FACTORS ASSOCIATED WITH SUGAR-SWEETENED BEVERAGES CONSUMPTION BEHAVIOR AMONG CHINESE ADOLESCENTS STUDENTS IN SCHOOL IN DING'AN DISTRICT, HAINAN PROVINCE

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摘要

题目: 海南省定安县中小学生含糖饮料消费行为相关因素分析

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近年来，青少年糖甜饮料（Sugar-Sweetened Beverages, SSBs）消费量的持续增加，已成为一个重大的公共卫生问题，尤其在城市化进程快速发展的地区尤为显著。了解 SSBs 的消费模式及其相关影响因素，对于制定有效的干预策略至关重要。本研究旨在（1）调查中国海南省定安县青少年的 SSBs 消费行为（2）分析与过量摄入 SSBs 相关的影响因素。

本研究采用横断面分析研究设计，通过意外抽样从定城镇三所中学抽取了 390 名 13-15 岁的学生。研究工具为结构式问卷，主要包括三个部分：个人因素、影响因素以及 SSBs 消费行为。数据分析采用描述性统计和推论性统计方法，包括卡方检验（Chi-square test）和 Fisher 精确概率法（Fisher’s exact test）。

研究结果显示，有 85.38%的学生每日从 SSBs 中摄入糖分≥25 克，属于肥胖风险增加组，仅有 14.62%的学生摄入量在正常范围内。与 SSBs 日摄入量显著相关的因素包

括：性别、年龄别体质指数（BMI）、学校内 SSBs 的可获得性、校园周边 SSBs 的可获得性、家长对饮用行为的控制以及营销媒体的接触。此外，那些曾尝试减少 SSBs 摄入的学生以及认为 SSBs 对健康有负面影响的学生，其实际糖摄入量反而更高，呈现出悖论现象。

研究结果强调了青少年 SSBs 过量摄入的高发生率，并揭示了改变行为的复杂性，表明单纯依赖知识传播的干预策略可能效果有限。因此，应当实施多层次的干预策略，特别是通过学校和家庭层面的环境及行为因素干预，以促进更健康的饮食行为。

Keywords: 含糖饮料、青少年、糖摄入量、公共卫生、中国

ABSTRACT

Title: Factors Associated with Sugar-Sweetened Beverages Consumption Behavior among Chinese Adolescents Students in Schools in Ding'an District, Hainan Province

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The increasing consumption of sugar-sweetened beverages (SSBs) among adolescents has become a major public health concern, particularly in rapidly urbanizing areas. Understanding the patterns of SSB consumption and associated factors is crucial for designing effective intervention strategies. This study aimed to (1) examine the SSB consumption behaviors among Chinese adolescents in Ding' an County, Hainan Province, and (2) identify factors associated with excessive SSB intake.

This research employed a cross-sectional analytical study design and was conducted among 390 students aged 13–15 years, selected through accidental sampling from three middle schools in Dingcheng town. A structured questionnaire was used as the research instrument and consisted of three sections: personal factors, influencing

factors, and SSB consumption behaviors. Data were analyzed using descriptive statistics and inferential statistics, including the chi-square test and Fisher's exact test.

The results revealed that 85.38% of students consumed ≥25 grams of sugar per day from sugar-sweetened beverages, categorizing them as being in the increased risk of obesity group, while only 14.62% fell within the normal range. Factors found to be significantly associated with daily sugar intake from SSBs included gender, BMI, access to sugar-sweetened beverages at school, access to SSBs in the surrounding areas, parental control over consumption, and exposure to marketing media. Moreover, students who reported having previously attempted to reduce their SSB consumption, as well as those who believed that SSBs have a negative impact on health, were paradoxically more likely to have higher sugar intake.

These findings highlighted the high prevalence of excessive SSB consumption among adolescents and indicated that strategies to reduce SSB intake should move beyond knowledge-based approaches. Instead, interventions should emphasize modifying environmental and behavioral determinants, particularly through school-based and family-oriented strategies to promote healthy consumption.

Keywords: sugar-sweetened beverages, adolescents, sugar intake, public health, China

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CHAPTER I

INTRODUCTION

Background and rationale

In the United States, the consumption of sugar-sweetened beverages (SSBs) remains notably high, with approximately 63% of adults and 80% of children and adolescents consuming SSBs at least once daily (Singh et al., 2015; Popkin & Hawkes, 2016). In Canada, SSB intake is also a significant public health concern, with rising consumption observed among both adolescents and adults (de Lorgeril et al., 2020). In Europe, SSB consumption levels vary widely across countries. Notably, Mexico has one of the highest per-capita SSBs consumption rates globally, which contributes substantially to the country's obesity and type 2 diabetes epidemics (Colchero et al., 2017; Perelli et al., 2023). In Brazil, consumption of SSBs is increasing among both adolescents and adults, raising concerns about associated health risks (Global Burden of Disease Study, 2017). Similarly, in India, the past decade has seen a rapid surge in SSB consumption, prompting heightened public health concerns regarding the burden of non-communicable diseases (World Health Organization, 2015). In China, SSB consumption has also risen rapidly, especially among adolescents and young adults. Empirical studies have shown a strong correlation between high SSB consumption and increased risk of obesity and type 2 diabetes (Debras et al., 2020; Alsulami et al., 2023).

In the U.S., a higher frequency of monthly SSB consumption among college students has been positively associated with increased likelihood of delinquent behaviors. Likewise, in countries such as Australia, Brazil, Canada, and Italy, a higher weekly

frequency of sugary drink consumption among children aged 9–15 years is significantly associated with elevated BMI and obesity risk (Liu & Zhou, 2022; Chen et al., 2020). Given that sugary drinks are a key source of added sugars—with high energy density, low satiety, and high addictive potential—long-term excessive intake presents significant health risks and has garnered widespread public health attention. Studies indicate that added sugars, particularly sucrose, fructose, and high-fructose corn syrup, affect the dopaminergic reward pathways in the brain, inducing hedonic effects (Malik & Hu, 2022). Frequent consumption of sugary beverages has been linked to adverse physical and mental health outcomes among children and adolescents, including increased risk of emotional distress, ADHD, conduct disorders, overweight, and obesity, as well as dental caries, tooth erosion, and non-specific diarrhea (Chen et al., 2020).

SSBs are a major contributor to the rising incidence of non-communicable diseases (NCDs), such as obesity, type 2 diabetes, cardiovascular disease, and certain types of cancer. Regular SSB intake is strongly associated with negative health outcomes and represents a pressing global public health challenge (Haque et al., 2020; Popkin & Hawkes, 2016). Sugary drinks are a primary source of added sugar and empty calories, resulting in excess energy intake and weight gain. Consuming more than one SSB per day is significantly associated with increased BMI and long-term obesity risk (Haque et al., 2020; Global Burden of Disease Study, 2017). The global rise in obesity is closely linked to the increased consumption of SSBs, particularly in low- and middle-income countries (LMICs), where dietary transitions are occurring rapidly (Global Burden of Disease Study, 2017). The high sugar content in SSBs leads to rapid spikes in blood glucose and insulin levels, which over time contribute to insulin resistance—a precursor to type 2 diabetes. Regular SSB intake is associated with a substantially increased risk of developing type 2

diabetes (Haque et al., 2020; Popkin & Hawkes, 2016). Meta-analyses show that individuals who consume one to two SSBs per day have a 26% higher risk of developing type 2 diabetes compared to non-regular consumers (Chazelas et al., 2019; Global Burden of Disease Study, 2017). Moreover, long-term SSB consumption can raise blood pressure and negatively alter lipid profiles by increasing triglycerides and reducing high-density lipoprotein (HDL) cholesterol levels. These effects heighten the risk of cardiovascular diseases, including coronary artery disease and stroke (Popkin & Hawkes, 2016; Global Burden of Disease Study, 2017). People who consume more than one sugary drink per day are at a significantly higher risk of developing heart disease (Haque et al., 2020; Chazelas et al., 2019).

With the progression of economic development and the steady rise in residents' income levels, beverage consumption in China has continued to increase. To maintain competitiveness, beverage companies have enhanced product taste and diversified offerings to move away from homogeneous products. While modern beverages aim to satisfy consumer preferences, they have also started to emphasize nutrition and health, becoming particularly appealing to younger consumers (Shi & Li, 2020). According to the national standard GB 10789 General Standard for Beverages, beverages in China are classified into 11 categories: carbonated beverages (soda), fruit and vegetable juice beverages, protein beverages, drinking water, tea beverages, coffee beverages, plant-based beverages, flavored beverages, special-purpose beverages, solid beverages, and others. The Scientific Research Report on Dietary Guidelines for Chinese Residents (2021) reports that sugar consumption in China is increasing annually, with SSBs and dairy products accounting for 42.1% of total sugar intake among urban residents (Chinese Nutrition Society, 2022).

China has established sugar intake guidelines specifically for children and adolescents, particularly concerning sugars derived from SSBs. Studies indicate that excessive sugar intake significantly increases the risk of obesity and other health problems (Li et al., 2022; Zhang et al., 2017). Multiple studies recommend that daily sugar intake for children and adolescents in China should not exceed 25 grams, as consumption above this threshold is closely associated with a heightened risk of obesity (Li et al., 2022; Zhang et al., 2017). Empirical data also reveal that children and adolescents in China continue to consume high levels of sugar, especially from SSBs, with average daily consumption ranging between 210–710 milliliters depending on demographic and geographic factors (Wang et al., 2021; Yang et al., 2022; Li et al., 2022). Therefore, reducing sugar consumption among this population is critical for promoting long-term health.

Domestic studies in China have further revealed that higher frequency of SSB consumption among primary and secondary school students is positively associated with an increased risk of central obesity (Xu et al., 2020). Among preschool children, frequent SSB intake has been linked to emotional and behavioral issues, while among high school students, it correlates with a higher incidence of risky behaviors such as smoking and alcohol use (Wang et al., 2021; Zhou et al., 2022). International research has also highlighted regional differences in consumer preferences for various types of sugary beverages. For instance, in North America, sports and energy drinks represent the highest share of SSB sales, whereas in the Asia-Pacific region, flavored beverages constitute a larger proportion. Overall, findings suggest that adolescents who regularly consume sugary drinks face greater risks of obesity, behavioral disorders, and engagement in other risk-related behaviors.

Despite the growing body of evidence globally and domestically, there is currently no study specifically examining the sugar-sweetened beverage consumption behaviors or the influencing factors among Chinese adolescents in Ding'an County, Hainan Province. This gap in the literature has led the researcher to investigate the current situation and associated factors of SSB consumption within this specific population. The results are expected to support the development of effective, context-specific prevention and intervention strategies.

Objective

1. To examine the sugar-sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province.
2. To examine the factors associated with the sugar-sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province.

Research question

1. What are the sugar-sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province?
2. What factors are associated with the sugar-sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province?

Hypothesis

1. Chinese adolescent students in Ding'an District, Hainan Province have a high level of sugar-sweetened beverage consumption.

2. Gender, BMI and access to sugar-sweetened beverages, and parental influence are significantly associated with sugar-sweetened beverage consumption behaviors among Chinese adolescent students.

Operational definition

1. Medical history or chronic conditions: The record of past and present health conditions, diseases, surgeries, and treatments an individual has received.

2. Access to sugar sweetened beverages: The availability and ease with which individuals can obtain SSBs in various settings.

3. Parental control over consumption: The extent to which parents regulate and monitor their children's intake of SSBs.

4. Access channels: The means through which adolescents obtain SSBs, such as vending machines, stores, or home supplies.

5. Reading nutrition labels to assess sugar content before consumption: The practice of checking the nutritional information on food and beverage packaging to assess sugar content before consumption.

6. BMI: Chinese WGOC percentile standard (WS/T 586-2018). To reflect local growth patterns in 13.0–15.0 year-olds, we also applied the sex- and age-specific percentiles recommended by the Working Group on Obesity in China. Underweight/ normal/ overweight/

obesity were defined as below the 5th, between the 5th and 85th, between the 85th and 95th, and at or above the 95th percentile of the BMI distribution, respectively.

- Underweight (<P5)
- Normal weight (P5-P85)
- Overweight (P85-P95)
- Obesity (>=P95)

7. Sugar sweetened beverage behavior (SSBs Behavior): The patterns and habits related to the consumption of beverages containing added sugars. The recommended daily sugar intake for children and adolescents in China is no more than 25 grams. Exceeding this amount is associated with an increased risk of obesity (Li et al., 2022; Zhang et al., 2017).

8. Adolescents students: Refers to male and female students aged 13-15 yearold residing in Ding Cheng Township, Ding'an District, Hainan Province.

Expected Benefits and applications

Expected Benefits

1. To provide empirical data on the consumption behaviors of sugar-sweetened beverages (SSBs) among Chinese adolescent students in Ding'an District, Hainan Province, which can be used as a baseline for future health promotion programs and educational interventions.

2. To identify key associated factors (such as gender, BMI, access to SSBs, and parental influence) related to SSBs consumption behaviors, which can guide the design of targeted health education campaigns aimed at reducing sugar intake among adolescents.

3. To support school administrators, public health officials, and policy makers in developing evidence-based strategies and school-based interventions to reduce the consumption of sugar-sweetened beverages and prevent related health risks such as obesity and metabolic disorders.

4. To promote awareness among parents and caregivers regarding their roles in shaping children's beverage choices and promoting healthier drinking habits within the family and home environment.

5. To serve as a reference for future research focusing on adolescent nutrition, consumption behaviors, and preventive health strategies in other regions of China or similar socio-cultural contexts.

Applications

1. School based interventions: Implementing programs in schools that focus on reducing the availability of SSBs and increasing the availability of healthier alternatives can directly influence student consumption behaviors.

2. Community health campaigns: Communitywide health campaigns that educate about the dangers of SSBs and promote healthier alternatives can be developed based on research findings.

3. Healthcare practices: Healthcare providers can use the research to better understand the dietary habits of adolescents and provide tailored advice during medical consultations.

4. Nutritional labeling initiatives: Enhancing nutritional labeling to make it easier for consumers, especially adolescents, to understand the sugar content in beverages, potentially influencing their purchasing decisions.

CHAPTER II

LITERATURE REVIEW

In the research on Factors influencing the consumption behavior of sugar-sweetened beverages among Chinese adolescent students at school in Ding'an District, Hainan Province, the researcher reviewed various documents, textbooks, books, articles, research papers, reports from different agencies, and related theoretical concepts as the foundation for developing a conceptual framework that guides the key issues in the study. The conclusions based on the following topics are as follows:

1. Chronic diseases
2. Sugar consumption
3. Risks associated with high sugar intake
4. Sugar consumption, guidelines, types, and high sugar foods and beverages
5. Beverage sales and sugar content in beverages in China
6. Consumption of sugar sweetened beverages abroad
7. Availability of sugar sweetened beverages
8. Tax policies on sugar sweetened beverages
9. Measurement of behavior of sugar sweetened beverages
10. Medical history or chronic conditions
11. Related research
12. Conceptual framework

Chronic Diseases

Incidence of chronic diseases

Chronic diseases, also known as non-communicable chronic diseases (NCDs), include cardiovascular diseases, cancer, respiratory diseases, diabetes, oral diseases, as well as kidney, bone, and neurological disorders. Chronic diseases have long courses and limited treatment efficacy, imposing heavy physical, mental, and economic burdens on patients and their families, significantly affecting their quality of life (Yang & Ding, 2020). With population aging and lifestyle changes, the burden of chronic diseases is gradually increasing worldwide. The rising degree of population aging and profound changes in residents' lifestyles have led to an increasing incidence and a trend of younger onset of chronic diseases. Over 190 million elderly people suffer from chronic diseases, with a hypertension prevalence rate of 25% and a dyslipidemia rate of 40% among residents aged 18 and above (Yang & Ding, 2020; Gordeev & Galushko, 2022). The overweight and obesity rate among children and adolescents aged 6 to 17 is 19.0%, highlighting the growing issue of obesity in children and adolescents (Kitamura et al., 2019). Chronic disease deaths account for more than 80% of total resident deaths, and the disease burden caused by chronic diseases exceeds 70% of the total disease burden (Sarnak et al., 2019).

The risk of dying from NCDs is exacerbated by tobacco use, lack of physical activity, harmful alcohol use, unhealthy diets, and air pollution. Detection, screening, and treatment of NCDs, along with providing palliative care, are key components in addressing these diseases.

In 2016, the WHO issued the “Fiscal Policies for Diet and Prevention of Non-communicable Diseases,” recommending the taxation of sugar-sweetened beverages (SSBs) to reduce their consumption, thereby helping to lower the risks of tooth decay, obesity, and type 2 diabetes, urging countries and regions worldwide to impose taxes on SSBs (Wadhwa et al., 2020).

Causes of chronic diseases

1. Dietary factors

The Health consumption index of Chinese residents measures the impact of consumption habits on health across different regions, including the consumption of vegetables, fruits, meat, dairy, tobacco, and alcohol, as well as physical activity levels. These data indicate that unreasonable diets (e.g., high salt, high sugar, high fat diets) and lack of exercise are major causes of chronic diseases. The World Health Organization's research also points out that personal lifestyle factors account for 60% of health impacts (Yang & Ding, 2020) .

2. Unhealthy lifestyles

Unhealthy lifestyles, such as poor diet, insufficient physical activity, tobacco use, and harmful alcohol use, are major risk factors for chronic diseases (Bennasar-Veny et al., 2020). For example, smoking and excessive alcohol consumption not only directly increase the risk of chronic diseases but also may trigger other serious health problems (Mathur et al., 2023). Additionally, the fast pace of modern life has led many to adopt more sedentary lifestyles, which not only affect cardiovascular health but also indirectly impact kidney health (Caprara, 2021). Therefore, changing unhealthy consumption behaviors, such as increasing vegetable and fruit intake, reducing meat

and fat consumption, and maintaining adequate physical activity, is crucial for preventing and controlling chronic diseases (Teesson et al., 2020).

3. Consumption behaviors

The relationship between the causes of chronic diseases and consumption behaviors of residents can be analyzed from multiple perspectives. Firstly, there is a close connection between the causes of chronic diseases and the medical consumption behaviors of residents. Chronic diseases such as cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes significantly affect the consumption behaviors of middle-aged and elderly families. These diseases not only reduce higher level consumption in families but also lead to significant reductions in daily living expenses in low income families (Nascimento de Almeida et al., 2020) . Moreover, without sufficient risk sharing mechanisms, the consumption capacity of families with chronic disease patients will be severely affected.

From the perspective of medical consumption behavior, the causes of chronic diseases are closely related to the medical choices and expenditures of residents. Research shows that resident categories, education levels, disease severity, and regional distribution significantly influence whether urban and rural residents seek medical treatment and their medical expenses (Ng et al., 2019) .This indicates that the causes of chronic diseases not only directly affect residents' medical consumption behaviors but also indirectly influence their medical consumption through their impact on residents' education levels and economic status.

In summary, there is a complex interplay between the causes of chronic diseases and residents' medical consumption behaviors. On one hand, the causes of chronic diseases directly affect residents' medical consumption behaviors; on the other

hand, the causes also indirectly influence medical consumption behaviors by affecting residents' lifestyles. Therefore, to effectively control the incidence of chronic diseases and reduce the burden of medical consumption, multiple measures are needed, including raising health awareness among residents, improving lifestyles, and strengthening disease prevention and control.

