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SCHOOL-BASED INTERVENTION IN REDUCING SUGAR-SWEETENED BEVERAGE CONSUMPTION AMONG CHILDREN AND ADOLESCENTS: A SYSTEMATIC LITERATURE REVIEW

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Abstract

Sugar-sweetened beverages (SSB) consumption in Indonesia has increased, contributing to the prevalence of obesity and cardiometabolic diseases. Schools represent a strategic setting to promote healthy lifestyles among children and adolescents. This study aimed to review school-based interventions for reducing SSB consumption and to identify their limitations and recommendations. A systematic literature review was conducted in accordance with PRISMA guidelines. Articles published between 2015 and 2025 were retrieved from PubMed, Scopus, and ProQuest. From an initial 705 articles, 8 studies met the eligibility criteria for inclusion. The findings revealed that most interventions utilized a combination of educational and environmental strategies, while others employed peer-influence or environmental-only approaches. Integrated approaches that addressed both educational and environmental strategies were generally associated with more favorable outcomes. Nevertheless, several limitations were identified, particularly those related to challenges in establishing causal inference and the potential for measurement bias. For further research, it is advised to adopt a participatory design approach, integrate interventions into school curriculum and policy framework, and improve both physical and social access to drinking water within the school environment.

Keywords**:** *sugar-sweetened beverages, consumption, school-based intervention, children, adolescents****.***

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INTRODUCTION

Sugar-sweetened beverages (SSB) represent a significant source of added sugars in the modern diet (Malik & Hu, 2019). The World Health Organization (WHO) defines SSB as all beverages containing free sugar, including carbonated and non-carbonated soft drinks, fruit or vegetable juice and drinks, liquid and powder concentrates, flavoured water, energy and sport drinks, ready-to-drink tea and coffee, and flavoured milk (World Health Organization, 2017). The WHO recommends reducing free sugar intake in adults and children to less than 10% of total energy intake (World Health Organization, 2015). Consistent with this, Peraturan Menteri Kesehatan Nomor 30 Tahun 2013 also sets a daily sugar consumption limit of 50 grams (4 tablespoons) per person. In Indonesia, SSB consumption reached 20.23 liters per capita in 2015, ranking third highest in the WHO South-East Asia Region Office (Ferretti & Mariani, 2019). The Indonesian Health Survey (SKI) in 2023 further highlights that SSB consumption is most prevalent among younger populations, involving 53% in the 5–9 age group, 51.4% in the 3–4 age group, and 50.7% in the 10–14 age group (Kementerian Kesehatan, 2023).

SSB consumption has consistently contributed to overweight, obesity, and related cardiometabolic disease, including type 2 diabetes, coronary heart disease, stroke, and certain cancers (Calcaterra et al., 2023; Malik & Hu, 2019; Santos et al., 2022). Data from Basic Health Research 2013 (Kementerian Kesehatan, 2013) and Basic Health Research 2018 (Kementerian Kesehatan, 2018), and the SKI 2023 (Kementerian Kesehatan, 2023), show an upward trend in overweight prevalence. Among those aged 5-12 years, it increased from 10.8% (2013), 10.8% (2018), to 11.9% (2023), while among those aged 13-15 years, it increased from 8.3% (2013), 11.2% (2018), to 12.1% (2023). In contrast, the prevalence of obesity showed fluctuating patterns. In the 5-12 age group, the rates were 8.0% (2013), 9.2% (2018), and 7.8% (2023); among the 13-15 age group, the rates were 2.5% (2013), 4.8% (2018), and 4.1% (2023). Despite the fluctuating prevalence, childhood obesity remains concerning as it often persists into adulthood and is related to cardiometabolic and psychosocial comorbidities, and early mortality (Jebeile et al., 2022).

Excessive weight gain and obesity can contribute to type 2 diabetes (Chandrasekaran & Weiskirchen, 2024). Indonesia ranks fifth globally in the number of adults with diabetes, with an estimated 20.4 million cases in 2024 and projected to reach 28.6 million cases by 2050 (International Diabetes Federation, 2025). This health crisis imposes a severe economic burden on the national health system. In the Indonesian National Health Insurance (JKN) program managed by BPJS Kesehatan, the four most costly catastrophic diseases (i.e., heart disease, cancer, stroke, and kidney failure) have surged from IDR 14.9 trillion in 2017 to IDR 34.7 trillion in 2023 (Kementerian Kesehatan, 2024). Addressing this escalating cost and its adverse health outcomes underscores the urgent need to strengthen promotive and preventive public health strategies.

