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KNOWLEDGE, ATTITUDE, AND PRACTICE ON SUGAR-SWEETENED BEVERAGES AMONG UNDERGRADUATE STUDENTS: A SYSTEMATIC LITERATURE REVIEW

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Abstract: *The consumption of sugar-sweetened beverages (SSBs) has become a significant global public health concern, particularly among university students. SSBs are associated with adverse health outcomes, including obesity, type 2 diabetes mellitus (T2DM), and cardiovascular diseases (CVD). Despite increased awareness of these risks, SSB consumption remains prevalent. Understanding the knowledge, attitudes, and practices (KAP) related to SSBs is crucial for designing effective interventions to reduce intake and mitigate health risks. This systematic literature review examines the KAP related to SSB consumption among university students. A comprehensive search of four databases (ProQuest, Scopus, ScienceDirect, PubMed) was conducted using the PICO framework. Relevant studies were selected through predefined criteria, yielding 45 articles for analysis. The review revealed varied levels of knowledge about SSBs among students, with high awareness in some populations not always translating into healthier practices. Taste preference, peer influence, and habitual consumption emerged as dominant factors driving SSB intake. Attitudes generally reflected an understanding of SSB-associated health risks; however, practices such as frequent and high-quantity consumption persisted, highlighting a disconnect between knowledge and behaviour. The findings emphasise the need for targeted interventions to address the knowledge-behaviour gap in SSB consumption among university students. Public health campaigns, policy measures, and educational programs tailored to sociocultural contexts are essential to mitigate excessive SSB intake and its health implications.*

Keywords: *sugar-sweetened beverages, knowledge, attitude, practice, obesity prevention, students*

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Introduction

Obesity has become a significant global public health issue, impacting people of all ages, backgrounds, and socioeconomic status. WHO defines obesity as abnormal or excessive fat accumulation with a body mass index (BMI) of ≥ 30 kg/m² (World Health Organization, 2020). Obesity has nearly tripled since 1975 worldwide, with an estimated 650 million adults (19%), 340 million adolescents (18%), and 39 million children (5%) with obesity according to WHO. In 2019, the National Health Morbidity Survey (NHMS) conducted in Malaysia showed an increase in the prevalence of obesity in adults from 15.1% in 2011 to 19.9% in 2019 (Institute for Public Health, 2011; Institute for Public Health (IPH), 2020). In Malaysia, the prevalence of obesity among undergraduate students is particularly alarming. A study revealed that among 1,000 undergraduate students from five Malaysian universities (University of Malaya, University Putra Malaysia, University of Science Malaysia, National University of Malaysia, and University of Technology Malaysia), 23% were overweight and 17.6% were obese, with soft drinks identified as a key contributing factor (Radzi et al., 2019).

Obesity is linked to serious health outcomes, even type 2 diabetes mellitus (T2DM) and cardiovascular disease (CVD), as well as other non-communicable diseases. In the UK Foresight program, Vandenbroeck et al. introduced a framework called "Obesity System Map" to describe the link between obesity determinants and interaction. The framework clusters all the factors contributing to obesity into seven clusters: social psychology, individual psychology, individual physical activity, physical activity environment, physiology, food consumption and food production (Vandenbroeck et al., 2007). The interconnection between these factors and obesity depends on the person's exposure to the factors. Jebeile et al. stated that dietary habits have been proven to be the independent risk factor for overweight and obesity (Jebeile et al., 2019). Urbanisation causes modern society to shift from diets high in complex carbohydrates and fibre to more varied diets with more fats, saturated fats, and sugar (Sproesser et al., 2019). This transition aligns with the rise of sugar-sweetened beverages (SSB) consumption within modern dietary norms (Aliah et al., 2020; Alothmani & Almoraie, 2023).

World Health Organization (WHO) defines SSB as all beverages containing free sugar. Free sugar includes naturally occurring sugars found in honey, syrups, fruit juices, and fruit juice concentrates, as well as monosaccharides (glucose and fructose) and disaccharides (sucrose or table sugar) added to food and beverages. SSB includes carbonated or non-carbonated soft drinks, 100% fruit or vegetable juices and drinks, liquid and powder concentrates, flavoured water, energy and soft drinks, ready-to-drink tea, ready-to-drink coffee, and flavoured milk drinks (World Health Organization, 2023). SSB consumption has become a trend in all populations and ubiquitous globally. A study conducted among adults in Australia stated that among 3430 participants, almost half (47.3%) had consumed SSB in the past week, with 13% having at least one drink a day on an average day (Miller, Braunack-Mayer, et al., 2020a). Furthermore, Benajiba and Mahboub (2019) reported that 85% of 1194 adults in Saudi Arabia consumed SSB. Moreover, a recent study conducted among 3600 young men who lived in Riyadh showed that 1468 (40.8%) of the participants consumed SSB. The prevalence of SSB intake is not only high among adults but also among university students. Likewise, when measuring the prevalence of SSB among undergraduate students in public universities in Malaysia, Ahmad et al. in their study found that 89.3% of university students consumed at least once SSB daily on average day (Ahmad, Md Zuki, Azahar, Boon, et al., 2019). Similarly, a study conducted among 350 students from a local university showed that, on average days, 71.1% of the participants consumed SSB more than one cup daily (Aliah et al., 2020).

