test (except for age, education, and main meal, for which a *t*-test was applied).
[b] ANOVA test (except for age, education, and main meal, for which a Pearson correlation was applied).

Table 3
Results from the two-part model (mean daily intake in mL) and the logistic model (daily consumption).

Variable	Mean daily intake (mL)						Daily consumption	
	Logistic: OR (95 % CI)		OLS: coefficient (95 % CI)		Incremental consumption (mL)[a] (95 % CI)		OR (95 % CI)	
Male **(ref: female)**	1.290***	(1.190, 1.400)	0.156***	(0.111, 0.201)	21.0***	(16.4, 25.7)	1.435***	(1.288, 1.599)
Age **(year)**	0.978***	(0.974, 0.982)	−0.005	(-0.007, −0.003)	−1.0***	(-1.2, −0.8)	0.996*	(0.991, 1.001)
Ever-married **(ref: never married)**	0.991	(0.905, 1.085)	0.010	(-0.036, 0.056)	0.6	(-4.1, 5.3)	1.102	(0.979, 1.242)
Education **(years)**	1.005	(0.996, 1.014)	−0.000	(-0.005, 0.004)	0.1	(-0.4, 0.6)	1.003	(0.991, 1.015)
Socioeconomic quintiles **(ref: quintile 1)**								
Quintile 2	1.131***	(1.037, 1.235)	0.082***	(0.029, 0.136)	9.9***	(5.0, 14.7)	1.216***	(1.072, 1.379)
Quintile 3	1.147***	(1.047, 1.256)	0.164***	(0.111, 0.216)	17.3***	(12.3, 22.4)	1.398***	(1.229, 1.590)
Quintile 4	1.194***	(1.084, 1.314)	0.140***	(0.085, 0.194)	16.3***	(11.1, 21.6)	1.310***	(1.145, 1.498)
Quintile 5 (highest)	1.282***	(1.153, 1.426)	0.134***	(0.074, 0.195)	18.0***	(12.1, 23.8)	1.284***	(1.102, 1.497)
Work-related physical activity **(ref: light)**								
Moderate	1.004	(0.942, 1.070)	0.069***	(0.033, 0.105)	6.0***	(2.4, 9.6)	1.277***	(1.168, 1.396)
High	1.069	(0.950, 1.203)	0.122***	(0.052, 0.192)	12.8***	(5.4, 20.3)	1.502***	(1.296, 1.741)
Living in urban **(ref: non-urban)**	1.057**	(0.992, 1.127)	0.064***	(0.028, 0.099)	7.1***	(3.5, 10.7)	1.126***	(1.033, 1.227)
Smoking status **(ref: never)**								
Current	1.441***	(1.304, 1.591)	0.045**	(-0.004, 0.094)	14.5***	(9.1, 19.8)	1.361***	(1.204, 1.538)
Ex-smoker	1.304***	(1.138, 1.493)	0.037	(-0.025, 0.099)	10.9***	(4.0, 17.8)	1.165*	(0.974, 1.393)
Alcohol drinking status **(ref: never/rarely)**								
Former	1.110***	(1.021, 1.207)	0.067*	(0.023, 0.112)	8.9***	(4.2, 13.5)	1.249***	(1.118, 1.395)
Occasionally	1.419***	(0.940, 1.250)	0.076***	(0.085, 0.221)	16.7***	(8.2, 24.3)	1.195**	(1.039, 1.375)
Usually	1.084	(1.265, 1.593)	0.153	(0.021, 0.130)	16.3***	(10.6, 22.9)	1.340***	(1.142, 1.573)
Unhealthy foods for 5–7 d/w **(ref: <5 d/w)**	1.074	(0.963, 1.198)	0.035***	(0.295, 0.411)	37.8***	(29.8, 45.8)	2.078***	(1.840, 2.347)
Vegetable for 5–7 d/w **(ref: <5 d/w)**	1.053	(0.986, 1.126)	0.028	(-0.008, 0.064)	3.9**	(0.3, 7.5)	1.371***	(1.248, 1.506)
Fruit for 5–7 d/w **(ref: <5 d/w)**	0.823***	(0.764, 0.887)	0.236***	(0.195, 0.276)	15.2***	(10.7, 19.7)	1.876***	(1.704, 2.066)