Sugar Consumption

Global consumption trends of sugar sweetened beverages

the past few decades, global consumption of SSBs has continuously risen, along with the increasing risks of obesity and diabetes. According to the 2016 Global Burden of Disease (GBD) study by The Lancet, the "total exposure" to SSBs by 40% between 1990 and 2016 (Global Burden of Disease Study, 2017)

Sugar consumption in China

China ranks third in global sugar consumption, following India and the European Union. In 2019, China's sugar consumption was 15.8 million tons, accounting for 9.04% of global consumption. High sugar intake is a major risk factor for obesity and high incidence of diabetes. Drinking 400ml of SSBs daily doubles the risk of diabetes; drinking 1000ml daily increases the risk nearly tenfold (Wang & Li, 2021).

Risks Associated with High Sugar Intake

Obesity and type 2 diabetes

Sugar sweetened beverages (SSBs) are a major source of added sugars in the diet. Habitual consumption of SSBs is associated with weight gain and higher risks of type 2 diabetes, cardiovascular diseases, and certain cancers. Each additional serving of SSBs per day is associated with an annual weight gain of 0.12 to 0.85 kilograms in adults (Guaresti, 2024). Each additional 355ml serving of SSBs per day increases the risk of metabolic syndrome by 14%, obesity by 12%, and type 2 diabetes by 27% (Silva et al., 2024).

Cardiovascular diseases

SSB intake is associated with increased risks of cardiovascular diseases. Each additional 250ml serving of SSBs per day is associated with a 17% increased risk of coronary heart disease and a 7% increased risk of stroke (Pacheco et al., 2023). SSB intake is also associated with an increased risk of gout. Each additional 355ml serving of SSBs per day increases the risk of hypertension by 11%. SSB intake is related to increased blood pressure and dyslipidemia, with each additional serving per day associated with an 8% to 9% increased risk of cardiovascular disease and a 15% increased risk of coronary heart disease (Li et al., 2023). SSBs have a high glycemic index and high energy content, leading to high glycemic loads after consumption, rapidly raising blood glucose and insulin levels, altering metabolism, increasing hunger, and weight gain.

Non-alcoholic fatty liver disease

Each additional serving of SSBs per day is associated with a 39% increased risk of non-alcoholic fatty liver disease (Alcaraz et al., 2023). This may be due to the high energy content of sugar, which can affect metabolism, induce liver steatosis, and increase serum concentrations of liver function biomarkers such as alanine aminotransferase.

Sugar Consumption, Guidelines, Types, and High Sugar Foods and Beverages

Dietary guidelines for sugar

According to the 2020-2025 Dietary Guidelines for Americans, adults should limit their intake of added sugars, recommending that daily added sugar intake should not exceed 10% of total energy (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2020). Additionally, studies indicate that excessive intake of added sugars increases the risk of obesity and type 2 diabetes, making it crucial to control sugar intake.

Types of sugar

Sugars can be categorized into monosaccharides, disaccharides, polysaccharides, and complex sugars: Monosaccharides: Such as glucose, fructose, and galactose, which are directly absorbed by the body. Disaccharides: Such as sucrose (composed of glucose and fructose), maltose, etc. Polysaccharides: Such as starch and cellulose, which need to be broken down into monosaccharides before absorption. Complex sugars: Such as oligosaccharides and polysaccharides, commonly found in plant-based foods (Stanhope, 2016)

High sugar foods

Many everyday foods and beverages contain high amounts of sugar, including:

Beverages: Such as regular cola (12 ounces containing 39 grams of carbohydrates), certain drinks (12 ounces containing 38 grams of carbohydrates), etc .(Bleich & Vercammen, 2018).

Desserts: Such as cakes, candies, dried fruits, etc.

Snacks: Such as hard candies, sweetened cereals, etc.

Fruits: Certain fruits such as lychees, mangoes, durians, etc., have high sugar content.

Types of beverages

Beverages come in a wide variety, and they can be classified based on different criteria: Carbonated drinks: Such as cola, sprite, etc. Juices and vegetable juices: Such as orange juice, apple juice, etc. Protein drinks: Such as protein shakes, etc. Packaged drinking water: Such as bottled water. Tea and coffee drinks: Such as green tea, black tea, latte, etc. Plant-based drinks: Such as coconut water, soy milk, etc.

Flavoured drinks: Such as sugar-sweetened juice drinks, sports and energy drinks, etc.

Beverage Sales and Sugar Content in Beverages in China

Market size and consumption trends

In recent years, China's beverage market has experienced significant growth, surpassing 1 trillion yuan in 2020 and reaching 1.2478 trillion yuan in 2022. This growth is driven by increasing consumer demand for various beverage categories, including

packaged drinking water, carbonated drinks, dairy products, and sparkling water(British Chamber of Commerce in China, 2023).

Consumer preferences and purchasing behaviors

Carbonated beverage production in China peaked at 18.107 million tons in 2014. Although production declined afterward, it rebounded in 2021, surpassing the 2014 levels due to the rising demand for beverages that align with trends such as "youthful, healthy, and aesthetic" (Daxue Consulting, 2022). Regarding consumer preferences and purchasing behaviors, Chinese consumers typically purchase carbonated beverages around 12 times per week, spending an average of 50-100 yuan monthly on these drinks. There is a notable preference for beverages in cans and plastic bottles, especially low-sugar and sugar-free options (Xinhuanet, 2022).

Health impacts and policies

Health impacts of high-sugar beverages are significant, with 46,000 deaths in 2019 attributed to their consumption, a 95% increase from 30 years ago. High sugar intake is a major contributor to obesity and diabetes, with China ranking third globally in sugar consumption at 15.8 million tons in 2019(Daxue Consulting, 2022).

Sugar free beverage market

The sugar-free beverage market has shown substantial growth, increasing from 3.2 billion yuan in 2016 to 14.3 billion yuan in 2021, and it is projected to reach 30.1 billion yuan by 2026 (Daxue Consulting, 2022) The market share of sugar-free beverages is expected to grow from about 1% in 2016 to over 6% by 2026.

Consumption of Sugar Sweetened Beverages Abroad

Global market trends

In 2020, the global beverage industry experienced a brief decline in investment and financing activities, but with the recovery of the global economy, the industry is showing positive growth trends. The WHO reports that taxing s SSBs can reduce consumption and decrease obesity, type 2 diabetes, and tooth decay (World Health Organization, 2016).

Health impacts

Excessive sugar intake leads to high rates of obesity, diabetes, heart disease, and liver disease globally, indirectly causing approximately 35 million deaths annually. In 2019, there were 463 million diabetes patients worldwide, and the number is expected to rise to 700 million by 2045(World Health Organization, 2016).

Policies and actions

The WHO suggests that if a tax on SSBs increases retail prices by at least 20%, consumption of these products would correspondingly decrease. Countries like Mexico, Hungary, the Philippines, the United Kingdom, and South Africa have implemented fiscal measures to tax SSBs (Zhu, 2024) .

Consumer preferences

Consumers' preference for SSBs is gradually decreasing, shifting towards healthier options like sugar free beverages.

Both China and other countries face health challenges and market changes related to the consumption of SSBs. While Chinese consumers' demand for carbonated drinks and sparkling water remains strong, increasing health awareness is driving rapid

growth in the sugar free beverage market. Globally, the health impacts of SSBs have garnered widespread attention, with governments implementing measures such as taxation to reduce consumption. In the future, health conscious and sugar free beverage products are expected to continue leading market trends.

Availability of Sugar Sweetened Beverages

Sugar sweetened beverages (SSBs)

Sugar sweetened beverages (SSBs) are drinks that contain any form of added sugars, such as sucrose, high fructose corn syrup, fruit juice concentrates, and starch sugars. Common SSBs include soda, sweetened fruit juices, sports drinks, energy drinks, sweetened milk, and sweetened tea/coffee.

Reasons for wide distribution in convenience stores and supermarkets.

High demand: SSBs are popular among consumers for their sweet taste and immediate energy boost, leading to high market demand (Cartwright et al., 2023).

1. High profit margins: SSBs generally have high profit margins. For retailers, selling SSBs can bring substantial economic benefits.

Brand promotion: Beverage companies often engage in extensive advertising and promotional activities to boost brand awareness and product sales, making retailers willing to offer these products (Bélanger-Gravel et al., 2022).

2. Convenience: SSB packaging is easy to carry and store, allowing consumers to purchase and consume them anytime, anywhere, increasing sales convenience(Phulkerd et al., 2022).

3. Diverse choices: Supermarkets and convenience stores offer a wide variety of brands and flavours of SSBs, catering to different consumer preferences and enhancing customer satisfaction (Cartwright et al., 2023).

4. SSBs' sweet taste and flavour are often more appealing to consumers, especially in hot summer months when chilled SSBs can quickly quench thirst and provide a cooling effect. Most consumers still prioritize taste when choosing beverages. In suitable price ranges and with relatively low health impacts, social occasions also drive consumer choices in beverages. 68% of consumers spend up to 50 yuan per week on beverages, with more than 7% spending over 100 yuan weekly(Zhou et al., 2022) .

Social and cultural factors

Social Lubricant: SSBs are often used in gatherings, social events, and family meals, serving as a bridge for communication and bringing people closer. For instance, during friends' gatherings, beverages can promote interaction and add to the atmosphere (Phulkerd et al., 2022) .

Cultural Customs: In some cultures, SSBs are part of celebrations. For example, at weddings, festive celebrations, and birthday parties, SSBs are often essential, symbolizing joy and good fortune(Cartwright et al., 2023).

Brand Identity: Some SSB brands have become cultural symbols, representing a lifestyle or attitude. People express their identification with a certain culture or brand by consuming these beverages(Bélanger-Gravel et al., 2022).

Emotional Connection: SSBs can evoke childhood memories or happy moments from specific occasions, strengthening emotional ties. For example, many people have deep emotional memories of certain beverages and recall happy times when drinking them.

Lack of health awareness

"Some 'sugar free' drinks do not contain sucrose but may contain fructose, excessive intake of which may induce hyperuricemia, increasing the risk of gout, urinary tract stones, and kidney stones (Cartwright et al., 2023). A series of health risks associated with excessive intake of SSBs include: "Firstly, sugar is a major source of obesity, and the large amount of sugar in beverages can lead to severe excess of calories and sugar in the body. If not consumed, it will increase weight and cause obesity. Excessive sugar intake may also cause metabolic disorders, raising levels of blood lipids, cholesterol, and low-density lipoproteins, leading to atherosclerosis and other cardiovascular diseases(Bélanger-Gravel et al., 2022).

Simultaneously, common carbonated drinks, milk tea, and other beverages can lead to the formation of dental caries, increased tooth sensitivity, surface erosion symptoms, and tooth surface pigmentation associated with beverage colouring. Thus, it is advisable to consume beverages in moderation and choose healthier options, with plain water being the best choice. Many consumers may not be fully aware of the potential health hazards of SSBs, and this lack of health awareness keeps SSB consumption high.

Lack of alternatives

Despite the availability of some healthy alternatives like sugar free beverages, tea, and water, these alternatives may not be as readily available or popular as SSBs in some areas. Consumers prefer "flavoured" beverages and may opt for milk tea, coffee, and carbonated drinks during work or school hours, avoiding plain water whenever possible.

Packaging and portability

SSBs are typically sold in portable bottles or cans, for instance: certain tea brands offer online orders with offline pickups for milk tea, and vending machines allow consumers to choose beverages through mobile payments. This convenience promotes the purchase and consumption of SSBs by consumers on the go. This portability also enhances consumer appeal (Bélanger-Gravel et al., 2022)

Availability in schools and workplaces

In some schools and workplaces, SSBs may be available through vending machines or cafeterias, making it easier for students and employees to access these beverages. For example, students often look forward to buying iced carbonated drinks to quench their thirst after physical education classes, especially in hot weather (Phulkerd et al., 2022)

Tax Policies on Sugar Sweetened Beverages

Increasing taxes on SSBs is a favourable policy measure to limit SSB intake, promote product transformation among beverage manufacturers, and reduce sugar content in beverages. Countries that tax based on beverage volume include the United States, Mexico, Belgium, Brunei, Norway, and the Philippines; countries that implement tiered taxes based on sugar content include the United Kingdom, Chile, France, Ireland, Portugal, and Spain; and countries that tax based on absolute sugar content include South Africa, Sri Lanka, and Mauritius (Shen et al., 2023) . Health Hazards of Sugar Sweetened Beverages and Control Strategies. Research indicates that SSB intake increases the risk of chronic diseases such as diabetes, cardiovascular

diseases, gout, and cancer, as well as the risk of premature death, increasing the overall disease burden. Due to the health hazards of excessive SSB intake, many countries have implemented measures to control their consumption, such as SSB taxation, restricting SSB marketing and promotion, using Front-of-package (FOP) labeling on SSBs, and reducing the availability of SSBs in schools (Du et al., 2018).

Measurement of Behavior of Sugar Sweetened Beverages

Measurement of behavior related to SSBs (SSBs) typically involves several key aspects:

1. Consumption Frequency: This refers to how often individuals consume SSBs, which can be measured on a daily, weekly, or monthly basis (Malik, 2019) .

2. Quantity Consumed: The amount of SSBs consumed per occasion or over a specific period, including serving sizes or total volume consumed (Bleich et al., 2020).

3. Type of SSBs: Identifying the specific types of beverages consumed, such as sodas, fruit drinks, energy drinks, or sweetened teas (Vargas-Garcia et al., 2017).

4. Context of Consumption: Understanding the situations in which SSBs are consumed, such as during meals, as snacks, at social events, or while engaging in specific activities (Rosi et al., 2018).

5. Purchasing Behavior: Examining where and how individuals acquire SSBs, including purchasing locations (e.g., grocery stores, vending machines, restaurants) and frequency of purchase (Zhen et al., 2020)

6. Awareness and Attitudes: Assessing knowledge about the health effects of SSBs and attitudes toward their consumption, including perceptions of health risks or benefits (Park et al., 2018).

7. Behavioral Influences: Factors that influence SSB consumption, such as advertising, peer influence, cultural norms, and availability (Smith et al., 2019) .

8. Substitution Behavior: Whether individuals substitute SSBs with other beverages (e.g., water, diet drinks) and the reasons for these choices (Bleich et al., 2020)

These measurements can be collected through various methods, including surveys, food diaries, observation, and sales data analysis (Malik, 2019; Bleich et al., 2020; Rosi et al., 2018).

Here are some examples of methods used to measure behaviors related to SSBs (SSBs):

1. Surveys and Questionnaires: These tools can include questions on the frequency, quantity, and types of SSBs consumed. They may also assess attitudes, knowledge, and perceived influences on SSB consumption. For instance, a question might ask, "How many times per week do you consume soda or other SSBs? (González-Muniesa et al., 2020).

2. Food Diaries or Journals: Participants document their daily intake of foods and beverages, noting the types and amounts of SSBs consumed. This method provides detailed consumption patterns and can be used to estimate daily caloric intake from SSBs (Vieux et al., 2021).

3. 24-Hour Dietary Recalls: This method involves asking participants to recall all the foods and beverages they consumed in the past 24 hours. It is commonly used in nutrition research and can be conducted through interviews or online platforms (Guthrie et al., 2018)

4. Observational Studies: Researchers observe and record SSB consumption in specific settings, such as schools, workplaces, or public spaces. This method helps understand the context of consumption and can identify environmental factors influencing behaviour (Khan & Smith, 2019).

5. Sales Data Analysis: This involves analyzing data from grocery stores, vending machines, or restaurants to determine the volume and frequency of SSB purchases. It provides objective data on consumption trends and can help assess the impact of interventions or policy changes (Ng et al., 2020)..

9.2.1 Focus Groups and Interviews: These qualitative methods involve discussions with participants to explore their attitudes, beliefs, and motivations regarding SSB consumption. They offer deeper insights into the reasons behind certain behaviors and preferences (Linares et al., 2020).

6. Ecological Momentary Assessment (EMA): This approach collects real-time data from participants using mobile devices. Participants report their SSB consumption and contextual factors (e.g., mood, location) at multiple points throughout the day (Leech et al., 2018).

6. Biomarker Analysis: Although less common, some studies measure biomarkers like blood glucose or insulin levels to assess the physiological impact of SSB consumption (Stookey et al., 2018).

Each method has its strengths and limitations. The choice of method depends on the research question, the population being studied, and available resources. Often, a combination of methods is used to obtain a comprehensive understanding of SSB consumption behaviors.

How to designing surveys and questionnaires for SSB consumption

1. Objective Definition

1. 1 Purpose: Clearly define the objectives, such as measuring the frequency, quantity, and types of SSBs consumed, and understanding related attitudes. This clarity helps in designing specific and relevant questions (Lobstein et al., 2019) .

1. 2 Target Population: Identify the demographic characteristics of participants, including age, gender, and socio-economic status. This helps tailor the questions to the specific audience (Drewnowski et al., 2020) .

2. Question Types

2.1 Frequency Questions: Ask about how often participants consume SSBs (e.g., "How many times per week do you drink soda?") (Park et al., 2018)

2.2 Quantity Questions: Inquire about the amount consumed per occasion or over a specific period (e.g., "How many ounces of soda do you typically drink per serving?") (Drewnowski et al., 2020) .

2.3 Type Questions: Include options for different types of SSBs (e.g., sodas, fruit drinks, energy drinks) to understand specific preferences (Ng et al., 2020).

2.4 Attitudinal Questions: Explore participants' attitudes towards SSBs, such as perceptions of taste, convenience, and healthiness (e.g., "Do you believe consuming SSBs is harmful to your health?") (Smith et al., 2019).

2.5 Knowledge Questions: Assess knowledge about the health impacts of SSBs (e.g., "Are you aware that SSBs can contribute to weight gain?") (González-Muniesa et al., 2020).

2.6 Influence Questions: Investigate factors influencing consumption, such as advertising, peer pressure, or availability (e.g., "How often do you purchase SSBs because of advertisements?") (Ng et al., 2020).

3. Question Format

3.1 Closed-Ended Questions: Use multiple-choice or Likert scale questions for quantifiable data (e.g., "On a scale of 1 to 5, how often do you consume SSBs?") (Stookey et al., 2018) .

3.2 Open-Ended Questions: Allow for qualitative insights into consumption habits and attitudes (e.g., "What influences your choice to drink SSBs?") (Lobstein et al., 2019) .

3.3 Survey Design Considerations

3.3.1 Clarity and Simplicity: Ensure that questions are clear, straightforward, and free from technical jargon, making them accessible to all respondents(Lobstein et al., 2019).

3.3.2 Pilot Testing: Conduct a pilot test to refine questions and ensure they are understood as intended(Smith et al., 2019).

3.3.3 Anonymity and Confidentiality: Assure participants of the anonymity and confidentiality of their responses to encourage honesty and accurate reporting (Drewnowski et al., 2020).

4. Data Collection

4.1 Administration: Surveys can be administered in person, online, or via mail, depending on the target population (Ng et al., 2020).

4.2 Timing: Consider the timing of survey distribution to maximize response rates, such as avoiding holiday seasons(Park et al., 2018) .