One of the determinants of obesity is the obesogenic food environment, which refers to daily settings such as communities, schools, or households that limit access to healthy food options and opportunities for physical activity (UNICEF Indonesia, 2022). Schools are ideal settings for intervention as children spend a significant portion of their daily lives there. This environment allows for developmentally and culturally appropriate lessons and activities that foster healthy lifestyles (Abdel Rahman et al., 2017), aligning with the “Healthy Setting” concept of the Ottawa Charter. Consequently, school-based interventions have emerged as a strategic approach to promote healthy behaviors. These interventions may target individual-level changes (knowledge, attitudes, practices, and behaviors); modify the physical or organizational environment; or combine both approaches (Nutland & Cragg, 2015). Studies suggest that a social environment that encourages healthy lifestyles among adolescents is expected to reduce the risk of obesity (Daka et al., 2025; Putri et al., 2025). This systematic literature review aims to identify types of school-based interventions designed to reduce SSB consumption among children and adolescents and to identify the limitations and recommendations arising from existing studies for future research.

METHODS

This study employed systematic literature review design and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The methodological details are outlined below:

Research Questions

The research addressed the following questions: (1) What types of school-based interventions have been implemented to reduce SSB consumption among children and adolescents? (2) What limitations are reported in the literature? and (3) What recommendations can be drawn to inform future school-based interventions?

Literature Search Strategy

A literature search was conducted across three electronic databases: ProQuest, PubMed, and Scopus. The search focused on English-language

articles published between 2015 and 2025. The search terms were structured around four key concepts: population (children, adolescents, students); setting (formal school setting); intervention (school-based interventions); and outcomes (beverage-related consumption). The search strategy was initially developed in Scopus and subsequently adapted for PubMed and ProQuest by adjusting database-specific field tags while maintaining the same Boolean logic. The detailed search strategy, exemplified by the Scopus syntax, is presented in Table 1.

Table 1. Literature Search Strategy

Database	Boolean String
Scopus	(TITLE-ABS-KEY (*School* OR "*Primary school*" OR "*Elementary school*" OR "*Junior High School*" OR "*Secondary school*" OR "*High school*" OR "*Senior High School*" OR *student* OR *children* OR *adolescent* OR *teenager* OR *youth*) AND TITLE-ABS-KEY ("*Health promotion school*" OR "*school health service*" OR "*school based intervention*" OR "*school based*" OR "*preventive program*" OR "*health promotion*" OR *program* OR *intervention* OR *initiative* OR *prevent* OR *project*) AND TITLE-ABS-KEY (*Sugar Sweetened Beverage* OR *Sweetened Beverage* OR *Sweetened Drink* OR *Sugary Drink* AND *intake* OR *consumption*)) AND PUBYEAR > 2014 AND PUBYEAR < 2026 AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (LANGUAGE , "English"))

Eligibility Criteria

Studies identified through database search were screened based on predefined eligibility criteria. The inclusion and exclusion criteria were categorized by population, intervention, outcomes, and study design, as detailed in Table 2.

Table 2. Eligibility Criteria

Category	Criteria
Population	Studies targeting children and adolescents enrolled in formal education (elementary, junior high, or senior high school). Studies focusing on preschool or college students were excluded
Intervention	Interventions conducted solely within the school-setting or explicitly defined as school-based by the authors. Multi-level or multi-setting approach were excluded to ensure that the desired outcome was really from the intervention in school setting
Outcomes	Only beverage-related outcomes were included, primarily focused on SSB or water consumption. Studies focusing on other outcomes were excluded
Study Design	Quantitative studies with experimental design were included. Qualitative, reviews, and protocols were excluded

Data Synthesis

Data synthesis was conducted by identifying each type of school-based intervention and highlighting the limitations and recommendations across studies. These findings are presented in the Results section (see Tables 3–5).