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On the other hand, the national and international organizations such as Ministry of Health (MOH) and WHO have recommended reducing the consumption of free sugars or added sugars to less than 10% of total daily energy intake (Ministry of Health Malaysia, 2016; World Health Organization, 2017). High SSB intake among undergraduates or university students could be worrying. This is because undergraduate students fall under the category of young adults, where this phase can be considered as a critical period for establishing dietary habits that can persist into later life (Tok et al., 2018). Frequent SSB consumption not only can lead to obesity but, in the future or in their elderhood, they may be exposed to the high possibility of getting hypertension, dental caries, T2DM, CVD, inflammation, insulin resistance, metabolic syndrome with impaired glucose tolerance, and impaired β-cell function (Whye Lian Cheah et al., 2023), which then can lead to mortality. According to Singh et al., 184,000 global deaths were estimated to be attributable to SSB intake, including 72.3% from T2DM, 24.2% from CVD, and 3.5% from obesity-related cancers (Singh et al., 2015). Besides, excessive sugar intake can negatively impact academic performance. A high sugar intake can cause inflammation to the brain, which then can impair hippocampal function, a region of the brain crucial for learning and memory. Additionally, damage in the hippocampus may impair the ability to successfully memorise new events or information and partially impair memory recall (Beilharz et al., 2014; Marek et al., 2023).

Decision-making on dietary intake can be associated with the level of knowledge, attitude, and practice (KAP) towards the contents of foods and beverages and their associated health-related impacts (Alothmani & Almoraie, 2023). Similarly, Ahmad et al. recorded that people with low level of knowledge on SSB tend to have high SSB consumption patterns (53.1%) (Ahmad, Md Zuki, Azahar, Boon, et al., 2019). Additionally, several studies also show that the knowledge and attitude towards SSB consumption was influenced by numerous factors, including sociodemographic and behavioural (Ahmad, Md Zuki, Azahar, Boon, et al., 2019; Badil et al., 2023; Miller et al., 2019). The knowledge and attitude towards SSB may influence the practice towards SSB consumption where the more nutritional knowledge individuals have about SSB, the lower their consumption (Alothmani & Almoraie, 2023). The knowledge on SSB is commonly measured by asking what SSB is, what types of SSB, and the deleterious effects of SSB (Ahmad, Md Zuki, Azahar, Khor, et al., 2019), while the attitude of SSB is measure by asking about the reason for SSB intake and how much SSB they prefer having and the practice of SSB is commonly measured by the frequency of SSB consumption and intention to reduce SSB consumption (Badil et al., 2023).

However, the relationship between knowledge, attitude, and practice regarding SSB consumption is complex and inconsistent. For instance, Tierney et al. found that limited knowledge of dietary sugars and sweeteners was a significant factor in SSB consumption among adults in Northern Ireland (Tierney et al., 2017). In contrast, another study reported that despite high knowledge and positive attitudes among students at King Abdulaziz University, only 37% demonstrated good practices regarding SSB consumption (Alothmani & Almoraie, 2023). In Malaysia, Ahmad, Md Zuki, Azahar, Boon, et al. (2019) found that even among participants with high knowledge levels about SSBs, 51.2% consumed SSBs three or more times daily, and 38.6% consumed them one to two times per day.

These inconsistencies highlight the need for further exploration that focuses on the knowledge, attitude, and practice of SSB consumption among undergraduate students, particularly in Malaysia. Hence, this study aims to synthesize existing evidence related to SSB consumption,

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including KAP regarding SSB consumption among university students. Specifically, this review seeks to evaluate the level of knowledge students possess regarding SSBs, the attitudes of these students towards the health risks linked to SSB consumption, and the consumption patterns of SSBs, identifying habitual behaviours and their prevalence within the demographic. This review also will look into the factors that influence KAP on SSB consumptions among university students. This review is essential for developing targeted interventions aimed at reducing excessive consumption of sugar-sweetened beverages (SSBs), which significantly contribute to obesity and other non-communicable diseases among young adults. Additionally, this study is important for addressing the eating habits of university students, as these habits often carry into adulthood (Braune et al., 2024). Overall, this review not only highlights the prevalence and factors influencing SSB consumption but also offers evidence-based recommendations for educational campaigns and policy measures specifically designed for this population.

Methodology

Search strategies

The PICO framework is used to aid in refining the search strategy and facilitating the retrieval of relevant articles (see Table 1).

Table 1: PICO framework used in article searching

	Components	Keywords / Criteria
P	Patient, Population, or Problem	Adults or students more than 18 years old
I	Intervention, Prognostic, Factor, Exposure	Knowledge, attitude, and practice on SSB
C	Comparison or intervention	(Not related)
O	Outcome	SSB consumption pattern

The search encompassed four distinct online databases employing Boolean operators 'AND', 'OR', and 'NOT' to refine search outcomes. Initially, the ProQuest Health and Medical Complete database used the 'Advanced Search' feature with keywords '(knowledge AND attitude AND practice) AND TITLE ("sugar-sweetened beverages" OR "sugar-added beverages" OR soda OR carbonated drink OR energy drink)', resulting in the discovery of 81 related articles. Subsequently, Scopus and Science Direct were accessed, employing the 'Advanced Search' feature with the keywords '(knowledge AND attitude AND practice) AND TITLE-ABSTRACT-KEYWORD ("sugar-sweetened beverages" OR "sugar-added beverages" OR soda OR carbonated drink OR energy drink)', yielding 289 and 180 articles, respectively. Additionally, PubMed was utilized with the search term '(knowledge AND attitude AND practice) AND (("sugar-sweetened beverages"[Title/Abstract] OR "sugar-added beverages" [Title/Abstract] OR soda [Title/Abstract] OR carbonated drink [Title/Abstract] OR energy drink [Title/Abstract]))', resulting in 154 articles.