5. Data Analysis

5.1 Quantitative Analysis: Use statistical methods to analyze closed-ended responses, identifying patterns and correlations in SSB consumption (Khan & Smith, 2019).

5.2 Qualitative Analysis: Analyze open-ended responses for themes and insights into attitudes and influences, providing a deeper understanding of consumption behaviors (Drewnowski et al., 2020).

5. Ethical Considerations

5.1 Informed Consent: Ensure that participants understand the survey's purpose and consent to participate, with clear information on how the data will be used (Lobstein et al., 2019).

5.2 Data Protection: Safeguard collected data according to ethical standards and regulations, ensuring confidentiality and security(González-Muniesa et al., 2020).

Medical history or chronic conditions

Sugary drinks and metabolic diseases

High intake of sugary drinks is closely associated with metabolic diseases such as metabolic syndrome and type 2 diabetes. High sugar intake from sugary drinks can significantly increase the incidence of insulin resistance, which interferes with the body's ability to regulate blood sugar, leading to blood sugar fluctuations and decreased insulin sensitivity. Long-term consumption of sugary drinks can lead to weight gain, especially the accumulation of visceral fat, thereby increasing the risk of diabetes and obesity (Malik & Hu, 2022) Characteristics of metabolic syndrome include obesity, elevated blood pressure, dyslipidemia, and hyperglycemia, and the consumption of sugar-sweetened beverages is directly related to these risk factors. Reducing your intake of sugary drinks can help improve insulin sensitivity and reduce your risk of metabolic syndrome.

Sugary drinks and cardiovascular health

Long-term intake of sugar-sweetened beverages has significant effects on the cardiovascular system, especially by increasing blood pressure and increasing the incidence of dyslipidemia, which increases the risk of cardiovascular disease. Studies have shown that sugary drinks can increase the incidence of heart disease and stroke by inducing chronic inflammation and insulin resistance, promoting cardiovascular problems such as atherosclerosis and hypertension (Malik & Hu, 2022) . Increased intake of sugary drinks is also associated with abnormal increases in blood lipid levels, particularly low-density lipoprotein (LDL) levels, and these changes can further worsen heart health.

Sugary drinks and liver disease

Long-term consumption of sugary drinks is significantly associated with the risk of non-alcoholic fatty liver disease (NAFLD) and non-alcoholic steatohepatitis (NASH). High-sugar drinks can lead to the accumulation of fat in the liver, eventually leading to fatty liver disease and may even develop into cirrhosis or liver cancer. These risks are particularly pronounced in the absence of adequate exercise and a concomitant high-calorie diet (Tseng et al., 2023). Studies have shown that reducing the intake of sugary drinks can effectively reduce liver fat accumulation and improve liver health (Malik & Hu, 2022).

Sugary drinks and cancer risk

Long-term consumption of sugary drinks may promote the occurrence of certain cancers, such as colon cancer and pancreatic cancer, by inducing chronic inflammation and increased insulin production. The metabolic disorder caused by high-sugar drinks can aggravate the inflammatory response throughout the body, thereby providing a favourable environment for the growth of cancer cells (Fardet & Boirie, 2014). In addition, sugary drinks may also indirectly increase the risk of certain cancers by affecting the immune system and accelerating cell proliferation.

Effects of sugary drinks on body weight and obesity

High calorie intake from sugary drinks is one of the main drivers of obesity, especially the accumulation of visceral fat, which is closely related to sugary drinks. Studies have shown that long-term and large-scale consumption of sugary drinks will increase body fat and waist circumference, especially the increase in abdominal fat, which is an important factor leading to metabolic syndrome (Zavala et al., 2024) . The

high sugar content in sugary drinks is quickly absorbed by the body, leading to excess energy, which in turn causes obesity and a series of obesity-related metabolic problems.

Related Research

In China

Hui Chen (2023). Sugary beverages and genetic risk in relation to brain structure and incident dementia: a prospective cohort study. Methods: We included 177,926 UK Biobank participants without dementia at baseline and followed them until March 2021. Intake of SSBs, ASBs, and NJs was assessed using repeated web-based 24-h dietary recalls from 2009 to 2012. We calculated a polygenic risk score (PRS) to indicate genetic predisposition of dementia for each individual. We estimated the HRs and 95% CIs using Cox proportional hazard models for dementia risk and β coefficients and 95% CIs using linear models for brain imaging markers. Results: During study follow-up (mean = 9.5 years), 1293 participants developed dementia (69.1 cases/ 100,000 person-years) excluding dementia cases within the first 2 years. Higher intake of SSBs and ASBs (>2 units/d compared with none) was each associated with a higher risk of dementia (HR: 1.34; 95% CI: 1.01, 1.77; P-trend = 0.040 for SSBs and 1.20; 95% CI: 0.84, 1.72; P-trend = 0.004 for ASBs). In contrast, moderate intake of NJs (>0-1 unit/d compared with none) was related to a lower dementia risk (HR: 0.77; 95% CI: 0.68, 0.87), a larger volume of brain gray matter (β = 0.05; 95% CI: 0.02, 0.08), and a lower volume of white matter hyperintensities (β = -0.07; 95% CI: -0.11, -0.03). The associations were not significantly modified by genetic risk (P-interactions = 0.839 for SSB × PRS, 0.732 for ASB × PRS, and 0.950 for NJ × PRS). (Chen et al. 2023) .

Lu Xiao (2022), The relationship between parents' knowledge of sugar-sweetened beverages and preschool children's consumption: the moderating role of parents' consumption of sugar-sweetened beverages. As the main caregivers of young children, parents' dietary nutrition knowledge and eating behaviors have an important impact on the development of children's beverage drinking habits. This study took 4,450 children aged 3 to 6 years old as the research subjects to explore the relationship between parents' knowledge of sugary drinks, consumption of sugary drinks and children's consumption of sugary drinks. The results found that the drinking rates of young children in five common sugary drinks: fruit and vegetable juice drinks, plant protein drinks, carbonated drinks, tea drinks, and energy drinks were 53.8%, 52.2%, 30.9%, 27.5%, and 2.3% respectively. It shows an upward trend compared with previous research results; parents' knowledge of sugary drinks significantly negatively predicts children's sugary drink consumption, and parents' sugary drink consumption significantly and positively predicts children's sugary drink consumption; parents' sugary drink consumption will inhibit parents' The positive effect of knowledge about sugary drinks on the consumption of sugary drinks among young children. The government, society, kindergartens, and families should jointly take measures to strengthen education and publicity on sugary drinks, improve parents' knowledge of sugary drinks, set an example for young children not to drink sugary drinks, and urge young children to develop the habit of not drinking sugary drinks. good habits (Lu & Hu, 2022)

Wang Jinying (2023). Analysis of the correlation between sugar-sweetened beverages and initial onset of type 2 diabetes ketoacidosis or ketosis. The main content is about the relationship between the intake of sugary drinks (SSB) and the onset of

type 2 diabetic ketosis (DK) or ketoacidosis (DKA) were analyzed. The study collected data on patients hospitalized in the First Affiliated Hospital of Nanchang University from January 2018 to December 2022, and compared the differences between the two groups of patients with a history of sugary drinks (SSB group) and a history of non-sugary drinks (NSSB group) Biochemical indicators, blood cell parameters, inflammatory indicators, etc. were analyzed using statistical methods to correlate SSB intake with type 2 diabetes DK or DKA. The results of the study show that a history of sugary drinks is an independent risk factor for initial onset of type 2 diabetic ketoacidosis, and such patients are more likely to discontinue medication after active treatment. Research highlights the importance of reducing intake of sugary drinks to prevent type 2 diabetes and its complications (Wang, 2023).

Zhao Weifeng (2024). The Impact of Sugar-Sweetened Beverage Consumption on the Physical and Mental Health of University Students. Excessive intake of sugary drinks will increase the risk of obesity, which will increase the burden on the body and lead to health risks. Therefore, the frequency of consumption of sugary drinks needs to be limited. In terms of mental health, the sugar drinks consumed, the worse the mental health of college students. In terms of gender differences, there is no obvious impact on the mental health of boys, while it has a significant negative impact on the mental health of girls. Judging from the timing and motivation of boys and girls in consuming sugary drinks, boys prefer to consume sugary drinks during sports and playing games to boost their mood, and boys mostly consume sugary drinks to quench their thirst and replenish their physical strength. Physiological purposes do not cause obvious psychological burden; girls, on the other hand, prefer to consume sugary drinks according to their mood, and drink them mostly during meals. This is for girls who are

sensitive, pay attention to diet structure, and care more about their image. It is more likely to cause psychological burden after ingesting sugar, which will lead to the deterioration of psychological status (Zhao et al., 2024).

Tao Jinya reported on several important health studies (2024). Exercise cannot offset the cardiovascular disease risk induced by sugary drink consumption. A study published in the Journal of the American College of Cardiology showed that using salt substitutes can reduce the incidence of high blood pressure in older adults without increasing low blood pressure. Blood pressure risk; another study published in the "American Journal of Clinical Nutrition" pointed out that regardless of the amount of exercise, the intake of high-sugar beverages is associated with an increased risk of cardiovascular disease, and exercise cannot completely offset its negative effects; finally, " Research in the British Journal of Nutrition found that kiwi fruit intake can significantly improve mood and vitality in just 4 days, providing a quick and effective way to improve mental health (Tao, 2024).

In Global

Mainul Haque (2020). A narrative review of the effects of sugar-sweetened beverages on human health: a key global health issue. This article points out that providing healthy and safe food is essential for human health, and unnecessary sugar added to food is a major global problem, which leads to multiple long-term and short-term health problems, as well as rising costs for individuals and governments. Excessive sugar intake has negative health effects, including poor health conditions such as obesity, type 2 diabetes and poor oral health, which exist in both well-resourced and under-resourced settings. A key aspect of nutrition guidance from governments and health promotion agencies is to raise public awareness of the "hidden" sugar, salt and

fat in processed foods and sugary drinks (SSBs) and guide individuals to reduce consumption (Haque, 2022).

Kawther M Hashem et al. (2024). United Kingdom of Great Britain and Northern Ireland. Bulletin of the World Health Organization. This document was published in 2024. "Outcomes of sugar reduction policies, United Kingdom of Great Britain and Northern Ireland". The document discusses the impact of poor diet on global death and disease, especially obesity and non-communicable diseases. The article points out that cheap, high-fat, high-sugar and high-salt ultra-processed foods and beverages are widely sold worldwide, posing a significant impact on health. The World Health Organization recommends reducing sugar intake to just 5% of energy intake through fiscal policies and food and beverage reformulation strategies. Over the past decade, the UK government has implemented several policies aimed at reducing sugar intake. The article compares the effects of taxes on the soft drinks industry and voluntary sugar reduction programs, analyzing how differences in policy design and implementation processes affect outcomes. The results showed that mandatory taxes reduced total sugar sales by 34.3%, while voluntary sugar reduction programs only reduced sugar intake, the main contributor, by 3.5%, far below the 20% target (Hashem et al., 2024).

Lucas Perelli, (2023). The article is titled "Health and economic burden of sugary beverage consumption in Brazil" and was written by. This study focused on the impact of SSBs (SSBs) on health and economic burden in Brazil. It used a three-stage approach to assess the direct effects of SSBs on diabetes, cardiovascular disease, and body mass index (BMI), as well as the effect of BMI on disease incidence. Results showed that 2.7% and 11% of overweight/obesity cases in adults and children,

respectively, were associated with SSBs. SSB consumption in Brazil was associated with a large number of cases (1,814,486), deaths (12,942), disability-adjusted life years (DALYs; 362,088 years), and substantial health costs (US$2,915.91 million) related to diabetes, cardiovascular disease, neoplastic disease, and other noncommunicable diseases (NCDs). The study highlights the urgent need for public policies to address SSB consumption, which is a recognized key risk factor for NCDs. The findings highlight the importance of interventions such as taxation, front-of-pack labeling, advertising restrictions, and modifications to the school environment to reduce SSB consumption and its associated health and economic burden (Perelli et al., 2023).

Hari, (2023). Sugar-sweetened beverage tax and its implications for public health. To study the Sugar sweetened beverage tax and its implications for public health. The consumption of SSBs (SSBs) has increased to higher levels in all corners of the world. Compared to solid foods, a high-sugar diet in the form of SSBs leads to increased calorie intake with little nutritional value and results in increased energy intake, leading to unhealthy weight gain, which is often associated with health problems such as obesity, diabetes, cardiovascular disease, early tooth decay and caries formation. It has also been observed that the consumption of SSBs is associated with unhealthy habits such as smoking, reduced physical activity, increased fast food intake, and increased screen time. Considering such adverse effects of SSBs, many countries are working to address the issue of increased SSB consumption through measures such as taxing SSBs. However, it is also extremely important to understand how these taxes can help governments generate higher revenues, which can in turn be used for various community needs in the respective countries. Conclusion: The same revenue can also be used to implement comprehensive health care programs, especially in low- and

middle-income countries (LMICs), by providing preventive, promotive, curative, rehabilitative, and palliative services as a way to achieve universal health coverage (UHC). (Hari et al., 2023).

Andrea Alcaraz et al. (2023). Health and economic burden of disease of sugar-sweetened beverage consumption in four Latin American and Caribbean countries: a modelling study. To study the Health and economic burden of disease of sugar-sweetened beverage consumption in four Latin American and Caribbean countries: a modelling study. The main contents of the study include: Evaluating the disease burden and health system costs caused by sugary beverage consumption in four countries in Latin America and the Caribbean (Argentina, Brazil, El Salvador, and Trinidad and Tobago). After systematically reviewing existing models, a comparative risk assessment framework was developed to estimate the health and economic impacts associated with sugary beverage consumption. The results showed that sugary beverage consumption was associated with 18,000 deaths (3.2% of total disease-related deaths), 7 million disease events (3.3% of total disease-related events), 500,000 disability-adjusted life years (DALYs), and US$2 billion in direct medical costs in these countries each year. The study also pointed out a variety of diseases associated with sugary beverage consumption, including type 2 diabetes, cardiovascular disease, cancer, etc., and paid special attention to overweight and obesity in children and adults. The article highlights the link between sugary drink consumption and major disease burden and death, and proposes potential targets for policy intervention, such as adjusting the price of sugary drinks, restricting advertising, and raising public awareness, to reduce the occurrence of related health problems (Alcaraz et al., 2023).

Conceptual Framework

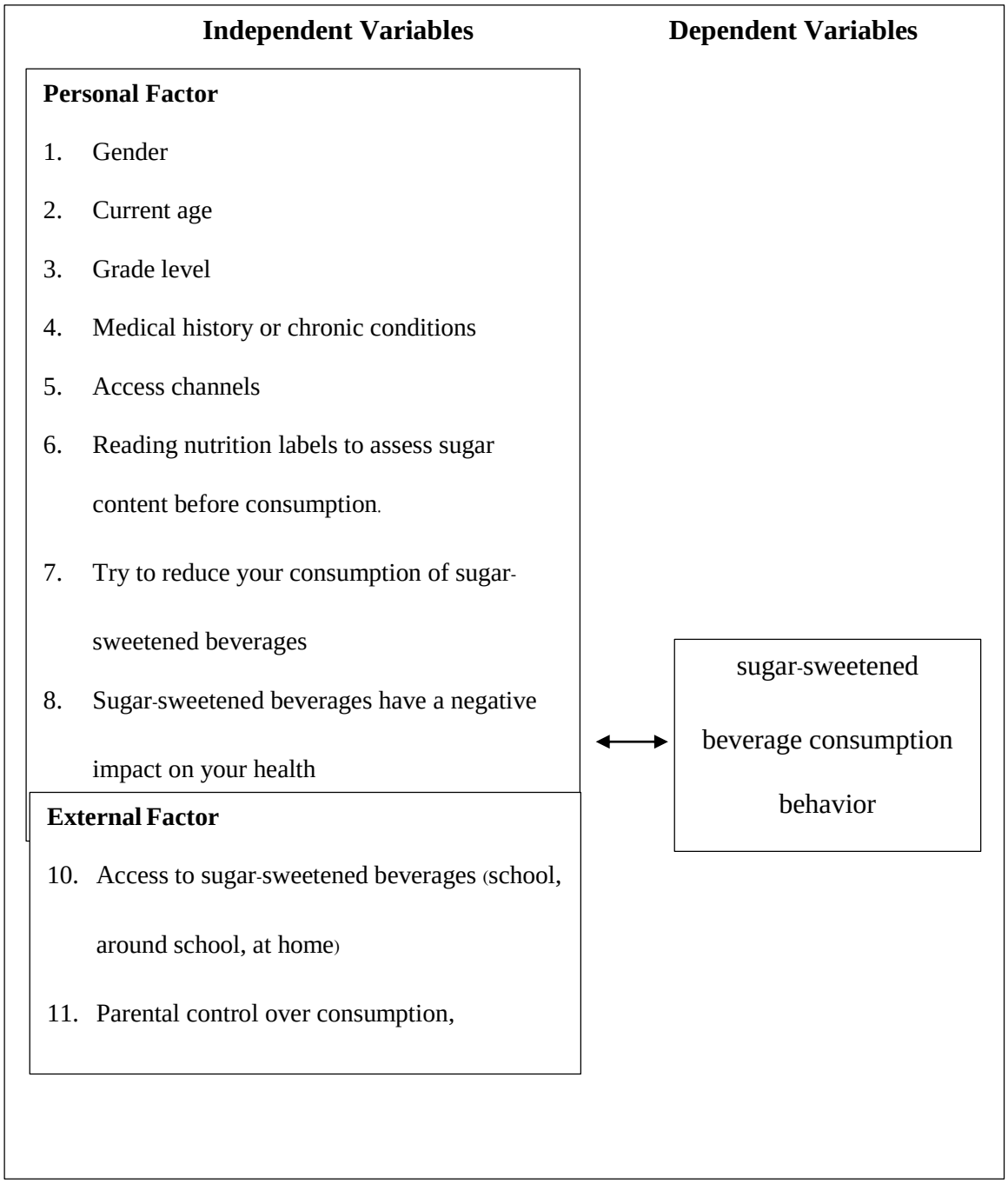


Figure 1 Conceptual Framework

CHAPTER III

RESEARCH METHODOLOGY

This research is a study on Factors influencing the consumption behavior of sugar-sweetened beverages among Chinese adolescent students at school in Ding'an District, Hainan Province, with the objective study prevalence of the sugar-sweetened beverage consumption behaviors, to study personal factors and investigate factors influencing sugar-sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province. The researcher followed the research process in the following steps:

1. Research Design
2. Population and Sample Size
3. Study Area
4. Study Period
5. Research Method
6. Measurement Instruments
7. Data Collection
8. Data Analysis

Research design

This research is a cross-sectional survey study conducted among adolescent students aged 13-15 years in Ding'an District, Hainan Province.