Main meal **(number per day)**	1.089*	(0.997, 1.190)	−0.092***	(-0.145, −0.039)	−5.5**	(-10.7, −0.2)	0.819***	(0.728, 0.920)
Non-home cooked **(ref: home-cooked)**	1.085*	(0.999, 1.179)	0.115***	(0.072, 0.158)	12.7***	(8.0, 17.3)	1.247***	(1.122, 1.385)
Food choice **(ref: cleanliness)**								
Taste	1.047	(0.949, 1.154)	0.108	(0.054, 0.161)	10.5***	(5.1, 15.8)	0.933	(0.814, 1.069)
Nutrition	0.943	(0.848, 1.048)	−0.050	(-0.113, 0.013)	−5.4*	(-11.0, 0.2)	0.753***	(0.641, 0.885)
Price	0.839**	(0.723, 0.974)	0.012	(-0.097, 0.072)	−6.0	(-13.6, 1.7)	0.796**	(0.637, 0.994)
Convenience	1.268***	(1.084, 1.483)	0.022	(-0.076, 0.120)	8.5*	(-1.0, 18.0)	1.292***	(1.082, 1.542)
Liking	1.323***	(1.194, 1.467)	0.088***	(0.034, 0.142)	15.7***	(10.1, 21.3)	1.221***	(1.066, 1.397)
Wanting	1.355***	(1.234, 1.489)	−0.045*	(-0.007, 0.097)	12.4***	(7.3, 17.6)	1.054	(0.928, 1.197)
Food label consideration **(ref: never/unsure)**								
Seen but no impact	1.311***	(1.215, 1.416)	−0.015	(-0.028, 0.059)	9.2***	(4.8, 13.5)	1.172***	(1.052, 1.305)
Seen and have impact	1.188***	(1.106, 1.277)	−0.002	(-0.040, 0.044)	5.1**	(1.0, 9.3)	0.979	(0.882, 1.088)
Leisure-time physical activity **(ref: sufficient)**								
Insufficient, willing in 1 m	1.025	(0.888, 1.182)	−0.001	(-0.074, 0.076)	0.8	(-6.7, 8.3)	1.151	(0.902, 1.337)
Insufficient, willing in 6 m	1.199***	(1.053, 1.364)	0.002	(-0.060, 0.063)	5.2	(-1.3, 11.6)	1.156*	(0.938, 1.295)
Insufficient, no/unclear willingness	1.009	(0.920, 1.108)	0.025	(-0.024, 0.073)	2.4	(-2.5, 7.2)	1.179**	(0.991, 1.260)
Weight status **(ref: normal)**								
Underweight	0.878*	(0.762, 1.011)	0.028	(-0.052, 0.107)	−1.5	(-9.4, 6.3)	0.915	(0.758, 1.105)
Overweight	1.144***	(1.068, 1.226)	0.018	(-0.022, 0.058)	5.4***	(1.4, 9.5)	1.028	(0.935, 1.131)
Obese	1.066	(0.949, 1.197)	−0.011	(-0.079, 0.056)	0.8	(-5.8, 7.5)	1.156	(0.973, 1.373)
Health problem **(ref: no health problem)**	0.919**	(0.851, 0.993)	−0.045*	(-0.095, 0.005)	−6.2***	(-10.9, −1.5)	0.928*	(0.826, 1.043)
Constant	1.139	(0.799, 1.625)	4.402***	(4.197, 4.606)	86.3***	(84.6, 88.0)	0.065	(0.041, 0.105)
Controlled regions (dummy: South)								
Bangkok	1.507***	(1.322, 1.718)	0.108***	(0.034, 0.181)	22.1***	(13.481, 30.628)	1.538	(1.279, 1.850)
Central	2.423***	(2.218, 2.647)	0.220***	(0.168, 0.272)	46.3***	(40.479, 52.210)	1.937	(1.691, 2.218)
North	1.197***	(1.092, 1.313)	−0.007	(-0.064, 0.050)	4.4	(-1.216, 10.110)	1.075	(0.927, 1.246)
Northeast	1.356***	(1.241, 1.481)	0.052*	(-0.004, 0.107)	13.2***	(7.496, 18.937)	1.212	(1.054, 1.393)
Number of observations	49,128		26,250		49,128		49,128	
Wald $chi^2(40)$	1610.59		–				1313.13	
Prob > chi^2	0.000		–				0.000	
Pseudo R^2	0.060		–				0.080	
Prob > F	–		0.000				–	
Adjusted R-squared	–		0.084				–	