Inclusion and exclusion criteria were rigorously applied to ensure relevance and quality during selection. Studies included in the review focused on populations aged 18 years and above, specifically investigating KAP related to SSBs and reporting measurable outcomes on SSB consumption patterns. Only peer-reviewed journal articles and empirical studies published in English within the last five years were included in the review. Moreover, articles unrelated to the topic and population of interest were excluded after being assessed for eligibility. After

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
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applying these criteria, a total of 16 relevant studies were included. An additional 29 articles were identified through a manual review of the reference lists of included studies, bringing the total number of studies included in the review was 45. The PRISMA flow chart of the search strategy is depicted in Figure **1**1.

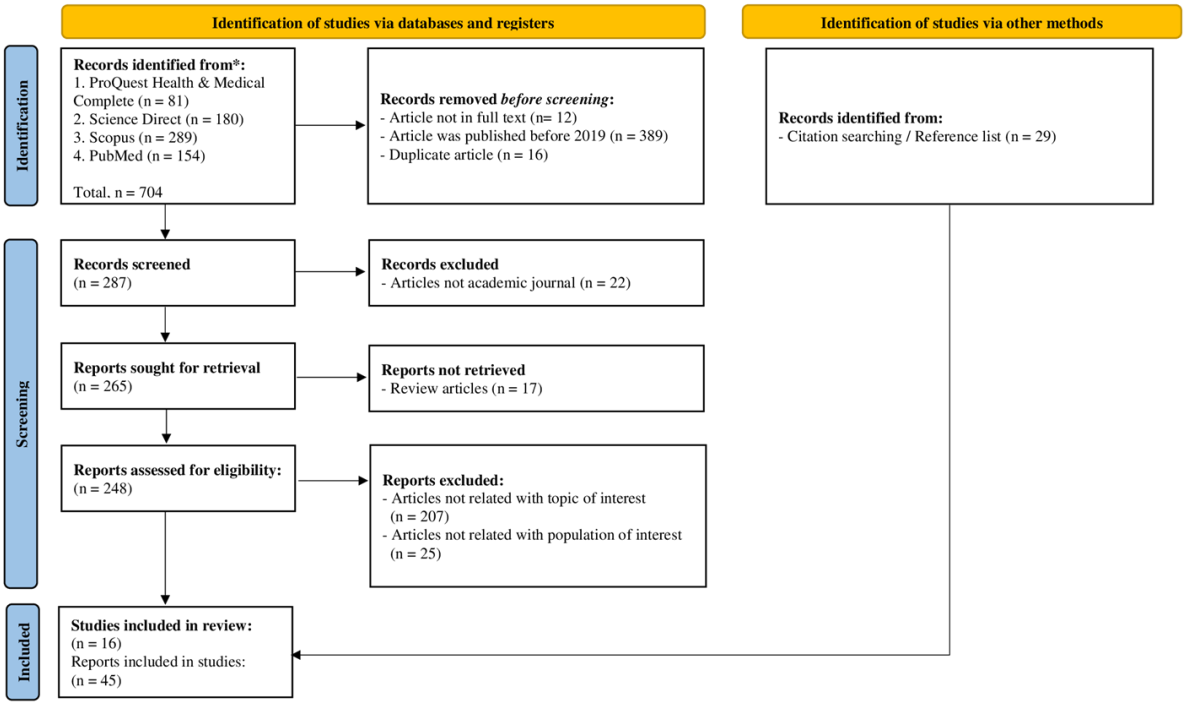

Figure 1: PRISMA flow chart of the literature search and study selection process

Results

Characteristics of the included studies

The literature review included 45 articles, primarily conducted in various geographical regions. The highest number of studies were from the Kingdom of Saudi Arabia (n = 10), followed by Malaysia (n = 7), with Pakistan and Australia each contributing six studies. The United States contributed five studies, while Jordan, Colombia, and India had two studies each. Iran, Hungary, South Africa, Türkiye, and Barbados each individually contributed one study. Of the 45 studies reviewed, twenty focused on adults aged 18 years and above, while 18 targeted university or college students, typically ranging from 18 to 26 years old. Some studies had diverse age ranges: one involved participant aged 5 to 55, three included participants aged 15 years and above, and one recruited individual aged 16 years and older. An interesting study investigated the correlation between household income and carbonated beverage consumption, requiring a single representative from each household (age unspecified). Another study involved participants from three groups: teens, parents, and teachers.

Regarding sample sizes, qualitative studies involved participant counts ranging between 32 and 57, while quantitative studies exhibited larger sample sizes, ranging between 90 and 811,808 participants. 39 of the articles used the cross-sectional study design, five used qualitative, and only one used the prospective cohort design. The characteristics of each study included are outlined in

Table **2**.