Population and sample size

Population

The population for this study consists of4,302adolescent students aged 13-15 years living in Ding Cheng Township, Ding'an County, Hainan Province, across three schools: Ding'an Middle School, Cheng nan Middle School, and Ding'an Experimental High School (Data fromhttp://f.hainnu.edu.cn/2022/0219/20220219034743986.docx, the dates are November 2024 - January 2024)

Sample

Inclusion criteria

1. Age range: young students between the ages of 13 and 15.
2. Schools: attending three schools in Dingan Township, Dingan County: Dingan Middle School, Chengnan Middle School, and experimental middle school.
3. Residence: Ding'an Township, Ding'an County.
4. Voluntary participation: Students and parents/ guardians agreed to particip ate in this survey.

Exclusion Criteria

1. Absenteeism: Students who are absent on the day of the survey.

2. Health Factors: Students with serious health issues or special needs that may affect their participation in the survey.

Sample size

To calculate the sample size for your study, you can use the following formula for determining the sample size from a population (n4Studies):

$$n = \frac{N \cdot Z^2 \cdot p \cdot (1-p)}{E^2 \cdot (N-1) + Z^2 \cdot p \cdot (1-p)}$$

From: Lohr, S. L. (2010). Sampling: design and analysis (2nd ed.). Cengage Learning.

Where

- n = sample size
- N = population size (4302 adolescent students aged 13-15 years)
- Z = Z-score (the number of standard deviations a data point is from the mean, often 1.96 for a 95% confidence level)
- p = estimated proportion of an attribute that is present in the population (if unknown, 0.5 is often used as it provides the maximum sample size)
- E = margin of error (often set at 0.05 for a 5% margin of error)

$$n = \frac{4302 \times 1.96^2 \times 0.5 \times (1 - 0.5)}{0.05^2 \times (4302 - 1) + 1.96^2 \times 0.5 \times (1 - 0.5)}$$

$$n = \frac{4302 \times 3.8416 \times 0.25}{0.0025 \times 4301 + 3.8416 \times 0.25}$$

$$n = \frac{4137.5308}{10.7525 + 0.9604}$$

$$n = \frac{4137.5308}{11.7129}$$

$$n \approx 353.33$$

To calculate the sample size with an additional 10% to account for potential non-responses or other issues, you can use the following method:

First, calculated 10% of the sample size:

10% 0f 354= 0.10x 354= 35.4

Then, add this 10% to the original sample size:

354+35.4= 389.4

The adjusted sample size is approximately 390 adolescent students aged 13-15 years residing in Ding Cheng Township, Ding'an County, Hainan Province.

To calculate the proportional allocation of students from each school, you need to determine the proportion of the total population each school represents and then apply this proportion to the total sample size. The formula for proportional allocation is:

$$n_i = \frac{N_i}{N} \times n$$

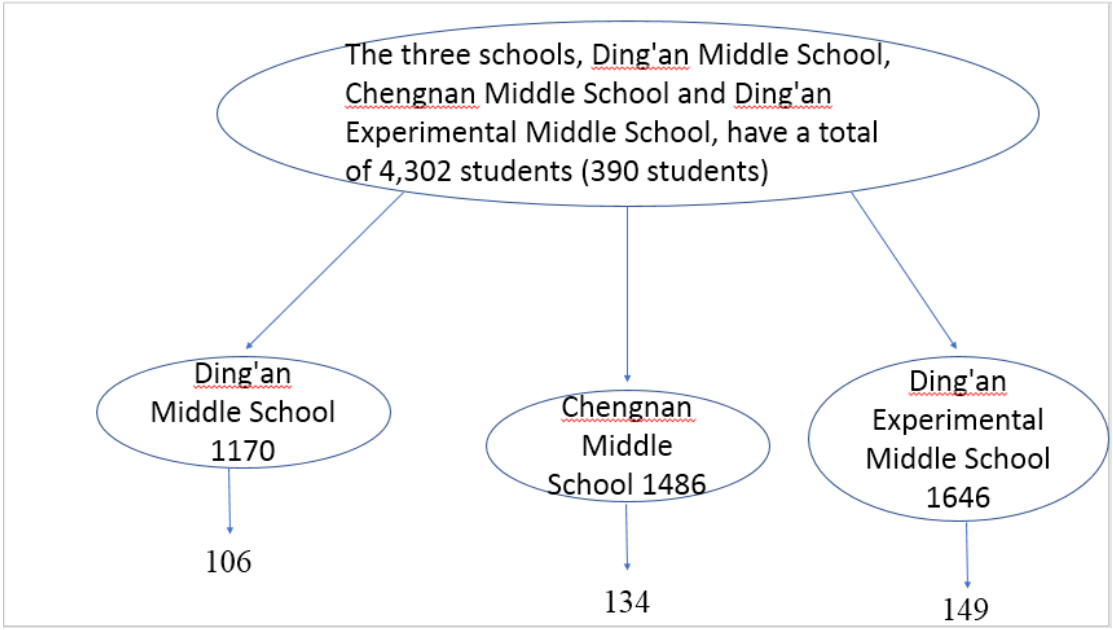
Where:

- n_i represents the sample size for each educational level.
- n is the total sample size.
- N_i is the population size for each educational level.
- N is the total population size.

Therefore, the probabilities of selecting adolescent students from three schools are shown in Table 1

Table 1 The table presents the population size of students from three schools and the proportionally allocated sample size for each school.

Name of School	**Number of adolescent students aged 13-15 years old**	
	Total	**Selected**
Ding'an Middle School	1170	106
Cheng nan Middle School	1486	134
Ding'an Experimental High School	1646	149
Total	**4302**	**390**



1.Overall Coverage and Representativeness

These three schools are the only secondary schools in Ding'an Township that cover the 13-15 age group (first to third years), with a total enrollment of 4,302 students, constituting the complete framework of the study population.

The students come from urban, suburban, and even rural areas around the town, and come from a wide variety of backgrounds, including family economy, parental literacy, and activities both inside and outside of school, which can better reflect the beverage consumption behaviors of the entire youth population in Ding'an County.

2.Operationalization of cluster sampling

The three schools as a "cluster" are convenient for obtaining school approval and organizing the distribution and collection of the questionnaires at one time, thus saving time and labor costs.

The high level of cooperation from the staff and the standardization of the internal management of the schools resulted in a high response rate and data integrity

3.Representation of geographic and social environments

Ding'an Middle School (town center), Chengnan Middle School (suburban), and Ding'an Experimental Middle School (new campus) represent different community environments: the convenience of the central city, the transition zone of the suburban area, and the consumption characteristics of the newly developed area.

By comparing the differences in consumption of sugary beverages among secondary school students in schools in different regions, the influence of urban/ rural/urbanization level on behavior can be explored.

Sampling

This study used Accidental sampling, Accidental sampling, also known as convenience sampling is a non-probability technique in which participants are chosen based on their ease of access and willingness to participate, making it ideal when time, budget, or access limit the feasibility of random sampling. In this study, we implemented this approach by launching an online questionnaire on Wen juan xing and distributing its link through WeChat and parent–teacher groups. Targeting 13- 15-year-old junior high students, the survey was completed with parental or guardian consent, ensuring age-appropriate responses. as shown in Table 1

Study area

In the middle schools located in Ding Cheng Township, Ding'an County, Hainan Province.

Study period

During the study period from November 2024 to February 2025.

Research method

Literature Review:

Collect and analyze existing literature on adolescent SSB consumption behaviors to clarify the research background and existing findings.

Questionnaire Design

The questionnaire consists of three parts. Design a structured questionnaire including the following sections:

1. Personal Information**:** Gender, current age**,** grade level**,** weight, height, medical history or chronic conditions.

2. Influencing Factors**:** Access to SSBs (school, around school, at home), Reading nutrition labels to assess sugar content before consumption, Access channels.

3. Sugar sweetened beverages behaviour. Frequency, types, and quantities of SSB consumption.

Mathematical Statistics Method

1. Pre-process data according to inclusion and exclusion criteria and check for anomalies to ensure data validity and authenticity.

2. Enter valid data into Excel to establish a database and analyze using SPSS 26.0 software (Chinese version).

3. Conduct descriptive statistical analysis, independent sample t-tests, and logistic regression analysis. A p-value of <0.05 is considered statistically significant.

Quality Control

1. Ensure data authenticity and completeness using a combination of online and offline surveys with strict quality control measures.

2. Confirm the validity and reliability of the SSBs.

3. Distribute questionnaires to targeted groups without using suggestive or leading language.

4. Use a double-entry method and strict logical checks to filter and exclude invalid questionnaires.

Measurement instruments

Explain the questionnaire you will use, including its various sections. For example:

1. Questionnaire Survey: Design a structured questionnaire including the following sections:

1.1 Section 1: Personal Information**:** Gender, current age, grade level, medical history or chronic conditions.

1.2 Section 2: Influencing Factors; Access to SSBs (school, around school, at home), Parental Control Over Consumption, Channels of Exposure to Marketing Media for Sugar-Sweetened Beverages, Reading Nutrition Labels for Sugar Content Before Consumption, Have you ever tried to reduce your consumption of sugar sweetened beverages, Do you think sugar sweetened beverages have a negative impact on your health

1.3 Section 3: Sugar sweetened beverages behaviour. Divided into 2 levels: Normal group and increased risk of obesity.

1.3.1. Normal group: Intake less than 25 g/day.

1.3.2. increased risk of obesity group: Intake equal to or more than 25 g/day.

Table 2 Interpretation of Sugar-Sweetened Beverage Consumption Behavior.

Level	Definition	Description
Normal group	< 25 g/day	Intake less than 25 g/day.
increased risk of obesity group	≥ 25 g/day	Intake equal to or more than 25 g/day.

(Li et al., 2022; Zhang et al., 2017).

2. Biological Measurements: Body measurements such as height, weight, BMI

Chinese WGOC percentile standard (WS/T 586-2018).To reflect local growth patterns in 13.0–15.0 year-olds, we also applied the sex- and age-specific percentiles recommended by the Working Group on Obesity in China. Underweight/ normal/ overweight/ obesity were defined as below the 5th, between the 5th and 85th, between the 85th and 95th, and at or above the 95th percentile of the BMI distribution, respectively.

- ☐ Underweight (<P5)
- ☐ Normal weight (P5-P85)
- ☐ Overweight (P85-P95)
- ☐ Obesity (>=P95)

Data collection

In this research, the researcher will follow these steps to collect data:

1. Request a letter of certification from ISEM, Chiang Rai Rajabhat University, to authorize the data collection process.

2. Coordinate with the relevant areas to conduct the data collection using the questionnaire.

3. Collect data using the questionnaire by coordinating with the heads of departments to schedule dates for data collection from the sample groups of each college.

4. The questionnaire used for data collection has been validated by three experts that the IOC value is ≥ 0.6, and its reliability has been calculated from a sample group similar to the target population of the research, consisting of 30 individuals, with a reliability score of .0.883

5. Data collection online via wenjuanxing, with the link shared in class Wechat/ QQ groups**.** A total of 390 junior high students **(**ages 13**-**15 year**-**old**)** completed the survey, after uploading verified parental consent and reminders were sent on days 3 and 6,submissions under two minutes or with identical answers were excluded, yielding 390 valid responses**.**

6. Verify the accuracy and completeness of the data obtained from the questionnaires.

Data analysis

1. To analyze the demographic characteristics and sugar-sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province, descriptive statistics were employed, including mean, standard deviation, minimum, maximum, frequency, and percentage.

2. To examine the associations between personal factors and eating disorder behaviors among the students, using descriptive statistics and inferential statistics, including the chi-square test and Fisher’s exact test.

CHAPTER IV

RESEARCH RESULTS

The title of the study was factors associated with sugar- sweetened beverages consumption behavior among Chinese adolescent students in school in Ding'an district, hainan province. This study aims to examine the sugar-sweetened beverage consumption behaviors and to examine the factors associated with the sugar- sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province. The researcher followed the research process in the following steps:

1 Section I: Personal Information.

2 Section II: An analysis the sugar-sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province**.**

3 Section III: An analysis of associations between factors associated with the sugar-sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province**.**

Section I: Personal Information.

Table 3: Number and percentage of respondents classified by gender (n=390).

Gender	Numbers	Percentage
Female	213	54.62
Male	177	45.38
Total	**390**	**100.00**

From Table 3, it was found that the majority of respondents, categorized by gender, were female, totalling 213 individuals (54.62%), while male respondents accounted for 177 individuals (45.38%).

Table 4: Number and percentage of respondents classified by age (n=390).

Age	Numbers	Percentage
13	127	32.56
14	147	37.70
15	116	29.74
Total	**390**	**100.00**

(Min=13, Max=15， $\overline{X}$ =13.97， SD=14.）

From Table 4, it was found that the majority of respondents, categorized by age, were fourteen years old, totalling 147 individuals (37.70%). This was followed by those aged thirteen, with 127 respondents (32.56%). The lowest proportion was fifteen-year-olds, with only 116 respondents (29.74%).

Table 5: Number and percentage of respondents classified by grade level (n=390).

Grade Level	Numbers	Percentage
Grade 7	127	32.56
Grade 8	147	37.70
Grade 9	116	29.74
Total	**390**	**100.00**

From Table 5, it was found that the majority of respondents, categorized by grade level, were in Grade 8, totalling 147 individuals (37.70%). This was followed by Grade 7, with 127 respondents (32.56%). The lowest proportion was Grade 9, with only 116 respondents (29.74%).

Table 6: Number and percentage of respondents by gender classified by BMI (n=390).

BMI for Age	Numbers	Percentage
Underweight(<P5)	1	0.26
Normal weight(P5-P85)	92	23.59
Overweight(85-P95)	182	46.67
Obesity(>=P95)	115	29.49
Total	**390**	**100.00**

(Chinese WGOC percentile standard (WS/T 586-2018)

From Table 6, it was found that the majority of respondents, categorized by BMI for age, were overweight (P85-P95), totalling 182 individuals (46.67%). This was followed by obesity (≥P95), with 115 respondents (29.49%). The lowest proportion was underweight (<P5), with only 1 respondent (0.26%). The remaining 23.59% (92 individuals) fell within the normal weight range (P5-P85).

Table 7 Number and percentage of respondents classified by medical history or chronic illnesses (n=390).

Medical History or Chronic Illnesses	Numbers	Percentage
No chronic illnesses	379	97.18
Have chronic illnesses	11	2.82
Total	**390**	**100.00**

From Table 7, it was found that the majority of respondents, categorized by medical history or chronic illnesses, reported having no chronic illnesses, totalling 379 individuals (97.18%), while those who reported having chronic illnesses accounted for 11 individuals (2.82%).

Table 8 Number and percentage of respondents classified by access to sugar-sweetened beverages at the school (n=390).

Access to Sugar-Sweetened Beverages around the school	Numbers	Percentage
No	138	35.38
Yes	252	64.62
Total	**390**	**100.00**

From Table 8, it was found that the majority of respondents, categorized by access to sugar-sweetened beverages at the school, answered “Yes,” totalling 252 individuals (64.62%), while those who answered “No” accounted for 138 individuals (35.38%).

Table 9 Number and percentage of respondents classified by access to sugar-sweetened beverages around the school (n=390).

Access to Sugar-Sweetened Beverages around the school	**Numbers**	**Percentage**
No	242	62.05
Yes	148	37.95
Total	**390**	**100.00**

From Table 9, it was found that the majority of respondents, categorized by access to sugar-sweetened beverages around the school, answered “No,” totalling 242 individuals (62.05%), while those who answered “Yes” accounted for 148 individuals (37.95%).

Table 10 Number and percentage of respondents classified by access to sugar-sweetened beverages at home (n=390).

Access to Sugar-Sweetened Beverages at home	Numbers	Percentage
No	181	46.41
Yes	209	53.59
Total	**390**	**100.00**

From Table 10, it was found that the majority of respondents, categorized by access to sugar-sweetened beverages at home, answered "Yes," totalling 209 individuals (53.59%), while those who answered "No" accounted for 181 individuals (46.41%).

Table 11 Number and percentage of respondents classified by parental control over consumption (n=390).

Parental control over consumption	Numbers	Percentage
Never	115	29.49
Sometimes	159	40.77
Always	116	29.74
Total	**390**	**100.00**

From Table 11, it was found that the majority of respondents, categorized by parental control over sugar-sweetened beverage consumption, selected “sometimes,” totalling 159 individuals (40.77%). This was followed by those who selected “always,” with 116 respondents (29.74%). The lowest proportion was “never,” with only 115 respondents (29.49%).

Table 12 Number and percentage of respondents classified by channels of exposure to marketing media for sugar-sweetened beverages (multiple-choice questions (n=390)

Channels of exposure to marketing media for sugar-sweetened beverages	**Numbers**	**Percentage**
Television	206	26.48
Print media	320	41.13
Online media	252	32.39
Total	**778**	**100.00**

From Table 12, it was found that the majority of respondents, categorized by channels of exposure to marketing media for sugar-sweetened beverages, were Print media, totaling 320 individuals (41.13%). This was followed by Online media, with 252 respondents (32.39%). The lowest proportion was Television, with only 206respondents (26.48%).

Table 13 Number and percentage of respondents classified by reading nutrition labels for sugar content before consumption (n=390).

Reading Nutrition Labels for Sugar Content Before Consumption	Numbers	Percentage
Never	138	35.38
Sometimes	154	39.49
Always	98	25.13
Total	**390**	**100.00**

From Table 13, it was found that the majority of respondents, categorized by reading nutrition labels for sugar content before consumption, selected "sometimes," totalling 154 individuals (39.49%). This was followed by those who selected "never," with 138 respondents (35.38%). The lowest proportion was "always," with only 98 respondents (25.13%).

Table 14 Number and percentage of respondents classified by have you ever tried to reduce your consumption of sugar sweetened beverages (n=390).

Have you ever tried to reduce your consumption of sugar sweetened beverages?	Numbers	Percentage
No	178	45.64
Yes	212	54.36
Total	**390**	**100.00**

From Table 14, it was found that the majority of respondents, categorized by have you ever tried to reduce your consumption of sugar sweetened beverages, answered “Yes,” totalling 212 individuals (54.36%), while those who answered “No” accounted for 178 individuals (45.64%).

Table 15 Number and percentage of respondents classified by do you think sugar sweetened beverages have a negative impact on your health (n=390).

Do you think sugar sweetened beverages have a negative impact on your health?	**Numbers**	**Percentage**
No	141	36.15
Yes	249	63.85
Total	**390**	**100.00**

From Table 15, it was found that the majority of respondents, categorized by do you think sugar sweetened beverages have a negative impact on your health, answered “Yes,” totalling 249 individuals (63.85%), while those who answered “No” accounted for 141 individuals (36.15%).

Section II: An analysis the sugar-sweetened beverage consumption behavior among Chinese adolescent students in Ding'an District, Hainan Province.

Table 16 Number and percentage of respondents classified by the recommended daily sugar intake (n=390).

The recommended daily sugar intake	Numbers	Percentage
Normal group (< 25 g/day)	62	15.90
increased risk of obesity group (≥ 25 g/day)	328	84.10
Total	**390**	**100.00**

(Li et al., 2022; Zhang et al., 2017).

From Table 16, it was found that the majority of respondents, categorized by the recommended daily sugar intake, were in the increased risk of obesity group (≥25g/day), totalling328 individuals (84.10%), while the normal group (<25g/day) accounted for 62 individuals (15.90%).

Section III: An analysis of associations between factors associated with the sugar-sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province.