d = day; m = month; mL = millilitre; OLS = Ordinary least squares; OR = odds ratio; ref = reference; w = week.
*** = p-value <0.01, ** = p-value <0.05, * = p-value <0.10; ref = reference group.
[a] Average marginal effect.

greater smoking and alcohol consumption in men than women. No multicollinearity among predictor variables was found.

The results from the two-part model and the logistic regression examining the determinants of SSB consumption are summarised in Table 3.

Results from the logistic part of the two-part model indicate that SSB consumers tend to be males ($p < 0.01$), younger ($p < 0.01$), from higher socioeconomic groups ($p < 0.01$), current or former smokers ($p < 0.01$), and often base food decisions on 'liking' and 'wanting' ($p < 0.01$). Additionally, they are more likely to have insufficient leisure-time physical activity (insufficient and willing to do more in 6 months; $p < 0.01$). SSB consumers also includes individuals with overweight ($p < 0.01$); however, being a SSB consumer is not associated with individuals who experience obesity ($p > 0.10$).

In the logistic model, the determinants influencing daily SSB consumption are largely similar to those observed in the two-part model. The logistic model further indicates that frequent SSB consumers (based on daily SSB intake) are more likely to consume alcohol regularly ($p <$

0.01), having moderate or high work-related physical activity ($p < 0.01$), and have frequent intake of unhealthy and non-home cooked foods ($p < 0.01$).

The model predicted average daily consumption of 86.3 mL/day per person (a constant of the marginal effect from the two-part model), closely aligning with the actual average of 85.2 mL. The model further shows that males consume 21.0 mL/day more than females ($p < 0.01$), and that each additional year of age decreases consumption by 1.0 mL/day ($p < 0.01$). A large increase in consumption is observed among individuals who regularly consume unhealthy foods, with an increase of 37.8 mL/day ($p < 0.01$) compared to those consuming unhealthy foods less frequently. Various unhealthy behaviours, such as smoking (14.5 mL/day, $p < 0.01$) and alcohol consumption (16.3 mL/day, $p < 0.01$), also contributed significantly to increased SSB consumption. Socioeconomic factors, including higher income levels, further influence the incremental amount of SSBs consumed, although the effect appears to plateau for the third to fifth income quartiles (16.3–18.0 mL/day, $p < 0.01$). Finally, individuals with overweight have an incremental increase in consumption of 5.4 mL/day ($p < 0.01$) compared to those with normal weight.

Those reporting fewer meals consumed per day ($p < 0.01$ in the logistic regression model) and those with a health problem are less likely to consume SSBs ($p < 0.05$ in the two-part model).

The results of the decomposition analysis suggest that various factors jointly influence SSB consumption based on socioeconomic status (Table 4). Focusing on those modifiable factors that have unfavourable implications, it was observed that factors explaining more consumption of SSBs by those of lower socioeconomic status include being current smokers, usual drinkers, making food decisions using 'taste', 'liking' or 'wanting', and engaging less in physical leisure activity, which are more prevalent in this group. On the other hand, frequent consumption of unhealthy foods, having overweight, as well as being occasional drinkers, explain the increased SSB consumption among those of higher socioeconomic status. Frequent consumption of fruits or vegetables also

Table 4
Results from the decomposition analysis of SSB consumption.