Data Analysis

Data analysis began with the removal of duplicate articles. This was followed by the screening of titles and abstracts to identify potentially relevant studies. Selected articles were then assessed through full-text review based on predefined eligibility criteria. The initial search across three databases yielded 705 records, of which 36 articles were assessed for eligibility. Of these, 28 articles were excluded for the following reasons: 11 studies were not conducted exclusively in school setting, but involved multi-setting (e.g., community-based) or multi-level interventions; 12 studies did not identify beverage-related consumption as the primary outcome of the intervention (other outcomes including screen time, physical activity, tobacco use); 4 studies were protocols; and 1 study did not report complete outcome data. Ultimately, eight studies met all inclusion criteria and were included in this review. The literature search and selection process is illustrated in the PRISMA flow diagram (Figure 1).

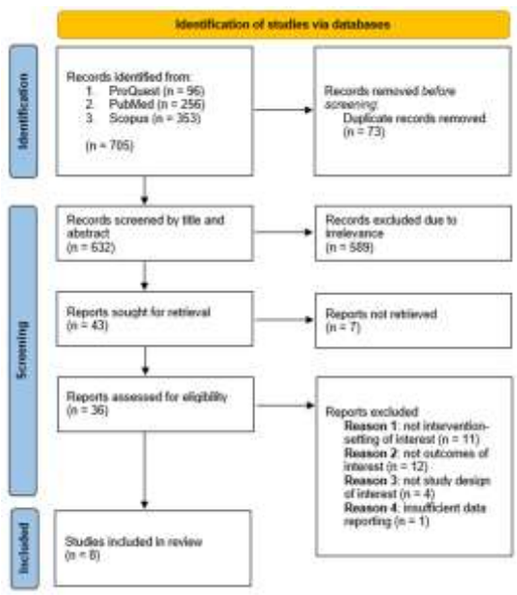

Figure 1. PRISMA flow diagram (Page et al., 2021)

RESULTS AND DISCUSSIONS

Table 3. Summary of the Studies Included in the Present Systematic Review

No	Author/ Year	Country	Design and Method	Population and Sample Size	Type	Intervention Details	Result
1	Tatum et al., (2024)	Virginia, USA	**Study design:** Quasi experimental **Study period:** Sept 2015–May 2016 **Measurement:** Self-reported survey and digital tracker at hydration station	Elementary school students (grade 4-5) *n* baseline=1.006 *n* follow up=1.029 no control group	EE	*"Hydration Initiatives"* including placement of hydration stations in high traffic area; promotional and educational activities during *Water Week;* and distributing reusable water bottles	Significant decrease in daily regular soda consumption ($p<0.001$), while no significant change was observed in total daily SSB and other SSB consumption (i.e., sport drinks, coffee drinks, sweet tea, juice drinks, punch, lemonade).
2	Olvera et al., (2024)	Mexico	**Study design:** Cluster RCT **Study period:** January–June 2015 **Measurement:** 24-hour recall specific beverage and water consumption trough interview	Elementary school students (grade 4-5) *n*=314 *n* intervention=146 *n* control=168	EE	**Intervention group:** Weekly 30-minutes classroom lessons by nutritionist and installation of drinking fountain in school corridor along with weekly provision of water jugs and reusable water bottles **Control group**: only received general nutritional recommendations	Significant increase (+200mL) in water consumption ($p=0.005$) and significant decrease (-94mL) in flavored milk consumption ($p=0.044$) in the intervention group as compared to the control group, with no significant decrease for other SSB consumption (i.e. water flavoured with fruits and added sugar, fruit juice, and soft drinks).
3	Irwin et al., (2019)	London, Ontario	**Study design:** Quasi experimental non RCT **Study period:** Oct 2016–June 2017 **Measurement:** Survey by parents and students	Elementary and middle school (grade 4-8) *n*=931 *n* intervention=521 *n* group 1=348 *n* group 2=173 *n* control=410	EE	*"Water Does Wonders"* **Intervention group 1:** Program Growing Chefs (promoting nutrition through cooking, food literacy workshop, healthy eating) and water bottle filling station **Intervention group 2:** Program UTRCA (topics including water conservation and treatment) and water bottle filling station **Control group:** only received the installation water bottle filling station	The results showed positive trends, although most changes were not statistically significant: **Intervention group 1:** water consumption increased by 2.18% and SSB consumption decreased by 1.17% as compared to the control group. **Intervention group 2:** Water consumption increased by 2.90% and SSB consumption decreased by 2.56% as compared to the control group.
4	Rauba et al.,	Chicago, USA	**Study design:**	Elementary school	EE	*"Educational Curriculum & Sugar*	Significant decrease in diet soda, SSB and