Table 17 Relationship between gender and the sugar received per day assessment criteria (n=390).

Gender	The recommended daily sugar intake		χ^2	p-Value
	Normal group	increased risk of obesity group		
Female	25	188	6.074	0.014*
Male	37	140		

* indicates statistical significance at the 0.05 level

From Table 17, the analysis using the Chi-square test revealed that gender was significantly associated with the recommended daily sugar intake at the 0.05 statistical significance level.

Table 18 Relationship between age and the recommended daily sugar intake **(**n=390**).**

Age	The recommended daily sugar intake		χ^2	p-Value
	Normal group	increased risk of obesity group		
13	18	109		
14	28	119	1.758	0.438
15	16	100		

From table18, the analysis using the Chi-square test revealed that age was not significantly associated with the recommended daily sugar intake at the 0. 05 significance level.

Table 19 Relationship between Grade and the recommended daily sugar intake **(**n=390**).**

Grade	The recommended daily sugar intake		χ^2	p-Value
	Normal group	increased risk of obesity group		
Grade 7	26	101		
Grade 8	22	125	3.355	0.200
Grade 9	14	102		

From Table 19, the analysis using the Chi-square test revealed that grade was not significantly associated with the recommended daily sugar intake at the 0.05 significance level.

Table 20 Relationship between BMI and the recommended daily sugar intake **(**n=390**).**

BMI	**The recommended daily sugar intake**		**Exact text**
	Normal group	**increased risk of obesity group**	
Underweight(<P5)	1	0	
Normal weight(P5-P85)	47	45	<0.001*
Overweight(85-P95)	12	170	
Obesity(>=P95)	2	113	

* indicates statistical significance at the 0.05 level

From Table 20, the analysis using the Chi-square test demonstrated that BMI levels were significantly associated with the recommended daily sugar intake at the 0.05 statistical significance level.

Table 21 Relationship between access to sugar-sweetened beverages at school and the sugar received per day assessment criteria (n=390).

Medical History or Chronic Illnesse	The recommended daily sugar intake		Exact text
	Normal group	increased risk of obesity group	
NO	62	317	0.225
YES	0	11	

* indicates statistical significance at the 0.05 level

From Table 21, the analysis using the Chi-square test revealed that Medical History or Chronic Illnesse was not significantly associated with the recommended daily sugar intake at the 0.05 significance level .

Table 22 Relationship between access to sugar-sweetened beverages around the school and the sugar received per day assessment criteria (n=390).

access to sugar-sweetened beverages around the school	The recommended daily sugar intake		χ^2	p-Value
	Normal group	increased risk of obesity group		
NO	30	108	5.451	0.020*
YES	32	220		

* indicates statistical significance at the 0.05 level

From Table 22, the analysis using the Chi-square test revealed that access to sugar-sweetened beverages at school was significantly associated the recommended daily sugar intake at the 0.05 statistical significance level.

Table 23 Relationship between access to sugar-sweetened beverages around school and the sugar received per day assessment criteria (n=390).

access to sugar-sweetened beverages around school	**The recommended daily sugar intake**		χ^2	**p-Value**
	Normal group	**increased risk of obesity group**		
NO	48	194	7.394	0.007*
YES	14	134		

* indicates statistical significance at the 0.05 level

From Table 23, the analysis using the Chi-square test revealed that access to sugar-sweetened beverages around school was significantly associated with the recommended daily sugar intake at the 0.05 statistical significance level.

Table 24 Relationship between access to sugar-sweetened beverages at home and the sugar received per day assessment criteria (n=390).

Access to sugar-sweetened beverages at home	The recommended daily sugar intake		χ^2	p-Value
	Normal group	increased risk of obesity group		
NO	31	150	0.382	0.537
YES	31	178		

From Table 24, the analysis using the Chi-square test revealed that access to sugar-sweetened beverages at home was not significantly associated with the recommended daily sugar intake at the 0.05 significance level

Table 25 Relationship between Parental control over consumption and the sugar received per day assessment criteria (n=390).

Parental control over consumption	The recommended daily sugar intake		χ^2	p-Value
	Normal group	increased risk of obesity group		
Never	23	92	8.244	0.016*
Sometimes	30	129		
Always	9	107		

* indicates statistical significance at the 0.05 level

From Table 25, the analysis using the Chi-square test revealed that Parental control over consumption was significantly associated with the recommended daily sugar intake at the 0.05 statistical significance level.

Table 26 Relationship between channel's of exposure to marketing media for Sugar-Sweetened Beverages and the sugar received per day assessment criteria (n=390)

Channels of Exposure to Marketing Media for Sugar-Sweetened Beverages	**The recommended daily sugar intake**		**Exact Test**
	Normal group	**increased risk of obesity group**	
Television	28	178	
Print media	55	265	<0.001*
Online media	40	212	

* indicates statistical significance at the 0.05 level

From table 26, the analysis using the Chi-square test revealed that channels of exposure to marketing media for sugar-sweetened beverages was significantly associated with the recommended daily sugar intake at the 0.05 statistical significance level.

Table 27 Relationship between Reading Nutrition Labels for Sugar Content Before Consumption and the sugar received per day assessment criteria (n=390).

Reading Nutrition Labels for Sugar Content Before Consumption	**The recommended daily sugar intake**		χ^2	**p-Value**
	Normal group	**increased risk of obesity group**		
Never	24	114		
Sometimes	23	131	0.363	0.837
Always	15	83		

From Table 27, the analysis using the Chi- square test revealed that Reading Nutrition Labels for Sugar Content Before Consumption was not significantly associated with the recommended daily sugar intake at the 0.05 significance level

Table 28 Relationship between have you ever tried to reduce your consumption of sugar sweetened beverages and the sugar received per day assessment criteria (n=390).

Have you ever tried to reduce your consumption of sugar sweetened beverages	**The recommended daily sugar intake**		χ^2	**p-Value**
	Normal group	**increased risk of obesity group**		
NO	38	140	7.277	0. 008*
YES	24	188		

* indicates statistical significance at the 0.05 level

From Table 28, the analysis using the Chi-square test revealed that have you ever tried to reduce your consumption of sugar sweetened beverages was significantly associated with the recommended daily sugar intake at the 0.05 statistical significance level.

Table 29 Relationship between Do you think sugar sweetened beverages have a negative impact on your health and the sugar received per day assessment criteria (n=390).

Do you think sugar sweetened beverages have a negative impact on your health?	**The recommended daily sugar intake**		**χ^2**	**p-Value**
	Normal group	**increased risk of obesity group**		
NO	30	111	4.779	0. 031*
YES	32	217		

* indicates statistical significance at the 0.05 level

From the table 29, the analysis using the Chi-square test revealed that Do you think sugar sweetened beverages have a negative impact on your health? was significantly associated with the recommended daily sugar intake at the 0.05 statistical significance level.

CHAPTER V

DISCUSSION AND CONCLUSION

The title of the study was factors influencing the consumption behavior of sugar sweetened beverages among Chinese adolescents students at school in Ding'an district, Hainan province. This study aims to study prevalence of the sugar-sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province and to study personal factors and sugar- sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province and investigate factors influencing sugar- sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province. The study population consists of the population for this study consists of4,302adolescent students aged 13- 15 years living in Ding Cheng Township, Ding'an County, Hainan Province, across three schools: Ding'an Middle School, Cheng nan Middle School, and Ding'an Experimental High School individuals. The sample size was determined using Taro Yamane' s formula, yielding a final sample of 390 individuals, selected through Stratified sampling sampling method. The study employed a structured questionnaire as the primary research instrument, comprising the following sections: Section 1: Personal Factors Section, Section 2 Influencing Factors and Section 3: Sugar Sweetened Beverage Consumption Behaviors

The collected data were analyzed using statistical software, employing the Descriptive Statistics: Mean, Standard Deviation, Frequency, Percentage. Inferential Statistics: chi-square test and Fisher's exact test for data processing. The study findings are structured as follows:

1. Summary of Research Findings
2. Discussion of Results
3. Study Limitation
4. Generalizability
5. Recommendation for further research

Summary of Research Findings

Personal information.

This study collected data from 390 students across three middle schools in Dingcheng Town, Ding' an County, Hainan Province (Ding' an Middle School, Chengnan Middle School, and Ding'an Experimental Middle School). The majority of respondents were in Grade 8 (147 students, 37.70%). In terms of health status, the highest category was overweight (P85–P95) with 182 students (46.67%), and among the combined overweight/obese group, males represented the largest share at 29.23%. A significant proportion of participants reported no chronic or underlying health conditions (379 students, 97.18%).

Exposure to sugar-sweetened beverage marketing occurred predominantly via print media (320 responses, 41.13%), while nutritional awareness peaked among those who "sometimes" read nutrition labels for sugar content (154 students, 39.49%). The most influential factor driving SSB consumption was packaging (e.g., color or celebrity endorsements), cited by 227 students (23.74%). Behaviorally and cognitively, the largest group believed that SSBs negatively impacted their health (249 students, 63.85%).

The sugar-sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province.

The data demonstrated a critical public health challenge: 84.10% of adolescents (n=328) exceeded the WHO-referenced threshold of 25g/day for added sugar intake, placing them in the increased risk of obesity group. Only a minority (15.90%, n=62) adhered to the safe consumption level (<25g/day).

Factors Associated with Sugar-Sweetened Beverage Consumption Behaviors among Chinese Adolescent Students in Ding'an District, Hainan Province.

The data were analyzed using chi-square tests. At the 0.05 level of statistical significance, the results showed that several factors were significantly associated with the daily sugar-intake criterion:

Chi-square test results showed that gender ($\chi^2 = 6.074$, $p = 0.014$), BMI ($p < 0.001$), access to SSBs at school ($\chi^2 = 5.451$, $p = 0.020$) and around school ($\chi^2 = 7.394$, $p = 0.007$), parental control over consumption ($\chi^2 = 8.244$, $p = 0.016$), marketing exposure channels ($p < 0.001$), and negative health perception of SSBs ($\chi^2 = 4.779$, $p = 0.031$) were all significantly associated with high sugar intake. Specifically, female students exceeded the sugar threshold more often (88.26%, 188/213) than males (79.10%, 140/177); overweight (P85–P95) and obese (≥P95) students showed markedly higher rates of high intake (93.41% and 98.26%, respectively) compared with their normal-weight peers (48.91%, 45/92); students with school access to SSBs (87.30%, 220/252) or nearby access (90.54%, 134/148) had elevated prevalence; and even those reporting "always" parental control (92.24%, 107/116) or acknowledging SSBs' negative health effects (87.15%, 217/249) still exceeded the recommended intake.

By contrast, age group ($\chi^2 = 1.758$, $p = 0.438$), grade level ($\chi^2 = 3.355$, $p = 0.200$), home access to SSBs ($\chi^2 = 0.382$, $p = 0.537$), and frequency of reading nutrition labels ($\chi^2 = 0.363$, $p = 0.837$) were not significantly associated with sugar-intake status.5.2 Discussion of results

Discussion of Results

The sugar-sweetened beverage consumption behaviors among Chinese adolescent students in Ding'an District, Hainan Province.

Based on the findings, the majority of respondents (84.10%) demonstrated sugar-sweetened beverage (SSBs) consumption behaviors that place them in the high-risk category (≥ 25 g/day). This finding is consistent with recent international and regional studies that have underscored the alarming prevalence of excessive SSBs intake among various populations. A global assessment of SSBs consumption patterns across 185 countries between 1990 and 2018 revealed that younger adults and males exhibited the highest levels of consumption. The study reported that in 2010 alone, high SSBs intake was associated with an estimated 184,000 deaths globally—primarily due to type 2 diabetes (72.3%), cardiovascular diseases (24.2%), and certain cancers (3.5%) (Lara-Castor et al., 2023) This global trend indicates that excessive intake of sugary beverages is a persistent and widespread issue. Moreover, a recent meta-analysis of longitudinal studies encompassing more than 15 million individuals confirmed that elevated SSBs consumption significantly increases the risk of developing non-communicable diseases such as obesity, type 2 diabetes, and coronary heart disease (Wang et al., 2021). The study demonstrated a dose-response relationship, where the

risk of disease rose in parallel with increased frequency and volume of SSBs consumption. In a study focusing on adults diagnosed with type 2 diabetes in the United States, researchers found that despite their medical condition, many individuals continued to consume SSBs regularly. This behavior was linked to poor glycemic control and increased risk of complications, highlighting the behavioral persistence of SSB intake even among high-risk groups (Bleich et al., 2020).

Collectively, these findings reinforce the urgent need for evidence-based interventions and public health policies aimed at reducing SSBs consumption. Strategies may include school-based health education, parental engagement, fiscal policies such as sugar taxes, and clearer nutritional labeling, all of which are vital to curb the growing burden of diet-related non-communicable diseases.

Factors Associated with Sugar-Sweetened Beverage Consumption Behaviors among Chinese Adolescent Students in Ding'an District, Hainan Province.

1. Gender and Sugar Intake

The present study identified a statistically significant association between gender and high-risk sugar intake among students at three middle schools in Dingcheng Town, Ding'an County, Hainan Province, with female participants significantly more likely to be increased risk of obesity group compared to males ($\chi^2 = 6.074, p = 0.014$). This finding aligns with emerging evidence highlighting gender-specific patterns in sugar consumption, driven by biological, psychological, and sociocultural factors.

Body image messaging amplifies sugar sensitivity in females: A 2023 study demonstrated that gender-targeted body image concerns—particularly messaging linking sugar consumption to physical appearance (e.g., weight gain, skin changes)—disproportionately influenced attitudes toward sugar-sweetened beverages (SSBs)

among girls. Females exhibited higher behavioral sensitivity to these narratives, potentially driving elevated sugar intake as both a coping mechanism and a reflection of societal pressures (Kong, 2023).

Rising added sugar consumption in adolescent girls: A 2022 longitudinal study of Chinese youth revealed that total and added sugar intake increased significantly across genders, with adolescent girls aged 13–17 showing the highest consumption levels (mean: 58.3 g/day). Processed snacks, sweetened beverages, and flavored dairy products were primary contributors, suggesting gendered marketing and peer influences may exacerbate these trends (Liu et al., 2022)

Persistent gender gaps in European youth: A 2021 Italian cohort study utilizing the Zuccherometro dietary tool found that girls aged 3–17 consumed 23% more daily sugar than boys, exceeding WHO recommendations by 40–60%. Gender disparities were most pronounced in baked goods (e.g., pastries, biscuits) and milk-based sweets, with preschool-aged girls already exhibiting concerning intake levels (Diani & Forchielli, 2021)

While males generally exhibit lower sugar-related risks, emerging data suggest complex gendered drivers: boys may prioritize energy-dense foods for athletic performance, whereas girls' consumption is more tightly linked to emotional regulation and body image stressors. However, methodological biases (e.g., underreporting of "feminized" foods like desserts by males) may obscure true prevalence gaps. Recent calls for gender-responsive nutritional interventions emphasize these nuances (Kong, 2023; Liu et al., 2022)

BMI and Sugar Intake

The present study observed a clear positive association between BMI and sugar intake: students classified as overweight or obese had significantly higher rates of excessive sugar consumption.

Magriplis et al. (2021), using data from the Greek National Nutrition and Health Survey, found that adolescents with overweight/obesity had a 41% probability of exceeding the 10%E sugar intake threshold, compared to 27% among normal-weight peers.

Li et al. (2022) reported that in Anhui Province, 58.3% of overweight/obese primary and middle school students consumed sugar-sweetened beverages ≥ 3 times/week, significantly more than their normal-weight counterparts (33.4%).

Bibiloni, Pons, & Tur (2020) summarized in a systematic review that overweight adolescents typically consumed 0.8–1.5 more servings of sugary drinks daily compared to normal-weight peers.

Access to SSBs at School

The present study found that on-campus access to sugary beverages was significantly associated with the risk of excessive sugar intake by χ^2 test. The rate of excessive sugar intake among students with on-campus access to sugary beverages amounted to 87.3% (220/252), which was significantly higher than that of the no-access group, which amounted to 78.3% (108/138) (χ^2=5.451, p=0.020). This result suggests that the accessibility of sugar-sweetened beverages on campus may exacerbate the problem of excessive sugar intake among adolescents.

Rocha et al. (2021), using Brazilian ERICA study data, showed that 74.6% of adolescents attending schools selling SSBs had consumed such beverages within the past day, versus 68.3% without access.

Kim & Lee (2024) demonstrated that vending machines in South Korean high schools significantly increased daily SSB intake ($\beta = 0.13$, $p = .039$).

Bobade & Ozoh (2022) found that 67.1% of Nigerian students in schools where SSBs were visible and accessible consumed them ≥7 times per week.

Access to SSBs Around School

The present study the χ^2 test found that the accessibility of sugary beverages around the campus was significantly associated with the risk of excessive sugar intake among students. Among students with accessibility to sugary drinks around campus, the rate of excessive sugar intake was 90.5% (134/148), which was significantly higher than 80.2% (194/242) in the no-access group, and the difference was statistically significant ($\chi^2 = 7.394$, $p = 0.007$). This result suggests that the easy accessibility of sugary beverages around schools may further exacerbate the problem of excessive sugar intake among adolescents.

Laska et al. (2020) reported that 81.7% of Minnesota children living within 500 meters of a convenience store drank SSBs daily, compared to 68.9% of those without such proximity.

Bivoltsis et al. (2021) observed that each additional SSB outlet within 250 meters of Australian schools increased weekly consumption by 0.4 occasions.

Franco et al. (2022) found that Chilean children aged 9–13 years exceeded WHO sugar guidelines more frequently when vending machines or supermarkets were within 400 m (78.4% vs. 64.7%).

Parental Control over Consumption

In the present study, the χ^2 test revealed that parental control over sugary drinks (SSBs) was significantly associated with the rate of sugar overdose among students, but with a paradoxical trend. The excess sugar intake rate was 80.0% (92/115) in the group of students who reported that their parents "never control", 81.1% (129/159) in the group of students whose parents "sometimes control", while the rate of students whose parents "always control" and "always control" were significantly associated with excess sugar intake. The highest excess rate of 92.2% (107/116) was found in the group of students whose parents were "always in control", which was significantly higher than the other groups (χ^2=8.244, p=0.016). This inverse association suggests that overly strict family dietary control may have complex interactions with adolescents' actual sugar intake behavior.

Lough, Wethington, & Hennessy (2022) analyzed U.S. data and found that strict parental restriction was positively associated with youth SSB consumption (β = 0.21, $p < 0.001$).

Garcia & Lee (2024) conducted a meta-review showing that adolescents under high parental control consumed 0.8–1.2 more SSB servings per day.

Rodriguez, Thompson, & Perez (2023) concluded that both excessive restriction and permissiveness led to increased adolescent sugar consumption (OR = 1.45, 95% CI: 1.12–1.88).

Exposure to SSB Marketing and Media

The present study exposure to television advertisements was found to be significantly associated with the risk of high intake of sugar-sweetened beverages (SSBs) by exact test. The rate of excess sugar intake among students with frequent

exposure to TV advertisements for sugary beverages was 86.4% (178/206), which was significantly higher than that of other media exposure groups (e.g., 82.8% for print media and 84.1% for online media), and the difference was statistically significant (p=0.001).