Variable	Mean daily intake (mL)		Daily consumption	
	E	C_k	E	C_k
Male **(ref: female)**	−0.267***	−0.009	−0.421***	−0.009
Age **(year)**	−0.494***	−0.015	−0.173*	−0.015
Ever-married **(ref: never married)**	−0.004	−0.033	0.055	−0.033
Education **(years)**	−0.025	0.121	−0.025	0.122
Socioeconomic quintiles **(ref: quintile 1)**				
Quintile 2	0.020***	−0.493	0.026***	−0.476
Quintile 3	0.041***	−0.124	0.059***	−0.095
Quintile 4	0.061***	0.306	0.066***	0.338
Quintile 5 (highest)	0.064***	0.768	0.063***	0.785
Work-related physical activity **(ref: light)**				
Moderate	0.023	−0.024	0.074***	−0.023
High	0.006	−0.171	0.021***	−0.176
Living in urban **(ref: non-urban)**	0.020**	0.162	0.055***	0.164
Smoking status **(ref: never)**				
Current	0.028***	−0.083	0.047***	−0.085
Ex-smoker	0.007**	0.015	0.008*	0.013
Alcohol drinking status **(ref: never/rarely)**				
Former	0.019***	−0.018	0.027***	−0.018
Occasionally	0.023***	0.055	0.018***	0.055
Usually	0.010***	−0.056	0.016***	−0.059
Unhealthy foods for 5–7 d/w **(ref: <5 d/w)**	0.042	0.070	0.072***	0.073
Vegetable for 5–7 d/w **(ref: <5 d/w)**	0.013	0.016	0.119***	0.017
Fruit for 5–7 d/w **(ref: <5 d/w)**	0.047***	0.111	0.143***	0.112
Main meal **(number per day)**	−0.486*	−0.004	−0.403***	−0.004
Non-home cooked **(ref: home-cooked)**	0.072*	0.217	0.080***	0.219
Food choice **(ref: cleanliness)**				
Taste	0.018	−0.014	−0.013	−0.013
Nutrition	−0.006	0.120	−0.023***	0.120
Price	−0.001**	−0.156	−0.010**	−0.153
Convenience	0.010***	0.010	0.014***	0.010
Liking	0.031***	−0.038	0.030***	−0.039
Wanting	0.028***	−0.061	0.007	−0.064
Food label consideration **(ref: never/unsure)**				
Seen but no impact	0.026***	0.026	0.040***	0.024
Seen and have impact	0.010***	0.110	−0.009	0.112
Leisure-time physical activity **(ref: sufficient)**				
Insufficient, willing in 1 m1	0.000	0.076	0.006	0.077
Insufficient, willing in 6 m1	0.005***	0.070	0.011*	0.073
Insufficient, no/unclear willingness	0.045	−0.064	0.104**	−0.065
Weight status **(ref: normal)**				
Underweight	0.000*	−0.029	−0.003	−0.026
Overweight	0.021***	0.007	0.010	0.007
Obese	0.003	−0.022	0.008	−0.022
Health problem **(ref: no health problem)**	−0.005	−0.053	−0.007*	−0.052

E = elasticity, the change in the outcome associated with a one-unit alteration in the explanatory variable, with a positive sign indicating an increase and a negative sign indicating a decrease in the outcome due to a positive change in the explanatory variable.
C_k = the degree of concentration of the explanatory variable across socioeconomic status was denoted as Ck. A negative Ck indicates a higher prevalence of the respective variable among lower socioeconomic individuals, while a positive Ck suggests a higher prevalence among those of higher socioeconomic status).
d = day; m = month; mL = millilitre; ref = reference; SSB = sugar-sweetened beverage; w = week.
*** = p-value <0.01, ** = p-value <0.05, * = p-value <0.10, The p-value indicates association of explanatory variable with SSB consumption obtained from the regression coefficient from the linear regression model.

explains increased SSB consumption among individuals with higher socioeconomic status.

Discussion

This study examined the factors influencing the consumption of SSBs in Thailand. The results showed that various demographic, socioeconomic, behavioural, habitual and health factors were associated with higher SSB consumption. Frequent SSB consumers were associated with having higher socioeconomic status. They also exhibited several unhealthy behaviours such as smoking, consuming unhealthy foods, being less active, and using appetitive motivations to choose foods. Furthermore, the study revealed that those of lower socioeconomic status often pair SSB consumption with smoking, regular drinking, appetitive motivations for choosing foods, and limited physical activity. Conversely, those of higher socioeconomic status combine SSB consumption with increased consumption of foods overall, regardless of whether the foods are healthy or unhealthy.