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
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Table 2: Characteristics of the included articles (n=45)

Author	Variable		Research method	Statistical test	Study setting	Study population	Sample size
	Independent	Dependent					
Abbas et al. (2021)	Knowledge and attitude on carbonated beverages	Frequency of carbonated beverages consumption	Cross-sectional	Chi-square test	Pakistan	University students	90
Ahmad et al. (2019)	1. Sociodemographic data 2. Knowledge on SSB	SSB consumption pattern	Cross-sectional	1. Chi-square test 2. Fisher's exact test	Malaysia	University students (19-26 years old)	401
Alfawaz et al. (2021)	Gender	1. SSB consumption pattern 2. Awareness on SSB	Cross-sectional	1. Chi-square test 2. Fisher's exact test 3. Kolmogorov-Smirnov test 4. Independent t-test	Saudi Arabia	Students (16-23 years old)	1,000
Al-Hanawi et al. (2022)	Sociodemographic data	SSB consumption pattern	Cross-sectional	1. Chi-square test 2. Logistic regression	Saudi Arabia	15-65 years old	10,735
(Aliah et al., 2020)	Body Mass Index (BMI)	SSB consumption pattern	Cross-sectional	1. Independent t-test 2. Chi-square test	Malaysia	University students (>18 years old)	350
(Alothmani & Almoraie, 2023)	Sociodemographic data	KAP of SSB	Cross-sectional	1. Chi-square test 2. Linear regression	Saudi Arabia	University students (18-25 years old)	380
AlTamimi et al. (2023)	Sociodemographic data	SSB consumption pattern	Cross-sectional	1. Chi-square test 2. Multivariate logistic regression	Saudi Arabia	Adults (20-35 years old)	3,600
Badil et al. (2023)	Gender	KAP on soft drink consumption	Cross-sectional	Chi-square test	Pakistan	University students	369
Bashir et al. (2023)	Study profession	SSB consumption pattern	Cross-sectional	Chi-square test	Pakistan	University students	401

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
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Author	Variable		Research method	Statistical test	Study setting	Study population	Sample size
	Independent	Dependent					
Bawadi et al. (2019)	1. BMI 2. Waist circumferences	SSB consumption pattern	Cross-sectional	Chi-square test	Jordan	College students (>18 years old)	967
Benajiba and Mahboub (2019)	Factor affecting soft drink consumption	Soft drink consumption pattern	Cross-sectional	1. One-way ANOVA 2. Chi-square test	Saudi Arabia	Adults (20-59 years old)	1,348
Benajiba et al. (2020)	Soft drink consumption pattern	Attitude towards soft drinks consumption	Cross-sectional	1. ANOVA 2. Spearman correlation	Saudi Arabia	Adults (20-60 years old)	905
Boozari et al. (2020)	1. Sleep duration 2. Sleep quality	Sugar and SSB intake	Cross-sectional	1. Kruskal - Wallis test 2. Chi-square test 3. Spearman correlation test	Iran	University students	395
Bosire et al. (2020)	Sociodemographic data	Awareness, perception, and attitudes towards SSB and SSB taxation	Qualitative	Thematic analysis	South Africa	Adults (18-55 years old)	57
Brownbill et al. (2020)	Knowledge of SSB	Perception of SSB	Qualitative	Thematic analysis	Australia	Adults (18-25 years old)	32
Budai and Lichthammer (2021)	1. Study background 2. BMI score 3. Physical activity	SSB consumption pattern	Cross-sectional	1. Independent t-test 2. Spearman's Rank 3. Mann-Whitney U	Hungary	University students	131
Cheah and Chua (2023)	Sociodemographic data	KAP on SSB	Cross-sectional	Chi-square test	Malaysia	University students (18-26 years old)	176
Cheah et al. (2023)	1. Sociodemographic data 2. Knowledge on SSB	SSB consumption pattern	Cross-sectional	Chi-square test	Malaysia	Undergraduate student (>18 years old)	208
Cheng and Lau (2022)	KAP on SSB	SSB consumption pattern	Cross-sectional	1. Chi-square test 2. Independent t-test	Malaysia	University students	100

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.academicinspired.com/jised
DOI: 10.55573/JISED.106912

Author	Variable		Research method	Statistical test	Study setting	Study population	Sample size
	Independent	Dependent					
				3. Linear regression			
(Castellanos & Miller, 2020)	Factors determine SSB consumption	Reason to change SSB consumption	Qualitative	Thematic analysis	United States	Adults (>18 years old)	43
Datta and Husain (2020)	Household economic status	Carbonated beverage consumption	Cross-sectional	Mean	Pakistan	Household representative (age not stated)	24,238
Gedi and Arik Tasyikan, (2022)	1. Sociodemographic data 2. Lifestyle factor	Knowledge, attitude, and consumption pattern of SSB	Cross-sectional	Logistic regression	Turkey	Adults (>18 years old)	325
Hess et al. (2019)	Age	Perception of SSB	Qualitative	Thematic analysis	United States	Students, Parents, Teacher	40
Imoisili et al. (2020)	1. Sociodemographic data 2. BMI status 3. State	SSB consumption pattern	Cross-sectional	1. Chi-square test 2. Multinominal logistic regression	Colombia and 3 US territories	Adults (>18 years old)	68,896
Islam et al. (2020)	Sociodemographic data	1. Beverage consumption pattern 2. Calorie intake.	Cross-sectional	1. Pearson correlation 2. Simple t-test 3. Linear regression	Saudi Arabia	Undergraduate students (>18 years old)	507
Jalloun (2021)	Sociodemographic data	Knowledge, attitude, and behavior of soft drink and energy drink	Cross-sectional	Chi-square test	Saudi Arabia	Adults (18-45 years old)	384
Mahoney et al. (2019)	Sociodemographic data	Caffeine-containing-beverages consumption pattern	Cross-sectional	1. Chi-square test 2. ANOVA test	United states	University students	1,248
Mangera and Adams (2021)	Knowledge and attitude of SSB	SSB consumption pattern	Cross-sectional	1. Chi-square test 2. Independent t-test 3. Pearson correlation	Barbados	Adults (>18 years old)	384