Potvin Kent et al. (2021) showed Canadian youth exposed to ≥5 social-media SSB ads/day consumed 0.48 more daily servings.

Scully et al. (2022) found that Australian adolescents exposed to ≥3 weekly SSB ads drank 0.41 more servings/day.

Fitton et al. (2023) found that in UK teens, digital marketing exposure to ≥4 ads/week predicted a weekly increase of 1.24 SSB servings over a 12-month period.

Attempted Reduction in Intake

In this study, the χ^2 test found that 88.7% (188/212) of the students who self-reported attempting to reduce their intake of sugar-sweetened beverages (SSBs) still had excessive sugar intake, which was significantly higher than the 78.7% (140/178) of the group who did not attempt to reduce sugar, and the difference was statistically significant (χ^2=7.277, p=0.008).

Calabro et al. (2022) found that interventions alone did not significantly reduce SSB intake (SMD = −0.05, 95% CI: −0.15–0.05).

Xiao et al. (2023) showed that intention to cut back failed to reduce SSB intake when self-regulation was weak.

Judah et al. (2020) observed only a small reduction in intake (from 2.3 to 2.1 servings/day, p = .34) after goal-setting interventions.

Risk Perception of SSBs

In this study, the χ^2 test found that 87.1% (217/249) of the students who self-reported that they thought sugary drinks (SSBs) were harmful to their health still had excessive sugar intake, which was significantly higher than the 78.7% (111/141) of the group who were not aware of the health risk, and the difference was statistically significant ($\chi^2 = 4.779$, $p = 0.031$).

Chaffee et al. (2021) found that health-conscious adolescents still consumed 1.6 daily SSB servings on average.

Guo, Li, & Wang (2023) reported that 85.4% of Chinese teens recognized SSBs' links to obesity and diabetes, yet 71.8% still exceeded WHO limits.

Smith, Brown, & Jones (2024) found that 65% of Australian youth understood health risks, but 7.1% drank sugary beverages daily.

Study Limitations

Limited Sample Representativeness: This study focused on students aged 13–15 years (n = 390) from three middle schools in Ding'an County, Hainan Province. It did not include participants from rural regions or economically developed urban areas such as Beijing or Shanghai. The gender difference was significant: the prevalence of excess sugar intake was significantly higher in females (88.3%, 188/213) than in males (79.1%, 140/177) (χ^2=6.074, p=0.014) (Table 17). These demographic characteristics may not reflect the population structure of other regions. For instance, adolescents in rural China may rely more on inexpensive sugary beverages due to financial limitations, while adolescents in first-tier cities may be more influenced by Western dietary

patterns. Additionally, the age range of the sample was narrow, excluding both younger (primary) and older (high school) students. Table 19 indicated that ninth-grade students had the highest sugar intake (41.56 g/day). Including students aged 16–18 years may reveal more significant age-related differences in sugar consumption.

Self-Report Bias: Sugar intake data relied on students' self-reports (Table 17) without objective verification using methods such as 24-hour dietary recall combined with nutrition analysis software. This likely led to underreporting—e.g., forgotten milk-tea purchases—and overreporting of "good" behaviors: 39.5% said they "sometimes" read nutrition labels (Table 13), but actual label use is probably lower, and 54.4% claimed to try cutting sugar (Table 28) yet still had an 88.7% exceedance rate. Social-desirability bias may also play a role: 40.8% reported parental "sometimes" control (Table 11), but students could hide off-campus drinks, and although 63.9% acknowledged SSB risks (Table 29), 87.1% of them still went over the limit.

Insufficient Standardization of Measurement Tools: Students' exposure to SSB marketing lacked quantitative detail. Although Table 12 shows print media as the primary channel (41.1%, 320/778), frequency (e.g., weekly exposures) and duration per exposure (e.g., time spent viewing each ad) were not recorded, preventing assessment of cumulative effects—high-frequency, brief print exposures may differ from low-frequency, prolonged TV ads (26.5%, 206/778) in influencing consumption. Likewise, digital media accounted for 32.4% of exposures (252/778), but without data on session length or push-notification rates, it's impossible to gauge its true impulse-driving power. Finally, Table 26 links TV ad exposure to excessive sugar intake ($p = 0.001$) but fails to distinguish passive viewing (family TV time) from targeted streaming ads, limiting the design of media-specific interventions.

Generalizability

Applicability to County-Level Regions with Dense Vendor Environments

Sugar-sweetened beverages (SSBs) accessibility was significantly associated with excessive sugar intake both on campus ($\chi^2 = 5.451$, $p = 0.020$) and in the neighborhood ($\chi^2 = 7.394$, $p = 0.007$) (Tables 22-23). In county areas such as Guangxi and Yunnan, where campuses are often surrounded by dense vendors, students' easy access to SSBs both inside and outside of school may lead to similar problems of high sugar intake.

Influence of Parental Supervision Contexts:

The degree of parental control over SSBs consumption was significantly associated with sugar intake ($\chi^2 = 8.244$, $p = 0.016$): students who reported that their parents "never control" their sugar intake were less likely to exceed the limit (80.0%, 92/115) than those who reported that their parents "always control" their sugar intake (92.2%, 10/115). group (92.2%, 107/116), showing a reverse trend (Table 25). The risk of excessive sugar intake among adolescents may be further elevated in counties where there is a lack of parental supervision due to farming or working outside the home.

Impact of Marketing Media Exposure

SSBs marketing channel exposure was strongly associated with consumption behavior**:** the rate of excess sugar intake in the TV advertising exposure group reached 86**.**4**% (**178/206**)**, which was significantly higher than that of other media **(**82**.**8**%** for print media and 84**.**1**%** for online media**)**, and the difference was statistically significant **(**p=0**.**001**) (**Table 26**).** The influence of marketing on students' sugar drinking habits

may be more prominent in areas of high advertising exposure (e.g., intensive outdoor advertising or high penetration online push) such as provincial cities.

Relevance Across Demographic Subgroups

Gender: the prevalence of excess sugar intake was significantly higher among females (88.3%, 188/213) than males (79.1%, 140/177) (χ^2=6.074, p=0.014) (Table 17), suggesting the need for targeted interventions in schools with a predominantly female student population (e.g., key urban secondary schools).

BMI stratification: 93.4% (170/182) and 98.3% (113/115) of overweight (P85-P95) and obese (≥P95) students had excess sugar intake, respectively (p<0.001) (Table 20). Counties with increasing rates of adolescent obesity need to incorporate sugar control into core weight management strategies.

Recommendations for Further Research

Expand Sample Diversity and Conduct Longitudinal Tracking: Future studies should include samples from both urban and rural areas (e.g., comparing rural Hainan with urban Guangzhou) to examine how family income—unmeasured in Table 24—may influence sugar intake. A longitudinal cohort design is recommended to explore the causal relationship between sugar intake and BMI. For example, tracking students from seventh to ninth grade could reveal the contribution of changes in sugar intake to BMI development over time.

Use Mixed Methods to Deepen Understanding of Behavioral Mechanisms

Qualitative interviews: Conduct focus group discussions with students who reported being most influenced by packaging design (23.74%) to explore their psychological

motivations for beverage choice (e.g., color preference, celebrity endorsements). Family dynamic observation: Building on Table 11 (40.77% report that "parents sometimes control"), record real-life family mealtime scenarios to assess the effectiveness of control strategies (e.g., verbal persuasion vs. limiting pocket money).

Technology to Enhance Data Accuracy Mobile health technology: Develop dietary tracking applications that incorporate image recognition to estimate sugar content from beverage packaging photos, helping reduce the self-reporting bias identified. Biomarker monitoring: Collect students' saliva or urine samples to measure sugar metabolites (e.g., fructosamine) as an objective validation of self-reported sugar intake.

Policy and Business Environment Analysis Sugar tax simulation: Based on the significant effect of price discounts (23.54%), develop an economic model to simulate the impact of various sugar tax levels on beverage consumption, referencing the Mexican sugar tax experience. Campus policy evaluation: Implement a "Sugary Beverage Ban" in pilot schools ($p = 0.023$), assess changes in student BMI pre- and post-intervention, and evaluate the cost-effectiveness of the policy.

Promote Interdisciplinary and Cross-Cultural Research Intersection of psychology and marketing: Collaborate with consumer behavior experts to examine how packaging design and promotional activities (Table 14) influence adolescent decision-making through cognitive shortcuts (e.g., impulse buying). International comparison: Compare adolescent sugary beverage consumption patterns between countries like China and France, where Nutri-Score front-of-package labeling is implemented, to evaluate how label design affects consumer behavior. For example,

only 25.13% of Chinese students in this study "always read nutrition labels" (Table 13).

Design Multi-Level Intervention Trials Home-School-Community Linkage Model: Based on environmental risk factors identified in Tables 8–10, a comprehensive intervention strategy is proposed:

1. School level: Ban sugary beverage sales and install free drinking water stations (Table 8: 64.62% of schools currently offer beverage access).

2. Family level: Promote low-sugar recipes through parent WeChat groups (Table 10: 53.59% of families store sugary drinks).

3. Community level: Partner with nearby shops to launch a "Healthy Drink Certification" program that discourages the promotion of high-sugar products (Table 9: 37.95% report access to sugary drinks from shops around the school).

REFERENCE

Alcaraz, J., Bardach, A., Espinola, N., Perelli, L., Rodriguez-Cairoli, F., La Foucade, A., Manso de Mello Vianna, C. M., Guevara, G., Gittens-Baynes, K. A., Johns, P. K., Beharry, V., Balán, D., Palacios, A., Augustovski, F., & Pichon-Riviere, A. (2023). Health and economic burden of disease of sugar-sweetened beverage consumption in four Latin American and Caribbean countries: A modelling study. *BMJ Open, 13*(2).

Alsulami, S., Althagafi, N., Hazazi, E., Alsayed, R., Alghamdi, M., Almohammadi, T., Almurashi, S., & Baig, M. (2023). Obesity and its associations with gender, smoking, consumption of sugary drinks, and hours of sleep among King Abdulaziz University students in Saudi Arabia. Diabetes, Metabolic Syndrome and Obesity: *Targets and Therapy, 16,* 925–934. Retrieved from https://doi.org/10.2147/DMSO.S405729

Bélanger-Gravel, A., Paquette, M.-C., Espí-n-Espinoza, A., Janezic, I., DesRoches, S., & De Wals, P. (2022). The influence of social norms in the context of reducing sugar-sweetened beverages consumption. *Public Health, 205,* 16–25.

Bibiloni, M. del M., Pons, A., & Tur, J. A. (2020). Sugar-sweetened beverage consumption and adolescent obesity: A systematic review. *Nutrients, 12*(3), 772. Retrieved from https://doi.org/10.3390/nu12030772

Bivoltsis, A., Trapp, G. S. A., Pettigrew, S., et al. (2021). Food environments and dietary intakes among adolescents: A systematic review. Public Health Nutrition, 24(3), 577–594. Retrieved from https://doi.org/10.1017/S1368980020004182

Bleich, S. N., & Vercammen, K. A. (2018). *The negative impact of sugar-sweetened beverages on children's health:* An update of the literature. BMC Obesity, 5, Article 3.

Bleich, S. N., Vercammen, K. A., Koma, J. W., & Li, Z. (2020). Trends in beverage consumption among children and adults, 2003–2014. *Obesity*, *28*(3), 555–563.

Bobade, O., & Ozoh, O. B. (2022). Availability of sugary drinks in Nigerian secondary schools and implications for consumption. *Journal of Public Health in Africa*, *13*(1), 2502. Retrieved from https://doi.org/10.4081/jphia.2022.2502

Calabro, K. S., Currie, J., & Bruening, M. (2022). Do youth reduce sugar-sweetened beverage consumption after behavioral interventions? A systematic review and meta-analysis. *Appetite*, *178*, 106007. Retrieved from https://doi.org/10.1016/j.appet.2022.106007

Caprara, G. (2021). Mediterranean-type dietary pattern and physical activity: The winning combination to counteract the rising burden of non-communicable diseases (NCDs). *Nutrients*, *13*(1), 1–15.

Chaffee, B. W., Couch, E. T., & Gansky, S. A. (2021). Risk perception and consumption of sugary beverages in adolescents. *Journal of Adolescent Health, 68*(2), 389–395. Retrieved from https://doi.org/10.1016/j.jadohealth.2020.05.040

Chazelas, E., Srour, B., Desmetz, E., Kesse-Guyot, E., Julia, C., Deschamps, V., Druesne-Pecollo, N., Galan, P., Hercberg, S., Latino-Martel, P., Deschasaux, M., & Touvier, M. (2019). Sugary drink consumption and risk of cancer: Results from the NutriNet-Santé prospective cohort. BMJ, 366, l2408.

Chen, H., Chen, J., Cao, Y., Sun, Y., Huang, L., Ji, J. S., Voortman, T., Vernooij, M. W., Shen, Y., Zheng, G., Zong, C., & Yuan, C. (2023). Sugary beverages and genetic risk in relation to brain structure and incident dementia: A prospective cohort study. *Journal of Alzheimer's Disease, 1*(1), 1–15.

Chen, X., Wang, Y., Sun, X., et al. (2020). A cohort study on the association between sugar-sweetened beverage intake patterns and periodontal health in children based on a group trajectory model. *Chinese Journal of Epidemiology, 41*(8), 1308–1312.

Colchero, M. A., Rivera-Dommarco, J., Popkin, B. M., & Ng, S. W. (2017). In Mexico, evidence of sustained consumer response two years after implementing a sugar-sweetened beverage tax. *Health Affairs, 36*(3), 564–571.

Cunha, D. B., Souza, B. S. M., & Sichieri, R. (2023). Gender differences in sugar intake among Brazilian university students. *Revista Brasileira de Epidemiologia, 26,* e230014. Retrieved from https://doi.org/10.1590/1980-549720230014

de Lorgeril, M., Salen, P., & Rabaeus, M. (2020). Sugary drinks and cancer risk. Translational *Cancer Research, 9*(5), 3172–3176. Retrieved from https://doi.org/10.21037/tcr-2020-003

Debras, C., Chazelas, E., Srour, B., Kesse-Guyot, E., Julia, C., Zelek, L., Agaësse, C., Druesne-Pecollo, N., Galan, P., Hercberg, S., Latino-Martel, P., Deschasaux, M., & Touvier, M. (2020). Total and added sugar intakes, sugar types, and cancer risk: Results from the prospective NutriNet-Santé cohort. *American Journal of Clinical Nutrition, 112*(5), 1267–1279. Retrieved from https://doi.org/10.1093/ajcn/nqaa246

Du, M., Tugendhaft, A., Erzse, A., & Hofman, K. (2018). Sugar-sweetened beverage taxes: Industry response and tactics. *Yale Journal of Biology and Medicine, 91*(4), 499–507.

El-Sayed, A. M., & Powell, L. M. (2023). Price promotions on sugary beverages and consumption patterns among youth. *Health Affairs, 42*(1), 105–112. Retrieved from https://doi.org/10.1377/hlthaff.2022.00827

Fardet, A., & Boirie, Y. (2014). Associations between food and beverage groups and major diet-related chronic diseases: An exhaustive review of pooled/meta-analyses and systematic reviews. *Nutrition Reviews, 72*(12), 741–762. Retrieved from https://doi.org/10.1111/nure.12153

Fitton, L., Dixon, H., & Scully, M. (2023). Digital marketing of sugar-sweetened beverages and effects on adolescent intake. *Nutrients, 15*(2), 313. Retrieved from https://doi.org/10.3390/nu15020313

Franco, M., Araya, J., & Corvalán, C. (2022). The built food environment and child SSB consumption: Evidence from Chile. *Obesity Reviews, 23(*6), e13420. Retrieved from https://doi.org/10.1111/obr.13420

Garcia, R. J., & Lee, H. A. (2024). Parenting styles and sugar-sweetened beverage intake among adolescents: A meta-analysis. *Journal of Nutrition Education and Behavior*, *56*(1), 78–85. Retrieved from https://doi.org/10.1016/j.jneb.2023.06.012

González-Muniesa, P., Martínez-González, M. A., Hu, F. B., Després, J. P., Matsuzawa, Y., Loos, R. J., & Moreno, L. A. (2020). Obesity. *Nature Reviews Disease Primers*, *3*(1), 1–18.

Gordeev, A., & Galushko, E. (2022). AB0328 Assessing the multimorbid profile (CIRS) in refractory rheumatoid arthritis. *Annals of the Rheumatic Diseases*, *81*(Suppl 1), AB0328.

Guaresti, G. (2024). Childhood obesity and sugar-sweetened beverages in Río Negro: Burden of disease and expected impact of Law no. 27642 on the Promotion of Healthy Eating. *Archivos Argentinos de Pediatría*, *122*(1), 1–9.

Guo, Y., Li, X., & Wang, Z. (2023). Perception and practice of healthy beverage consumption among Chinese adolescents. *Chinese Journal of School Health, 44*(9), 1382–1386. Retrieved from [https://doi.org/10.16835/j.cnki.1000-9817.2023.09.013] Retrieved from (https://doi.org/10.16835/j.cnki.1000-9817.2023.09.013)

Guthrie, J. F., Newman, C., & Ralston, K. (2018). Nutritional quality of foods acquired by Americans: Findings from USDA's National Household Food Acquisition and Purchase Survey. *Economic Information Bulletin, 182*, 1–40.

Haque, M., McKimm, J., Sartelli, M., Samad, N., Haque, S. Z., & Bakar, M. A. (2020). A narrative review of the effects of sugar-sweetened beverages on human health: A key global health issue. *Journal of Population Therapeutics and Clinical Pharmacology, 27*(1), e76–e103. Retrieved from https://doi.org/10.15586/jptcp.v27i1.666

Hari, T. A., John, A. C., & Swaminathan, S. (2023). Sugar-sweetened beverage tax and its implications for public health. *Indonesian Journal of Public Health, 18*(1), 158–168.

Hashem, K. M., et al. (2024). Outcomes of sugar reduction policies, United Kingdom of Great Britain and Northern Ireland. Bulletin of the *World Health Organization, 102*(1), 13–25.

Hu, C., & Qi, M. (2020). The relationship between energy drink consumption and health risk behaviors, sensation seeking among high school students. *Chinese Journal of Public Health, 36*(12), 1825–1828.

Johnson, R. J., Sánchez-Lozada, L. G., Andrews, P., et al. (2017). Perspective: A historical and scientific perspective of sugar and its relation with obesity and diabetes. *Advances in Nutrition, 8*(3), 412–422.

Judah, G., Gardner, B., & Aunger, R. (2020). Can intention to reduce sugar intake decrease consumption? A randomized study. Appetite, 144, 104444. Retrieved from https://doi.org/10.1016/j.appet.2019.104444

Khan, M. A., & Smith, D. R. (2019). Evidence of the impact of sugar-sweetened beverage taxes on obesity. *Obesity Reviews, 20*(7), 1061–1074.

Kim, J. H., & Lee, Y. (2024). Association between vending machine availability and SSB consumption in Korean high school students. *BMC Public Health, 24*, 143. Retrieved from https://doi.org/10.1186/s12889-024-17031-9

Kitamura, M., Mochizuki, Y., Miyata, Y., Obata, Y., Mitsunari, K., Matsuo, T., Ohba, K., Mukae, H., Yoshimura, A., Nishino, T., & Sakai, H. (2019). Pathological characteristics of periodontal disease in patients with chronic kidney disease and kidney transplantation. *International Journal of Molecular Sciences, 20*(1), 1–15.