The observed daily consumption rate of 15.8 % and an average intake of 85.2 mL/day appear low compared to previous studies[9,10,36] (e.g., 25.6 %–70.0 % daily consumption, and 225 mL/day). The intake of 85.2 mL/day, which is roughly equivalent to 40 kcal (assuming 12 g of sugar per 100 mL),[57] may not significantly contribute to daily calorie intake or impact health directly. This low consumption could be attributed to the survey being conducted during the COVID-19 lockdown, which may have affected access to SSBs.[32] Additionally, other factors may contribute to this discrepancy; for instance, this study focuses on adults, while other studies include younger age groups, which typically have higher consumption rates.[10]

The findings that individuals with lower socioeconomic status had lower SSB consumption and that SSB consumption was not linked to educational attainment are inconsistent with conventional economic frameworks. These frameworks typically predict an inverse relationship between such factors and unhealthy behaviours.[24,58,59] This discrepancy can be explained by the fact that in high-income countries, SSBs are often identified as inferior goods, leading to decreased consumption with increasing income, while the opposite remains true for several low- and middle-income countries.[60] In a high-income setting, SSBs might be perceived by the wealthy as a cheap product associated with those of lower socioeconomic status. In low and middle-income countries, including Thailand, overconsumption of foods, whether healthy or unhealthy, appears to be more prevalent among individuals of higher socioeconomic status,[61] and this pattern is observed in this study. This can be attributed to factors such as greater affordability and the cultural influence that associates unhealthy foods with wealth and status, leading high-income individuals to consume more.[62]

The extensive literature discusses how certain demographic, socioeconomic and behavioural characteristics impact the consumption of SSBs either locally in Thailand[9,10,28] or internationally.[15–18,21,22,35,38–40] This study further explored the less apparent psychological aspects of food choices, revealing that some individuals might be more susceptible to instant gratification from SSBs. Those driven by appetitive motivations, such as 'liking' and 'wanting', were found to consume more SSBs. In particular, these food-related decisions are linked to brain mechanisms with addiction behaviours, from the increased dopamine.[42] While these mechanisms have been acknowledged in psychological research,[63,64] they remain underrepresented in social science studies. Integrating these insights could further illuminate another cause of SSB consumption, beyond just identifying who consumes these beverages, but also why they do so. Specifically, their decision to purchase and consume SSBs is not limited to economic conditions or self-discipline, but could be indicative at a deeper level of the possible existence of an inherent addictive susceptibility.[18] Future research may aim to understand the underlying factors, such as environment, psychosocial elements, or biology that influence these individuals' food motivations. This could lead to more effective and compassionate policies in addressing SSB consumption. In addition, the study revealed frequent SSB consumers also engaged in other unhealthy behaviours like smoking, being less physically active, and overeating. These behaviours are related with lower self-control with a higher positive time preference, where immediate rewards are prioritised over the long-term benefits such as improved health and reduced risk of chronic diseases.[24,65] Changing behaviours in these populations can therefore be challenging as relying solely on individuals' willpower may not be adequate to encourage people to discontinue their unhealthy behaviours.[66] There is evidence to suggest that the food industry is aware of this cluster of susceptibilities and exploits them by targeting vulnerable individuals often referred to as 'heavy consumers' for profit.[67]

This study indicates the potential unequal distribution of benefits from any policy to reduce consumption of SSBs in which the benefits would accrue more to people of higher socioeconomic status due to their higher consumption of SSBs. This could indicate that the regressivity of SSB taxes, which tend to disproportionately burden those of lower socioeconomic status,[68] may be less pronounced as they consume fewer SSBs. However, merely considering the level of SSB consumption is not enough when assessing the impact of SSB taxes.[31] For example, previous studies have indicated that there is an association between socioeconomic status and people's degree of price responsiveness to SSBs,[69,70] which could yield distinct policy benefits for various socioeconomic groups. It is essential to concurrently evaluate these relevant factors, especially in their health outcomes. Such evaluations are frequently conducted in modelling studies.[71]