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
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Author	Variable		Research method	Statistical test	Study setting	Study population	Sample size
	Independent	Dependent					
Mathur et al. (2020)	1. Socioeconomic data 2. Fried food consumption	SSB consumption pattern	Cross-sectional	1. Chi-square test 2. Multiple logistic regression	India	15-54 years old	811,808
Md Shukri et al., 2021	Sociodemographic data	KAP of Bubble Tea consumption	Cross-sectional	Chi-square	Malaysia	University students (18-32 years old)	212
Metta et al. (2022)	KAP of carbonated drinks	Consumption of carbonated drinks	Cross-sectional	Frequency	Saudi Arabia	University students (18-26 years old)	204
Miller et al. (2019)	1. Sociodemographic data 2. Knowledge of SSB	SSB consumption pattern	Cross-sectional	Chi-square test	Australia	Adults (>18 years old)	2,732
Miller, Braunack-Mayer, et al. (2020)	1. SSB consumption pattern 2. Selection and preference towards SSBs	KAP of SSB	Qualitative	Thematic Analysis	Australia	Adults (21-50 years old)	57
Miller, Ettridge, et al. (2020a)	1. Sociodemographic data 2. Frequency of beverage consumption	Knowledge and belief on SSB and artificial sweetened beverages (ASB)	Cross-sectional	1. Chi-square 2. Logistic regression	Australia	Adults (>18 years old)	3,430
Miller, Ettridge, et al. (2020b)	Behavioral and sociodemographic data	SSB consumption pattern	Cross-sectional	1. Chi-square test 2. Linear regression	Australia	Adults (>18 years old)	3,430
Mohsin et al. (2022)	1. Socioeconomic background 2. Frequency of SSB consumption	Awareness, self-efficacy, and intention towards SSBs consumption	Cross-sectional	Chi-square test	Pakistan	Adults (>18 years old)	200
Nawab et al. (2021)	1. Age 2. Gender	1. SSB consumption pattern 2. Awareness of SSB	Cross-sectional	Frequency	Pakistan	5-55 years old	208

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.academicinspired.com/jised
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Author	Variable		Research method	Statistical test	Study setting	Study population	Sample size
	Independent	Dependent					
Norman-Burgdolf et al. (2021)	Sociodemographic data	SSB consumption pattern	Prospective cohort study	1. Chi-square test 2. Fisher's exact test	Australia	Adults (22-84 years old)	150
Park et al. (2019)	Knowledge on health condition	SSB consumption pattern	Cross-sectional	1. Chi-square test 2. Multinominal logistic regression	United states	Adults (>18 years old)	1,000
Park, Lee, & Blanck (2023)	1. Knowledge, attitude, and practice on health 2. Sociodemographic data	SSB consumption pattern	Cross-sectional	1. Chi-square test 2. Multinominal logistic regression	United States	Adults (>18 years old)	4,034
Santana-Jiménez et al. (2023)	1. Sociodemographic data 2. Body adiposity	Sugary drink consumption pattern	Cross-sectional	One-way ANOVA	Colombia	Adults (19-75 years old)	1,491
Subaiea et al. (2019)	1. Sociodemographic data 2. Knowledge of energy drink	Energy drink consumption pattern	Cross-sectional	1. Chi-square test 2. ANOVA test	Saudi Arabia	>15 years old	783
Subramanian et al. (2023)	1. Sociodemographic data 2. Awareness of SSB content	1. SSB consumption pattern 2. Attitude towards SSB	Cross-sectional	1. Chi-square test 2. Fisher's exact test	India	Adults (18-79 years old)	1,007
(Teng et al., 2019)	Sociodemographic data	Plain water and SSB consumption pattern	Cross-sectional	Chi-square test	Malaysia	Undergraduate students (>18 years old)	376
Thiab et al. (2023)	Sociodemographic data	KAP of energy drinks	Cross-sectional	Pearson correlation	Jordan	University students	734

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
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Quality Assessment

The critical appraisal tools used are The Joanna Briggs Institute (JBI). Critical appraisal of articles enables one to evaluate the trustworthiness and the relevance of the included articles. The process of critical appraisal started with the development of research questions. The critical appraisal for cross-sectional is shown in Table 3, while the critical appraisal for cohort and qualitative studies is shown in Table **4**4 and Table **5**5, respectively.

Table 3: JBI Analytical Cross-sectional Critical Appraisal for the included articles (Source: Moola et al., 2017a)

	Abbas et al. (2021)	Ahmad et al. (2019)	Alfawaz et al. (2021)	Al-Hanawi et al. (2022)	(Aliah et al., 2020)	**(Alothmani & Almoraie, 2023)**	AlTamimi et al. (2023)	Badil et al. (2023)	Bashir et al. (2023)	Bawadi et al. (2019)	Benajiba and Mahboub (2019)	Benajiba et al. (2020)	Boozari et al. (2020)
Were the criteria for inclusion in the sample clearly defined?	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were the study subjects, and the setting described in detail?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was the exposure measured in a valid and reliable way?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were objective, standard criteria used for measurement of the condition?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were confounding factors identified?	No	No	No	No	No	No	No	No	No	No	No	No	No
Were strategies to	No	No	No	No	No	No	No	No	No	No	No	No	No