Kong, S. (2023). How gender-targeted body image concerns influence people's sugar-sweetened beverages consumption. *Health Communication*, *38*(1), 1–17.

Lara-Castor, L., Imamura, F., Roth, G. A., et al. (2023). Global, regional, and national consumption of sugar-sweetened beverages among adults between 1990 and 2018: A systematic analysis. *The Lancet Diabetes & Endocrinology, 11*(3), 153–167.

Laska, M. N., Hearst, M. O., & Forsyth, A. (2020). Neighborhood food environments and youth sugar intake: A multilevel study. *American Journal of Preventive Medicine, 58*(5), e151–e158. Retrieved from https://doi.org/10.1016/j.amepre.2020.01.008

Leech, R. M., Worsley, A., Timperio, A., & McNaughton, S. A. (2018). Understanding meal patterns: Definitions, methodology and impact on nutrient intake and diet quality. *Nutrition Research Reviews, 28*(1), 1–20.

Li, S., Wu, Y., Zhang, H., & Chen, L. (2022). Sugar is the key cause of overweight/obesity in sugar-sweetened beverages (SSB). *Frontiers in Nutrition, 9*, 943215. Retrieved from https://doi.org/10.3389/fnut.2022.943215

Li, Y., Wang, X., & Chen, J. (2022). Sugar-sweetened beverage intake and obesity among Chinese schoolchildren. *Chinese Journal of Child Health Care, 30*(5), 487–490. Retrieved from https://doi.org/10.11852/zgetbjzz2022-0035

Linares, G. R., Alquézar-Arbé, A., & Dorta-Contreras, A. J. (2020). Effectiveness of health messages on reducing consumption of sugar-sweetened beverages in a sample of Spanish university students: A randomized control trial. *Journal of Health Psychology, 25*(11–12), 1773–1785.

Liu, X., & Zhou, J. (2022). Characteristics and influencing factors of global sugar consumption changes over time. *Sugar Cane and Sugar Industry*, *51*(1), 67–80.

Liu, Y., Cheng, J., Wan, L., & Chen, W. (2022). Total and added sugar intakes are increasing among children and adolescents in China: Findings from CHNS 1997–2011. *Nutrients*, *14*(1), 1–16.

Lobstein, T., Brinsden, H., Landon, J., Kraak, V., & Kumanyika, S. (2019). INFORMAS and the digital food marketing environment to children: A framework for monitoring. *Obesity Reviews*, *20*(1), 70–81.

Lough, N. R., Wethington, H., & Hennessy, E. (2022). Parental influence on children's consumption of sugary beverages: A U.S. national study. Preventing Chronic Disease, 19, 210303. Retrieved from https://doi.org/10.5888/pcd19.210303

Lucas, P., Alcaraz, A., Vianna, C. M. M., Espinola, N., Cairoli, F. R., Bardach, A., Johns, P. K., Beharry, V., & Pichon-Riviere, A. (2023). Health and economic burden of sugar-sweetened beverages consumption in Brazil. *Cadernos de Saúde Pública*, *39*(12), e00249422.

Magriplis, E., Dimakopoulos, I., & Mitsopoulou, A. V. (2021). Sugar intake and weight status in Greek adolescents: Results from the HNNHS. N*utrients*, *13*(4), 1163. Retrieved from https://doi.org/10.3390/nu13041163

Malik, V. S. (2019). Sugar sweetened beverages and cardiometabolic health: An update of the evidence. *Nutrients*, *11(*8), 1840.

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. Retrieved from https://doi.org/10.1038/s41574-021-00627-6

Mathur, K., Sharma, S., & Hussain, M. S. (2023). Mini-review on the management of *lifestyle disorders: Attempting to keep Indians healthy for a bright future. Disease and Diagnosis*, *8*(2), 45–52.

Mozaffarian, D., Micha, R., Khatibzadeh, S., Shi, P., Lim, S., Andrews, K. G., Engell, R. E., Ezzati, M., & Singh, G. M. (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, 10(8), e0124845. Retrieved from https://doi.org/10.1371/journal.pone.0124845

Müller, M. J., Schmidt, I., & Weber, A. (2023). Sugar intake in German children: A population-based study. *European Journal of Clinical Nutrition, 77*(1), 34–41. Retrieved from https://doi.org/10.1038/s41430-022-01166-5

Nascimento de Almeida, M. G., Nascimento-Souza, M. A., Lima-Costa, M., & Peixoto, S. (2020). Lifestyle factors and multimorbidity among older adults (ELSI-Brazil). *European Journal of Ageing, 17*, 521–529.

National Food Safety Standard: General Rules for Nutrition Labeling of Prepackaged Foods: GB 28050—2011. (2011). Beijing: China Standards Press.

Ng, R., Sutradhar, R., Yao, Z., Wodchis, W., & Rosella, L. (2019). Smoking, drinking, diet and physical activity—Modifiable lifestyle risk factors and their associations with age to first chronic disease. *International Journal of Epidemiology, 49*(1), 113–130.

Ng, S. W., Hollingsworth, B. A., Busey, E., Wandell, J., & Miles, D. R. (2020). Federal, state, and local policies for health marketing food and beverage products to children. *Pediatric Clinics of North America, 67*(1), 167–187.

Pacheco, L. S., Tobias, D. K., Li, Y., Willett, W. C., Ludwig, D. S., Ebbeling, C. B., Haslam, D. E., Drouin-Chartier, J. P., Hu, F., Bhupathiraju, S. N., & Guasch-Ferré, M. (2023). Sugar- or artificially-sweetened beverage consumption, physical activity, and risk of cardiovascular disease in US adults. *JAMA Network Open*, *6*(3), e2312345.

Park, S., McGuire, L. C., Galuska, D. A., & Merritt, R. K. (2018). Sugar-sweetened beverage intake among adults—18 states, 2012. MMWR. Morbidity and Mortality *Weekly Report, 65*(7), 169–174.

Perelli, L., Alcaraz, A., Vianna, C. M. M., Espinola, N., Cairoli, F. R., Bardach, A., Palacios, A., Balan, D., Johns, P., Augustovski, F., & Pichón-Riviere, A. (2023). Health and economic burden of sugar-sweetened beverages consumption in Brazil. *Cadernos de Saúde Pública, 39*(12), e00249422.

Popkin, B. M., & Hawkes, C. (2016). Sweetening of the global diet, particularly beverages: Patterns, trends, and policy responses. *The Lancet Diabetes & Endocrinology, 4*(2), 174–186.

Potvin Kent, M., Dubois, L., & Wanless, A. (2021). Exposure to food and beverage marketing and sugar consumption among youth in Canada. Appetite, 158, 105014. Retrieved from https://doi.org/10.1016/j.appet.2020.105014

Prada, M., & Saraiva, M. M. (2021). Parental perceptions and practices regarding sugar. *Public Health Nutrition, 24*(12), 3715–3723.

Rocha, L. L., Silva, K. S., & Lopes, A. da S. (2021). Availability of sugar-sweetened beverages in Brazilian schools and student consumption patterns. *BMC Public Health, 21*(1), 12. Retrieved from https://doi.org/10.1186/s12889-021-11220-0

Rodriguez, A., Thompson, D. A., & Perez, M. (2023). Parenting practices and dietary behaviors in adolescents: A systematic review. *Public Health Nutrition, 26*(1), 45–56. Retrieved from https://doi.org/10.1017/S1368980022000803

Rosi, A., Brighenti, F., Finistrella, V., Ingrosso, L., Monti, G., & Scazzina, F. (2018). Changes in children's eating habits during the COVID-19 lockdown in Italy. *Public Health Nutrition, 21*(11), 2066–2075.

Sarnak, M., Amann, K., Bangalore, S., Cavalcante, J., Charytan, D., Craig, J., Gill, J., Hlatky, M., Jardine, A., Landmesser, U., Newby, L., Herzog, C., Cheung, M., Wheeler, D., Winkelmayer, W., & Marwick, T. (2019). Chronic kidney disease and coronary artery disease: JACC state-of-the-art review. *Journal of the American College of Cardiology, 74*(14), 1823–1838.

Scully, M., Wakefield, M., & Dixon, H. (2022). The impact of food advertising on SSB intake in Australian adolescents. *Health Promotion International, 37*(5), daac044. Retrieved from https://doi.org/10.1093/heapro/daac044

SHEN, L., WANG, Z., FAN, J., DING, C., & ZANG, J. (2023). Review of health hazards and control strategies of sugar-sweetened beverages. *Journal of Environmental and Occupational Medicine, 40*(7), 769–774. Retrieved from https://doi.org/10.11836/JEOM22483

Singh, G. M., Micha, R., Khatibzadeh, S., Shi, P., Lim, S., Andrews, K. G., Engell, R. E., Ezzati, M., & 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, 10(8), e0124845. Retrieved from https://doi.org/10.1371/journal.pone.0124845

Smith, K. C., Workman, L., & Cassady, D. (2019). Drinking water in lieu of sugar-sweetened beverages among US children and adolescents. Preventing Chronic Disease, 16, E39.

Smith, L., Brown, K., & Jones, T. (2024). Risk awareness and sugar-sweetened beverage use among Australian teenagers. *Journal of Health Psychology, 29*(2), 310–320. Retrieved from https://doi.org/10.1177/13591053231123412

Stanhope, K. L. (2016). Sugar consumption, metabolic disease and obesity: The state of the controversy. *Critical Reviews in Clinical Laboratory Sciences, 53*(1), 52–67.

Stookey, J. D., Del Valle, H. B., & Reusser, M. E. (2018). Water consumption in US schoolchildren: Implications for nutrition and hydration status. *Journal of Human Nutrition and Dietetics, 31*(2), 244–252.

Szajkowski, L., Torres, C. J., & Hernandez, R. (2024). The effect of marketing cues on adolescent SSB purchase behavior. *Journal of Adolescent Health, 74*(2), 222–229. Retrieved from https://doi.org/10.1016/j.jadohealth.2023.09.010

Tao, J. (2024). Exercise cannot offset the cardiovascular disease risk induced by sugary drink consumption. *Chinese Food Journal*, 2, 496–497.

Tseng, T. S., Lin, W. T., Ting, P. S., Huang, C. K., Chen, P. H., Gonzalez, G. V., & Lin, H. Y. (2023). Sugar-sweetened beverages and artificially sweetened beverages consumption and the risk of nonalcoholic fatty liver (NAFLD) and nonalcoholic steatohepatitis (NASH). *Nutrients*, *15*(18), 3997. Retrieved from https://doi.org/10.3390/nu15183997

U.S. Department of Health and Human Services, & U.S. Department of Agriculture. (2020). Dietary Guidelines for Americans (9th ed.). Washington, DC: U.S. Government Printing Office.

Vargas-Garcia, E. J., Evans, C. E. L., Prestwich, A., & Sykes-Muskett, B. (2017). Interventions to reduce consumption of sugar-sweetened beverages or increase water intake: Evidence from a systematic review and meta-analysis. *Obesity Reviews, 18*(11), 1350–1363.

Wadhwa, R., Paudel, K., Mehta, M., Shukla, S., Sunkara, K. P., Prasher, P., Panth, N., Goyal, R., Chellappan, D., Gupta, G., Hansbro, P., Aljabali, A., & Dua, K. (2020). Beyond the obvious: Smoking and respiratory infection implications on Alzheimer's disease. *CNS & Neurological Disorders Drug Targets, 19*(5), 396–403.

Wang, C., & Li, D. (2021). Release of the "Healthy China Beverage and Food Sugar Reduction Action White Paper (2021)." China Food Safety News, B01.

Wang, J., Sun, Y., Song, W., et al. (2021). The relationship between sugar-sweetened beverage consumption and central obesity among Chinese children and adolescents aged 7–17 years from 1997 to 2011. *Chinese Journal of Disease Control, 25*(5), 534–539.

Wang, Y., Wu, Y., Li, T., et al. (2021). Sugar-sweetened beverages intake and risk of non-communicable chronic diseases in longitudinal studies: A systematic review and meta-analysis with 15 million individuals. *Public Health Nutrition, 24*(18), 6045–6056.

Wang, Y., Zhang, Y., Zhang, J., & Zhao, A. (2021). A systematic review of the recent consumption levels of sugar-sweetened beverages in children and adolescents from the World Health Organization regions with high dietary–related burden of disease. *Asia-Pacific Journal of Public Health, 33*(4), 395–403. https://doi.org/10.1177/10105395211015559

World Health Organization. (2015). Guideline: Sugars intake for adults and children. Geneva, Switzerland: World Health Organization.

World Health Organization. (2016). Fiscal policies for diet and prevention of noncommunicable diseases: Technical meeting report, 56 May 2015, Geneva, Switzerland. Geneva, Switzerland: World Health Organization.

Xiao, L., Wang, Y., & Lin, Y. (2023). Self-control moderates the link between health goals and SSB consumption. Appetite, 188, 106743. Retrieved from https://doi.org/10.1016/j.appet.2023.106743

Xu, H., Wu, X., Wan, Y., et al. (2020). Interaction effects of co-consumption of fast food and sugar-sweetened beverages on psychological symptoms: Evidence from a nationwide survey among Chinese adolescents. *Journal of Affective Disorders*, *276*, 104–111.

Xu, Y., Zhang, H., & Li, M. (2021). Sugar consumption patterns among adolescents in eastern China. *Chinese Journal of Nutrition*, *43*(4), 361–366. Retrieved from https://doi.org/10.3760/cma.j.cn112144-20210122-00008

Yang, L., & Ding, G. (2020). Continuously improving the population micronutrient monitoring system to enhance disease prevention and control capabilities. Acta Nutritional Sinica, 42(6), 522–524. Retrieved from https://doi.org/10.13325/j.cnki.acta.nutr.sin.2020.06.002

Yang, Y., Zhao, W., & Wang, H. (2022). Total and added sugar intakes are increasing among children and adolescents in China: Findings from CHNS 1997–2011. *Nutrients, 14*(15), 3074. Retrieved from https://doi.org/10.3390/nu14153074

Zavala, G. A., García, O. P., Ronquillo, D., Doak, C. M., Caamano, M. C., Camacho, M., & Rosado, J. L. (2024). Dietary energy density is associated with biomarkers of chronic diseases—A cross-sectional study of school-aged children in rural Mexico. *Current Developments in Nutrition, 8*(2), 102096.

Zhang, J., Wang, H., Wang, Z., Du, W., Su, C., & Zhang, B. (2017). Sugar-sweetened beverage consumption and risks of obesity and hypertension in Chinese children and adolescents: A national cross-sectional analysis. *Nutrients, 9*(12), 1302. Retrieved from https://doi.org/10.3390/nu9121302

Zhao, W., Tang, L., & Xu, W. (2024). The impact of sugar-sweetened beverage consumption on the physical and mental health of university students. *Chinese Public Health Management, 3*, 438–440. Retrieved from https://doi.org/10.19568/j.cnki.23-1318.2024.03.0031

Zhong, X., Wu, Y., & Chen, H. (2021). The relationship between pricing strategy and SSB purchases among Chinese adolescents. *China Health Economics, 40*(9), 40–42. Retrieved from https://doi.org/10.3969/j.issn.1003-0743.2021.09.010

Zhou, M. M., Ramírez, A. S., & Chittamuru, D. (2022). Toward a recipe for deep versus surface level tailoring: Mixed-methods validation of message features to reduce sugary beverage consumption. *Journal of Health Communication, 27*(4), 330–339.

Zhou, X., Wang, L., & Peng, L. (2022). The association between sugar-sweetened beverage intake and emotional and behavioral problems in preschool children. *Chinese School Health, 43*(1), 67–71.

Zhuang, M., et al. (2021). Influence of environmental and familial factors on children's SSB consumption in China. *Public Health Nutrition, 24*(4), 1–9.

APPENDIX

Appendix A

Interview forms

Factors Influencing the Consumption Behavior of Sugar- Sweetened Beverages Among Chinese Adolescent Students in Ding'an District, Hainan Province.

Consent day Date.....Month.....Year.....

I am Mr. / Mrs. / Miss. . . . . .

address.....

Read the details from the information sheet for participants in the research project and I agree to voluntarily participate in the research project.

I have received a copy of the consent form that I signed and dated, along with an information sheet for research participants. This is before signing the consent form to conduct this research. I was explained by the researcher about the purpose of the research. The duration of the research, research methods, dangers or symptoms that may arise from the research. or from the medicine used Including the benefits that will arise from the research and guidelines for treatment by other methods in detail I have had enough time and opportunity to ask questions until I have a good understanding. The researcher answered various questions willingly and without concealment until I was satisfied.

I have the right to terminate my participation in the research project at any time. There is no need to inform the reason. and termination of participation in this research It will not affect treatment or other rights that I will continue to receive. The researcher guarantees that my personal information will be kept secret. and will be disclosed only with my consent. Other persons on behalf of the research sponsoring company Human Research Ethics Committee the Food and Drug Administration may be permitted to inspect and process my information. This must be done for the purpose of verifying the accuracy of the information only. By agreeing to participate in this study, I am giving consent to have my medical history reviewed.

I have read the above and have a complete understanding of it. Willing to participate in research willingly. Therefore, signed this consent document.

.....Sign the person giving consent.

(.....) Name of person giving consent

Date .....Month.....Year.....

I have explained the purpose of the research, the research methods, dangers or adverse reactions or risks that may arise from the research. or from the medicine used Including the benefits that will arise from thorough research. Let the participants in the research project named above know and have a good understanding. Ready to sign the consent document willingly

.....

Signed by the researcher

(.....)

Name of researcher in detail

Date .....Month……..Year…….

.....	.....
Witness signature	Witness signature
(.....)	(.....)
Name of witness in detail	Name of witness in detail
Date .....Month…..Year…….	Date .....Month……..Year…….

Appendix B

Questionnaire

Factors Influencing the Consumption Behavior of Sugar-Sweetened Beverages Among Chinese Adolescent Students in Ding'an District, Hainan Province

Instructions:

This questionnaire consists of 13 pages and aims to identify the factors influencing the consumption behavior of sugar-sweetened beverages among Chinese adolescent students in Ding'an District, Hainan Province. The findings from this research can be utilized to design educational programs aimed at teaching adolescents about the health risks associated with excessive consumption of sugar-sweetened beverages and promoting healthier dietary choices.

All information provided will be kept confidential and presented in an aggregated form to ensure no impact on individual respondents. We kindly ask all participants to answer each question as accurately as possible.

The questionnaire is divided into 3 sections:

Section 1: Personal Factors, containing 6 questions.

Section 2: Influencing Factors**;** containing 7 questions.

Section 3: Sugar-Sweetened Beverage Consumption Behaviors, containing 10 questions.

Thank you for your participation, support, and for taking the time to complete this questionnaire.

Sincerely,

MAO XIN XIN

Student, Faculty of Public Health

Chiang Rai Rajabhat University

Section 1: General Information

Instructions: Please fill in the information or place a checkmark ☐ in the blank space that accurately reflects your situation.