Several policy implications can be drawn from this study. First, the findings suggest that individuals who consume SSBs frequently are also likely to engage in other unhealthy behaviours which highlights the need to address such clusters of unhealthy behaviours collectively.[72] Secondly, it is necessary for policies to address the underlying behavioural factors that contribute to SSB consumption, taking into account the complex and interconnected nature of these factors. For example, the finding that individuals displayed addiction-like behaviours towards SSBs might indicate that they might be less responsive to a price increase from a policy such as a tax on SSBs.[73] Due to habit formation, this can make it challenging for them to abruptly stop SSB consumption.[74] Therefore, it might be more sensible for a gradual shift of these consumers towards beverages with reduced sugar content. One way to facilitate this is through a dual tax mechanism: taxing high-sugar drinks more heavily while offering tax incentives for beverages with lower sugar, thereby making them more financially appealing. Lastly, it is crucial to ensure that the approach chosen addresses the unique challenges of lower socioeconomic groups. For example, given the observed high prevalence of smoking and alcohol consumption in lower socioeconomic groups, it is vital to note that these groups might already be burdened with other health-related taxes.[75] Introducing subsidies for healthy foods could offset the financial impact of an SSB tax if introduced in Thailand.

Cross-sectional data limits our ability to establish causality in the observed inverse relationship between health conditions (including NCDs) and SSB consumption. While higher SSB intake is generally expected to be positively associated with adverse health outcomes, this study suggested the opposite pattern, where individuals with health conditions reported lower SSB consumption. This may be due to reverse causality, where efforts to reduce intake after developing health conditions rather than indicating that higher consumption leads to lower reported health conditions.[10]

A strength of this study was its use of an extensive and representative dataset from the Thai population. Also, the study expands existing knowledge in Thailand on how other various factors influencing SSB consumption[9,10,28] and the decomposition analysis reveals unique patterns of SSB consumption across different socioeconomic groups, a dimension not explored in prior research.

The study has several limitations. First, the data did not differentiate between the types of SSBs, limiting the ability to capture variations in

the types of SSBs consumed across socioeconomic groups. In contrast, while the overall results suggest that higher socioeconomic groups consume more SSBs, previous research in Thailand suggested that certain types of SSBs, such as energy drinks, were consumed more among individuals of lower socioeconomic status.[10] Energy drinks might be favoured by less advantaged groups, such as those engaged in labour-intensive work, as they serve as an important source of energy, possibly consumed out of necessity rather than for pleasure. Taxing SSBs without considering the type of beverage could raise questions about the equity of such policies and their potential unintended consequences for vulnerable populations. Second, the self-reported dietary data may be prone to biases, such as social desirability bias – where individuals may report their overall dietary intake to align with perceived social norms, particularly in certain populations such as those who have excessive weight.[76] Third, the survey's reliance on past-30-day consumption may be prone to recall bias and could underestimate consumption levels. However, this time frame may be reasonable as shorter periods such as 24-h dietary recalls may not reflect usual consumption patterns.[77] Lastly, the findings in this study are specific to adult populations (aged 25 to 59) and may not be replicable in younger or older demographics.

Conclusions

In Thailand, individuals of higher socioeconomic status typically consume more SSBs. Those who frequently consume SSBs often exhibit various unhealthy behaviours, some of which are akin to addiction. These tendencies are particularly pronounced among individuals with lower socioeconomic status. This insight should be considered when formulating policies aimed at reducing SSB consumption in Thailand. Policymakers should prioritise interventions that address overall unhealthy behaviours alongside those targeting the overconsumption of SSBs.

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Competing interests

The authors declare no competing interests.

CRediT authorship contribution statement

Kittiphong Thiboonboon: Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Validation. **Richard De Abreu Lourenco:** Conceptualization, Writing – review & editing, Supervision, Validation. **Jody Church:** Writing – review & editing, Supervision, Validation. **Stephen Goodall:** Conceptualization, Writing – review & editing, Supervision, Validation.

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