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
Journal of Islamic, Social, Economics and Development (JISED)
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	Abbas et al. (2021)	Ahmad et al. (2019)	Alfawaz et al. (2021)	Al-Hanawi et al. (2022)	(Aliah et al., 2020)	**(Alothmani & Almoraie, 2023)**	AlTamimi et al. (2023)	Badil et al. (2023)	Bashir et al. (2023)	Bawadi et al. (2019)	Benajiba and Mahboub (2019)	Benajiba et al. (2020)	Boozari et al. (2020)
deal with confounding factors stated?													
Were the outcomes measured in a valid and reliable way?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was appropriate statistical analysis used?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were the criteria for inclusion in the sample clearly defined?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were the study subjects and the setting described in detail?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was the exposure measured in a valid and reliable way?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were objective, standard criteria used for measurement of the condition?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were confounding factors identified?	No	No	No	No	No	No	No	No	No	No	No	No	No

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
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Journal website: www.academicinspired.com/jised
DOI: 10.55573/JISED.106912

	Abbas et al. (2021)	Ahmad et al. (2019)	Alfawaz et al. (2021)	Al-Hanawi et al. (2022)	(Aliah et al., 2020)	**(Alothmani & Almoraie, 2023)**	AlTamimi et al. (2023)	Badil et al. (2023)	Bashir et al. (2023)	Bawadi et al. (2019)	Benajiba and Mahboub (2019)	Benajiba et al. (2020)	Boozari et al. (2020)
Were strategies to deal with confounding factors stated?	No	No	No	No	No	No	No	No	No	No	No	No	No
Were the outcomes measured in a valid and reliable way?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was appropriate statistical analysis used?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were the criteria for inclusion in the sample clearly defined?	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were the study subjects and the setting described in detail?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was the exposure measured in a valid and reliable way?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were objective, standard criteria used for measurement of the condition?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.academicinspired.com/jised
DOI: 10.55573/JISED.106912

	Abbas et al. (2021)	Ahmad et al. (2019)	Alfawaz et al. (2021)	Al-Hanawi et al. (2022)	(Aliah et al., 2020)	**(Alothmani & Almoraie, 2023)**	AlTamimi et al. (2023)	Badil et al. (2023)	Bashir et al. (2023)	Bawadi et al. (2019)	Benajiba and Mahboub (2019)	Benajiba et al. (2020)	Boozari et al. (2020)
Were confounding factors identified?	No	No	No	No	No	No	No	No	No	No	No	No	No
Were strategies to deal with confounding factors stated?	No	No	No	No	No	No	No	No	No	No	No	No	No
Were the outcomes measured in a valid and reliable way?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was appropriate statistical analysis used?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4: JBI Cohort study Critical Appraisal for the included article (Source: Moola et al., 2017b)

	Norman-Burgdolf et al. (2021)
Were the two groups similar and recruited from the same population?	Unclear
Were the exposures measured similarly to assign people to both exposed and unexposed groups?	Yes
Was the exposure measured in a valid and reliable way?	Yes
Were confounding factors identified?	Yes
Were strategies to deal with confounding factors stated?	Yes
Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	Unclear
Were the outcomes measured in a valid and reliable way?	Yes
Was the follow up time reported and sufficient to be long enough for outcomes to occur?	Yes
Was follow up complete, and if not, were the reasons to loss to follow up described and explored?	Yes
Were strategies to address incomplete follow up utilized?	No
Was appropriate statistical analysis used?	Yes

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.academicinspired.com/jised
DOI: 10.55573/JISED.106912

Table 5: JBI Qualitative Critical Appraisal Tool for the included articles (Source: Lockwood et al., 2017)

	Bosire et al. (2020)	Brownbill et al. (2020)	(Castellanos & Miller, 2020)	Hess et al. (2019)	Miller, Braunack-Mayer, et al. (2020)
Is there congruity between the stated philosophical perspective and the research methodology?	Yes	Yes	Yes	Yes	Yes
Is there congruity between the research methodology and the research question or objectives?	Yes	Yes	Yes	Yes	Yes
Is there congruity between the research methodology and the methods used to collect data?	Yes	Yes	Yes	Yes	Yes
Is there congruity between the research methodology and the representation and analysis of data?	Yes	Yes	Yes	Yes	Yes
Is there congruity between the research methodology and the interpretation of results?	Yes	Yes	Yes	Yes	Yes
Is there a statement locating the researcher culturally or theoretically?	No	No	No	No	No
Is the influence of the researcher on the research, and vice-versa, addressed?	No	No	No	No	No
Are participants, and their voices, adequately represented?	Yes	Yes	Yes	Yes	Yes
Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?	Yes	Yes	Yes	Yes	Yes
Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?	Yes	Yes	Yes	Yes	Yes

Discussion

Knowledge on SSB consumption among adults

Numerous studies have explored the level of knowledge levels about SSBs among a diverse population. Abbas et al. (2021) found high knowledge among medical students, with 90% recognizing the name of carbonated drinks, 85.5% aware of their harmful effects, and 75.5% knowledgeable about the ingredients. Similarly, Ahmad et al. (2019) assessed SSB knowledge among undergraduate students, revealing that 90.5% had a high level of knowledge. A study by Alothmani and Almoraie (2023) reported 93.0% of university students have high knowledge scores. Badil et al., (2023) measured SSB knowledge among nursing students, showing that 95.0% were familiar with soft drinks, 84.0% knew their harmful effects, and 86.0% acknowledged the adverse effects on health.