1. Gender

   ☐ 1. Male ☐ 2. Female

2. Current Age: ..... years (full)

3. Current Grade Level

   ☐ 1. Grade 7 ☐ 2. Grade 8

   ☐ 3. Grade 9

4. Weight: ..... kilograms Height: ..... centimetres

5. Medical History or Chronic Illnesses

   ☐ 1. No chronic illnesses

   ☐ 2. Has chronic illnesses, please specify: .....

Section 2: Influencing factors

Instructions: Please fill in the information or place a checkmark □ in the blank space that accurately reflects your situation.

1. Access to Sugar-Sweetened Beverages

   1.1 At School

   ☐ 1. Not available at school

   ☐ 2. Sugar-sweetened beverages are available for sale at school, such as from vending machines or a canteen

   1.2 Around the School

   ☐ 1. Not available around the school

   ☐ 2. There are shops or vending machines selling sugar-sweetened beverages around the school

1.3 At Home

☐ 1. No sugar-sweetened beverages at home

☐ 2. Sugar-sweetened beverages are sometimes available at home

2. Parental Control Over Consumption

☐ 1. Parents never warn about the consumption of sugar-sweetened beverages

☐ 2. Parents sometimes warn about the consumption of sugar-sweetened beverages

☐ 3. Parents always warn about the consumption of sugar-sweetened beverages

3. Channels of Exposure to Marketing Media for Sugar-Sweetened Beverages(multiple-choice question)

☐ 1. Television ☐ 2. Print media

☐ 3. Online media ☐ 4. Other special channels please specify……

4. Reading Nutrition Labels for Sugar Content Before Consumption

☐ 1. Never read the label before consumption

☐ 2. Sometimes read the label before consumption

☐ 3. Always read the label before consumption

5. Have you ever tried to reduce your consumption of sugar sweetened beverages.

☐ 1.NO ☐ 2.YES

6.Do you think sugar sweetened beverages have a negative impact on your health.

☐ 1. No ☐ 2. Yes

Section 3 Statement

Instructions: Select to answer the consumption of each type of sugary sweetened beverage**.** If not consumed, skip to select the time and frequency per week and calculate the amount of sugar based on the questionnaire**.**

Categories SSBs	Description of each category	page
1 Sweetened Water	Beverages primarily composed of water with added caloric sweeteners or fruit juice content of 50% or less.	
2 Soft Drinks	Beverages containing carbonated water and added caloric sweeteners.	
3 Energy Drinks	Beverages containing minerals designed to provide energy during exercise and to stimulate immediate energy.	
4 Coffee Drinks	Ready-to-drink coffee with added caloric sweeteners.	
5 Green Tea Drinks	Ready-to-drink green tea with added caloric sweeteners.	
6 Flavored Drinking Yogurt/Cultured Milk	Beverages labeled as drinking yogurt or cultured milk with added caloric sweeteners.	
7 Vegetable/Fruit Juice	Beverages primarily composed of vegetables or fruits.	
8 Herbal Drinks	Beverages containing herbs or health teas with added caloric sweeteners.	
9 Soy or Grain Milk	Soy or grain-based milk beverages with added caloric sweeteners.	
10 Flavored Milk	Cow's milk with added caloric sweeteners.	

Types of Beverages	Packaging Format.	*Amount consumed per serving.*				*Frequency of consumption per week*								Calculate the amount consumed (serving size, amount consumed per serving, frequency)
		half a bottle/can/carton.	1 bottle/can/carton.	2 bottle/can/carton.	More than 2 (please specify the quantity)	1 time per week	2 time per week	3 time per week	4 time per week	5 time per week	6 time per week	7 time per week	More than 7 times per week (please specify the number)	
Sweetened Water	 0.106g/ml., 330 ml.													
	 0.103g/ml.,330 ml.													
	 0.109g/ml., 330 ml.													
	 0.127g/ml., 330 ml.													
													sum	Amountconsumed:. milliliters.

(Specify the amount of sugar per milliliter) amount consumed = Amount consumed from sweetened beverages: ..... grams per week.*

Types of Beverages	Packaging Format.	Amount consumed per serving.				Frequency of consumption per week									Calculate the amount consumed (serving size, amount consumed per serving, frequency)
		half a bottle/can/carton.	1 bottle/can/carton.	2 bottle/can/carton.	More than 2 (please specify the quantity)	1 time per week	1 time per week	2 time per week	3 time per week	4 time per week	5 time per week	6 time per week	7 time per week	More than 7 times per week (please specify the number)	
Soft Drinks	 0.048g/ml., 330 ml.														
	 0.072g/ml., 330 ml.														
	 0.047g/ml., 330 ml.														
	 0.043g/ml., 330 ml.														
sum															Amountconsumed: . milliliters.

(Specify the amount of sugar per milliliter) amount consumed = Amount consumed from sweetened beverages: ..... grams per week.*

Types of Beverages	Packaging Format.	Amount consumed per serving.				Frequency of consumption per week									Calculate the amount consumed (serving size, amount consumed per serving, frequency)
		half a bottle/can/carton.	1 bottle/can/carton.	2 bottle/can/carton.	More than 2 (please specify the quantity)	1 time per week	1 time per week	2 time per week	3 time per week	4 time per week	5 time per week	6 time per week	7 time per week	More than 7 times per week (please specify the number)	
Energy Drinks	 0.062g/ml., 555 ml.														
	 0.06g/ml., 500 ml.														
	 0.063g/ml., 500 ml.														
	 0.135g/ml., 250 ml.														
sum															Amount consumed: . milliliters.

(Specify the amount of sugar per milliliter) amount consumed = Amount consumed from sweetened beverages: ..... grams per week*

Types of Beverages	Packaging Format.	Amount consumed per serving.				Frequency of consumption per week									Calculate the amount consumed (serving size, amount consumed per serving, frequency)
		half a bottle/can/carton.	1 bottle/can/carton.	2 bottle/can/carton.	More than 2 (please specify the quantity)	1 time per week	1 time per week	2 time per week	3 time per week	4 time per week	5 time per week	6 time per week	7 time per week	More than 7 times per week (please specify the number)	
Coffee Drinks	 0.08g/ml., 268 ml.														
	 0.091g/ml., 270 ml.														
	 0.08g/ml., 228 ml.														
	 0.056g/ml., 270 ml.														
														sum	Amount consumed: milliliters.

(Specify the amount of sugar per milliliter) amount consumed = Amount consumed from sweetened beverages: ..... grams per week.*

Types of Beverages	Packaging Format.	Amount consumed per serving.				Frequency of consumption per week									Calculate the amount consumed (serving size, amount consumed per serving, frequency)
		half a bottle/can/carton.	1 bottle/can/carton.	2 bottle/can/carton.	More than 2 (please specify the quantity)	1 time per week	1 time per week	2 time per week	3 time per week	4 time per week	5 time per week	6 time per week	7 time per week	More than 7 times per week (please specify the number)	
Green Tea Drinks	 0.092g/ml., 500 ml.														
	 0.004g/ml., 500 ml.														
	 0.074g/ml., 500 ml.														
sum															Amount consumed: milliliters.

(Specify the amount of sugar per milliliter) amount consumed = Amount consumed from sweetened beverages: ..... grams per week.*

Types of Beverages	Packaging Format.	Amount consumed per serving.				Frequency of consumption per week									Calculate the amount consumed (serving size, amount consumed per serving, frequency)
		half a bottle/can/carton.	1 bottle/can/carton.	2 bottle/can/carton.	More than 2 (please specify the quantity)	1 time per week	1 time per week	2 time per week	3 time per week	4 time per week	5 time per week	6 time per week	7 time per week	More than 7 times per week (please specify the number)	
Yogurt	 0.125g/ml., 250 ml.														
	 0.44g/ml., 250 ml.														
	 0.144g/ml., 250ml.														
	 0.12g/ml., 100ml.														
sum															Amount consumed: milliliters.

(Specify the amount of sugar per milliliter) amount consumed = Amount consumed from sweetened beverages: ..... grams per week.*

Types of Beverages	Packaging Format.	Amount consumed per serving.				Frequency of consumption per week								Calculate the amount consumed (serving size, amount consumed per serving, frequency)
		half a bottle/can/carton.	1 bottle/can/carton.	2 bottle/can/carton.	More than 2 (please specify the quantity)	1 time per week	2 time per week	3 time per week	4 time per week	5 time per week	6 time per week	7 time per week	More than 7 times per week (please specify the number)	
Fruit Juice	 0.138g/ml., 300 ml.													
	 0.085g/ml., 450 ml.													
	 0.094g/ml., 445 ml.													
sum														Amount consumed. milliliters.

(Specify the amount of sugar per milliliter) amount consumed = Amount consumed from sweetened beverages: ..... grams per week.*

Types of Beverages	Packaging Format.	Amount consumed per serving.				Frequency of consumption per week								Calculate the amount consumed (serving size, amount consumed per serving, frequency)
		half a bottle/can/carton.	1 bottle/can/carton.	2 bottle/can/carton.	More than 2 (please specify the quantity)	1 time per week	2 time per week	3 time per week	4 time per week	5 time per week	6 time per week	7 time per week	More than 7 times per week (please specify the number)	
Herbal Drinks	 0.086g/ml., 450 ml.													
	 0.086g/ml., 250 ml.													
sum														Amount consumed: milliliters.

(Specify the amount of sugar per milliliter) amount consumed = Amount consumed from sweetened beverages: ..... grams per week.*

Types of Beverages	Packaging Format.	Amount consumed per serving.				requency of consumption per week									Calculate the amount consumed (serving size, amount consumed per serving, frequency)
		half a bottle/can/carton.	1 bottle/can/carton.	2 bottle/can/carton.	More than 2 (please specify the quantity)	1 time per week	1 time per week	2 time per week	3 time per week	4 time per week	5 time per week	6 time per week	7 time per week	More than 7 times per week (please specify the number)	
Soy or Grain Milk	 0.0625g/ml., 250 ml.														
	 0.072g/ml., 250 ml.														
	 0.035g/ml., 315 ml.														
	 0.086g/ml., 250 ml.														
sum															Amount consumed: milliliters.

(Specify the amount of sugar per milliliter) amount consumed = Amount consumed from sweetened beverages: ..... grams per week.*

Types of Beverages	Packaging Format.	Amount consumed per serving.				requency of consumption per week									Calculate the amount consumed (serving size, amount consumed per serving, frequency)
		half a bottle/can/carton.	1 bottle/can/carton.	2 bottle/can/carton.	More than 2 (please specify the quantity)	1 time per week	1 time per week	2 time per week	3 time per week	4 time per week	5 time per week	6 time per week	7 time per week	More than 7 times per week (please specify the number)	
Flavored Milk	 0.055g/ml., 250 ml.														
	 0.05g/ml., 250 ml.														
	 0.055g/ml. , 250 ml.														
	 0.05g/ml. , 250 ml.														
sum															Amount consumed: milliliters.

(Specify the amount of sugar per milliliter) amount consumed = Amount consumed from sweetened beverages: ..... grams per week.*

Summary of Sugar Content Calculation

Categories SSBs	calculate	Grams per week
Sweetened Water		
Soft Drinks		
Energy Drinks		
Coffee Drinks		
Green Tea Drinks		
Flavored Drinking/Yogurt/Cultured Milk		
Vegetable/Fruit Juice		
Herbal Drinks		
Soy or Grain Milk		
Flavored Milk		

Includes sugars obtained from all beverages**…….** Weekly intake grams

The amount of sugar obtained **...** Weekly / amount of sugar received per day **... (**g**)**

The sugar assessment criteria calculated are as follows**:** greater than or equal to 24 g, which means that the risk group that should be monitored is less than 24 g**.** It refers to the normal group that controls sugar consumption well**.**

However, the above criteria are for healthy people **(**healthy people**)** and do not include groups**.** Adolescents with congenital diseases or illnesses !

User Manual of Sugary Drink Consumption Questionnaire

Use Sugary Drink Consumption Behavior of Chinese Adolescents

The Sugary Sweet Drink Consumption Questionnaire is prepared for adolescents. Children aged 13-15 use the questionnaire to determine the amount of sugar obtained from sweetened drinks.

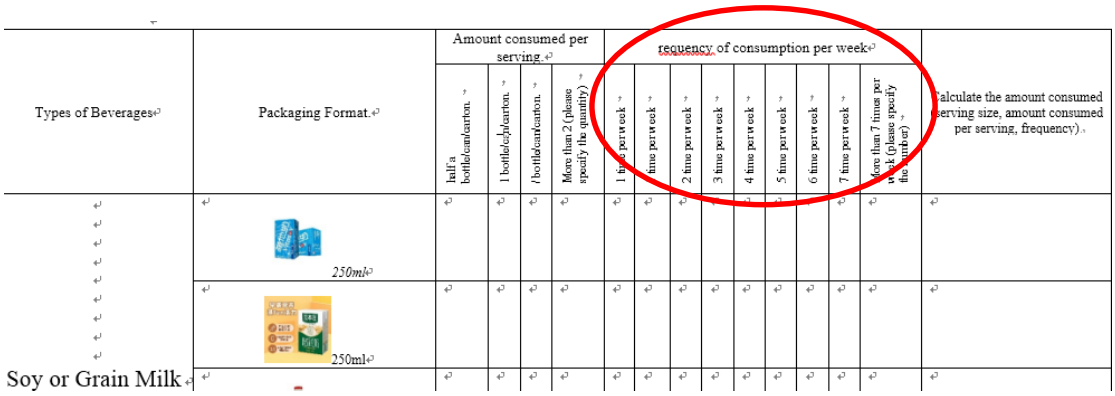
Sugar, only from beverage products in closed containers, which will require information. In the past 1 week, it can be the amount of water received in 1 week

How to make a questionnaire

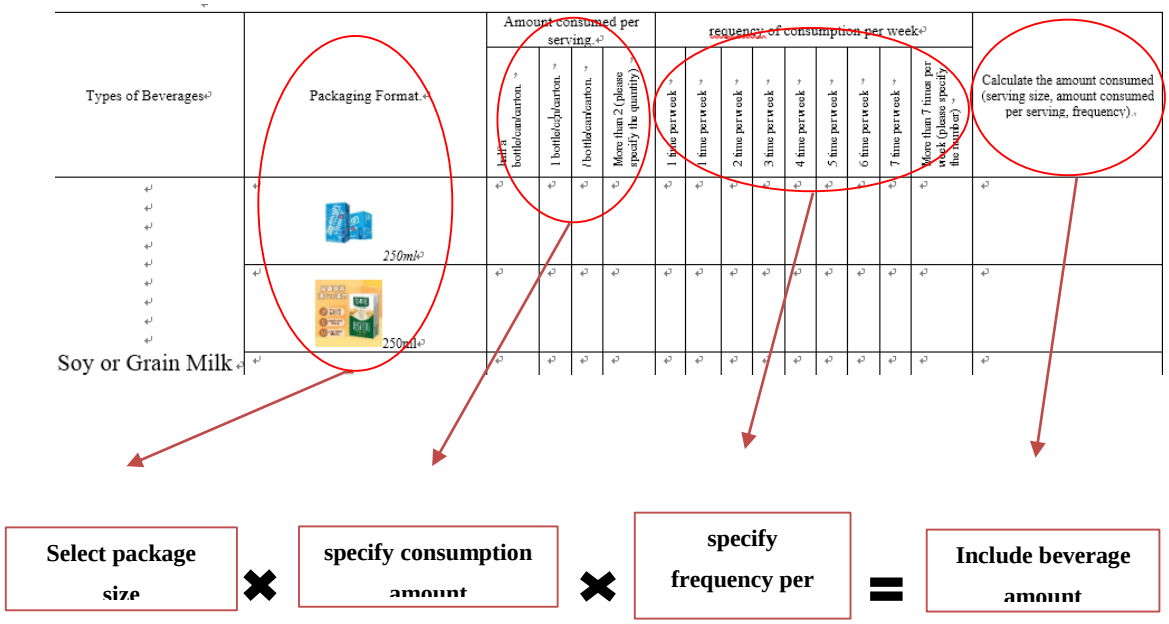
1. Ask students to choose the packaging format of the beverage. Then tick the check mark √ in the number， Drink each drink. If you don't drink, if you don't drink, don't answer. If there is a number to continue drinking， more than 2 times, specify the actual consumption.

Types of Beverages	Packaging Format	Amount consumed per serving				requency of consumption per week								Calculate the amount consumed (serving size, amount consumed per serving, frequency)
		half a bottle/can/carton	1 bottle/can/carton	1/bottle/can/carton	More than 2 (please specify the quantity)	1 time per week	1 time per week	2 time per week	3 time per week	4 time per week	5 time per week	6 time per week	7 time per week	More than 7 times per week (please specify the number)	
Soy or Grain Milk	 250ml														
	 250ml														

2. Ask students to check the mark √ in the weekly consumption frequency channel (if any). If the frequency is more than 7 times a week, please specify the number.



3. From there, work your way up to all the packaging sizes for each beverage group based on the beverage volume of the recipe.



Select package size ✖ **specify consumption amount** ✖ **specify frequency per** = **Include beverage amount**

When all sizes are packaged together as a drink amount

4. The amount of water received from each group of drinks using this recipe

Types of Beverages	Packaging Format	Amount consumed per serving				requency of consumption per week								Calculate the amount consumed (serving size, amount consumed per serving, frequency)
		half a	1 bottle/can/carton	2 bottle/can/carton	More than 2 (please specify the quantity)	1 time per week	1 time per week	2 time per week	3 time per week	4 time per week	5 time per week	6 time per week	7 time per week	More than 7 times per week (please specify the number)	
Green Tea Drinks	 500ml														
	 0.008g/ml 500ml														
	 0.0148g/ml 500ml														
															Amount consumed: ..... milliliters.

Sugar content of each drink in the group includes amount consumed = ✖ **In the group includes amount consumed** = **Sugar obtained from the drink**

5. Add up all the beverage groups like this until the amount of sugar you have, it will be the amount of sugar you get from consuming sugary sweetened drinks in 1 week

糖含量计算摘要

Categories SSBs	*calculate*		*Grams per week*
Sweetened Water:	calculate		
Soft Drinks:	calculate		
Energy Drinks:	calculate		
Coffee Drinks	calculate		
Green Tea Drinks	calculate		
Flavored Drinking Yogurt/Cultured Milk	calculate		
Vegetable/Fruit Juice	. calculate		
Herbal Drinks	. calculate		
Soy or **Grain Milk**	calculate		
Flavored **Milk**	calculate		
Includes sugars obtained from all beverages.			Weekly intake grams

6. To know the energy (Kcal) consumed, sweetened drinks with added sugar can continue as follows

Obtained from all group drinks ✖ **4KCAL** = **All energy obtained from sugar in the drink**

Researcher Notes

Level	Definition	Description
Normal group	< 25 g/day	Intake less than 25 g/day.
increased risk of obesity group	≥ 25 g/day	Intake equal to or more than 25 g/day.

The package size of the beverages specified in this questionnaire is from Sugar-sweetened drinks per group in 2024

(Li et al., 2022; Zhang et al., 2017).

BIOGRAPHY

Name - Surname	Miss Mao Xinxin
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