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.academicinspired.com/jised
DOI: 10.55573/JISED.106912

Contrastingly, Brownbill et al., (2020) found that participants had little knowledge of sugar content in beverages, even though they acknowledged the harmful effects of excessive sugar consumption. Cheah and Chua (2023) found that only 19.3% of young adults had good knowledge of SSB, while Cheah et al. (2023) reported 88.9% high knowledge among university students. In another study, Md Shukri et al. (2021) highlighted low awareness about sugar and calorie content in bubble tea (30.7% and 13.2%, respectively). Moreover, Mangera and Adams (2021) focused on people with type 2 diabetes mellitus (T2DM), revealing that 88.1% of participants have little knowledge of *Coca-Cola*'s caloric content and 92.1% have little knowledge of the recommended maximum calorie intake of sugar per day.

Metta et al. (2022) explored carbonated drink knowledge among dental students and found that 98.5% have heard about carbonated drinks, 53.9% do not know the components of carbonated drinks, 61.8% know the caloric value of carbonated drinks, 97.1% think carbonated drinks are bad for health, 86.8% know the ill effects of carbonated drinks on general health, and 58.8% know the adverse effects of carbonated drinks on teeth. On the other side, Miller, Braunack-Mayer, et al. (2020b) found inconsistencies in perceptions of sugar content and healthiness across different beverage types, where some participants believed in the health benefits of natural juices, while others questioned the distinction between naturally and artificially sweetened juices.

Thiab et al. (2023) reported a neutral level of knowledge about energy drinks among university students, as the mean score of knowledge is 7.1 (Standard deviation, SD = 2.2), while Nawab et al. (2021) found that 79.11% of participants were aware of health issues caused by soft drinks. In a study conducted by Miller, Ettridge, et al. (2020a), the authors highlighted that while most participants understood sugar intake guidelines, there were varying levels of awareness regarding specific health problems associated with regular SSB consumption. A study by Contreras-Manzano et al. (2024) suggested that warning labels can potentially reduce SSB intake among youth and adult populations effectively.

These studies collectively suggest a varied spectrum of knowledge among different populations regarding the components, effects, and health implications of consuming carbonated drinks and SSBs. The difference could be associated with health's potential role in shaping the knowledge related to SSBs. As evidenced by (Kühn et al., 2022), health literacy influences the student's ability to access, understand, and apply information, thus improving their decision-making about dietary choices.

Attitude on SSB consumption among adults

The attitudes and preferences towards SSBs have been extensively explored in recent studies. In a study conducted by Abbas et al. (2021), the authors revealed that 92.2% of university students did not recommend prolonged consumption of carbonated drinks, with 82.2% favoring fruit juice over carbonated options. Additionally, Abbas et al. (2021) also emphasized that taste played a significant role in influencing carbonated drink consumption for 46.6% of university students, and a noteworthy 77.7% of them expressed a desire for more information about carbonated beverages, along with a willingness to educate others.

Another study by Alfawaz et al. (2021) reported that 56.0% of participants were willing to order soft drinks, and a significant 90.0% preferred regular soft drinks over diet options. In another study, (Alothmani & Almoraie, 2023) explored attitudes towards sugar-sweetened beverages through six dichotomous questions, revealing that 99.0% of participants exhibited positive

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.academicinspired.com/jised
DOI: 10.55573/JISED.106912

attitudes. Badil et al. (2023) measured attitudes using three questions, with 50.0% choosing soft drinks based on taste, 60.0% preferring 100 ml servings, and 59.0% enjoying soft drinks at home with family and friends. Besides, Benajiba et al. (2020) employed a Likert scale to measure attitudes towards sweetened soft drinks, with participants displaying positive attitudes for variables like "healthy" (76.5%) and "indispensable at the moment of eating" (50.2%).

Habits and addiction were identified as major reasons for SSB consumption across different age groups (Bosire et al., 2020). A recent study by Cheah and Chua (2023) found that 90.9% of young adults aged between 18 and 26 exhibited a positive attitude towards SSB. According to (Castellanos & Miller, 2020), taste preference emerged as a key factor in SSB consumption, with participants associating it with childhood memories and energy needs. Despite awareness of health risks, Hess et al. (2019) stated that taste and peer pressure remained primary motivators for SSB consumption. Mahoney et al. (2019) discovered that students used caffeine for several reasons, including to feel awake, enjoy the taste, and improve concentration. In addition, Subramanian et al. (2023) identified taste and peer pressure as primary reasons for SSB consumption, with 16.7% attempting to stop using SSBs. Mangera and Adams (2021) delved into the knowledge, attitudes, and practices regarding SSB among individuals with T2DM, revealing that 91.0% believed cutting back on SSBs would be easy.

Furthermore, Metta et al. (2022) investigated attitudes towards carbonated drinks, finding that 72.5% of dental students enjoyed having them, 72.1% of them were willing to quit, 85.8% of dental students consumed them with meals, and 95.1% of them would not recommend prolonged consumption. A study by Thiab et al. (2023) observed a neutral attitude (mean score for attitude = 3.9, SD = 1.0) towards energy drinks, with 70.5% of the participants acknowledging their potential harmful side effects. According to Teng, Nordin, and Shah (2019), university students preferred cold SSBs for their taste, consumed them frequently during lunch, and often chose them based on taste, while Subaiea et al. (2019) found that participants consumed energy drinks for fatigue reduction, increased alertness, and assistance during long driving trips.

These studies provide valuable insights into the multifaceted attitudes, preferences, and motivations influencing the consumption of SSBs and carbonated drinks among diverse populations. They shed light on various factors contributing to their continued popularity despite growing health concerns. It is worth mentioning that taste dominates the attitude towards SSB consumption despite the outweighing health concerns. Warner et al. (2017) highlight that students predominantly choose SSBs for their appealing taste, demonstrating that preference for sweetness can outweigh knowledge of associated health risks. Besides, Tang et al. (2021) also found that adults in the United Kingdom prioritize the pleasure derived from sweet-tasting beverages over their potential negative health impacts. Therefore, this study reinforces the need to address the strong influence of taste that drives SSB consumption patterns, especially among younger populations.

Practice on SSB consumption among adults

In their examination of carbonated drink consumption patterns, Abbas et al. (2021) reported that only 8.8% of participants abstained from any carbonated drinks. Additionally, 39.0% of participants consumed 1 to 3 drinks per week, 40.0% consumed 4 to 6 drinks per week, and 12.2% consumed more than 6 drinks per week. In a study conducted by Alfawaz et al. (2021), findings revealed that 28.0% of participants consumed soft drinks daily, 24.0% consumed them 1 to 2 times per week, 22.0% consumed them 3 to 4 times per week, and 10.0% consumed them

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.academicinspired.com/jised
DOI: 10.55573/JISED.106912

1 to 2 times per month. Interestingly, 61.0% of participants reported that they consume one 330 ml bottle at a time.

Aliah et al. (2020) classified SSB consumption into three, low, moderate, and high, finding that 49.4% of participants consumed moderate amounts of SSB (500 ml/d). When examining practices toward SSB, Alothmani and Almoraie (2023) found that only 37.0% of participants exhibited good practices. In another study, Badil et al. (2023) explored participant preferences and practices, revealing that 76.0% expressed a liking for soft drinks, 66.0% agreed to refrain from them, and 51.0% favored fruit juice. Moreover, Benajiba and Mahboub (2019) reported that 85.8% of participants consumed sweetened soft drinks, with 6% being daily consumers and 26.8% consuming them at least once weekly.

Considering frequency and quantity associations, Benajiba et al. (2020) found that 40.0% of participants consumed soft drinks 1 to 2 times or 3 to 4 times per week, establishing a positive association between frequency and quantity. In another study, Cheah et al. (2023) revealed low SSB practice among university students as 38.0% consume more than three times per day and 46.6% of the participants consume SSB at least once daily. Similarly, Cheah and Chua (2023) found that 80.7% of university students exhibited poor practices towards SSB.

Bashir et al. (2023) noted a significant gender association in soft drink consumption frequency, highlighting that 52.4% of male university students consumed soft drinks 2 to 3 times per day. Other than that, Md Shukri et al. (2021) found that the consumption of bubble tea among university students is low as majority (52.4%) consumer bubble tea once per month. Mahoney et al. (2019) highlighted high caffeine consumption among university students, noted that 92.0% of the university students who participate in the study consumed caffeine, with mean daily caffeine consumption is 173 mg/d. In a study by Subramanian et al. (2023) show that 96.3% of adults is SSB consumer, with 60.3% consumed SSB occasionally and 49.7% consumed between 100 and 200 ml each time. Furthermore, Miller et al. (2019) over half of participants had consumed SSBs at least once in the past week, either 1 to 6 times (moderate consumption; 35%) or 7 or more times (frequent consumption; 16%).

In a related study, Miller, Braunack-Mayer, et al. (2020b) revealed high SSB consumption habits, with some of the participants claimed that multiple SSB intake per day is considered normal. In a separate study by Miller, Ettridge, et al. (2020b), 47.3% of adults reported SSB consumption in the past week, and 13.6% of them consumed at least one drink daily. Additionally, Park et al. (2023) reported 30% of adults drinking SSB more than 2 times per day in 2021. Comparatively, in 2019 Park et al. (2019) found that 87.7% of adults consumed SSBs more than 1 time per day, 58.2% consumed SSB more than 2 times per day, and 35.6% consumed SSB more than 3 times per day in the past month. Lastly, Nawab et al. (2021) estimated that 85.8% of the population consumes soft drinks.

In short, the findings suggested that university students are a high-risk group with poor adherence to healthy SSB consumption practices, despite some awareness of health risks. Hence, targeted public health initiatives should raise awareness, promote healthier alternatives, and address cultural and lifestyle factors to reduce excessive SSB intake.

Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.academicinspired.com/jised
DOI: 10.55573/JISED.106912

Conclusion

To conclude, the review indicates varying knowledge, attitudes and practices towards sugar-sweetened beverage (SSB) consumption among adults, especially university-level students. Despite the high levels of awareness regarding the harmful effects of SSBs reported in many studies, knowledge does not always translate into behavior, as taste preference, peer influence, and habitual consumption play a major role in driving SSB intake. Although some respondents expressed an interest in reducing consumption, the data indicated that adverse practices (e.g., high-frequency and high-quantity SSB consumption) persist across populations. The findings highlight the importance of tailored interventions, including public health campaigns, educational initiatives, and policy measures, to close the knowledge-behavior gap and encourage healthier consumption behaviors. Incorporating SSBs culture, lifestyle, and taste factors into subsequent social marketing efforts is key to reducing excessive consumption and the associated health problems.

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Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
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Volume: 10 Issues: 69 Special Issue [January, 2025] pp. 175 - 183
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