No	Author/ Year	Country	Design and Method	Population and Sample Size	Type	Intervention Details	Result
	(2017)		One-group pretest and post-test **Study period:** Nov 2014–2015 **Measurement:** 24-hour beverage recall survey	students (grade 3-5) *n* baseline=213 *n* follow-up=211 no control group		*Show"* including demonstrating the sugar amount in SSB using visual aids; installation of drinking fountain and water bottle filling station; and reinforcement activities such as weekly announcement, water bottle raffle, and posters	real fruit juice, and other SSB consumption ($p<0.05$), while water consumption increased from 3.3 to 3.6 servings per day, but the change was not statistically significant ($p>0.05$)
5	Smit et al., (2016)	Netherlands	**Study design:** Cluster RCT (pilot study) **Study period:** January–March 2014 **Measurement:** Self-reported survey	Primary school students aged 9-13 *n*=210 *n* intervention=106 *n* control=104	SN	*"Share H2O"* **Intervention group:** selection and training of influential agents (IA) and providing reusable water bottles for IA to stimulate their peers. The IAs promote water consumption among their peers and receive follow-up sessions for reinforcement. **Control group:** No intervention implemented	Significant interaction effect between condition and time for water consumption ($p=0.021$); post-hoc showed significant water increase in the intervention group ($p=0.018$), but not in the control group. Significant interaction effect between condition and time for SSB consumption ($p=0.015$); post-hoc showed significant SSB decrease in the intervention group ($p<0.001$), but not in the control group.
6	Franken et al., (2018)	Caribbean Island, South America	**Study design:** Cluster RCT **Study period:** January–March 2016 **Measurement:** Self-reported survey	Primary school students aged 10-14 (grade 5-6) *n*=377 *n* intervention=192 *n* control=185	SN	A peer-influence intervention, adapted from the "*Share H2O*" pilot study of Smit et al., (2016)	No significant increase in water consumption but significantly increased in the intervention group with a high perceived injunctive norm ($p=0.05$). Significant reduction in SSB consumption in the intervention group as compared to the control group ($p=0.04$)
7	Sutherland et al., (2022)	New South Wales, Australia	**Study design:** Cluster RCT **Study period:** March–July 2018 **Measurement:** Self-reported survey; observation; and photography and written documentation	Secondary school student (year 7-9) *n* intervention=473 *n* control=389	ES	"*SwitchURsip Strategies*" **Intervention group:** changing the availability and placement of SSB; reducing the promotion of SSB and receiving pictograms promotional posters; changing or marking up the pricing of SSB; and installing water stations and provided drink bottles. **Control group:** Usual school programs	Significant decrease in daily SSB consumption among girls in the intervention group as compared to the control group ($p=0.03$) No significant changes observed in daily SSB consumption ($p=0.57$) in the intervention group as compared to the control group.

No	Author/ Year	Country	Design and Method	Population and Sample Size	Type	Intervention Details	Result
						and operations	
8	Stamos et al., (2019)	Brussel, Belgium	**Study design:** Quasi experimental non-equivalent control group **Study period:** April–June 2017 **Measurement:** Beverage sales data from vending machine company and school cafeteria sales	3 high schools (*n*=2.959 students) *n* intervention= 2 high schools *n* control= 1 high school	ES	*"Traffic Light System (TLS) labelling and assortment changes"* **School 1**: TLS in vending machines and increased the availability of healthier beverages **School 2**: TLS in school cafeteria and increased the availability of healthier beverages **School 3**: No intervention or changes in vending machines TLS drinks categories: **Green**: no sugar **Amber**: some sugar and good nutrients or artificially sweetened **Red**: sugar and no good nutrients	Significant decrease in red drinks purchases from baseline to the intervention in both intervention school ($p<0.001$) and more strongly in school 1, as compared to the control group. No significant decrease for red drinks purchases in post-intervention period either school 1 or school 2. Significant decrease in red drink purchases relative to the green drinks ($p=0.001$) and amber drinks ($p<0.001$) in school 1, and relative to amber drinks only ($p<0.001$) in school 2, as compared to the control group.

Abbreviation: EE, educational and environmental strategies; SN, social network-based approach; and ES, purely environmental strategies

As shown in Table 3, eight school-based intervention studies were included in this review. Six of the studies involved elementary or junior high school students, and two were conducted among high school students. The sample sizes ranged from 210 participants in the pilot study to nearly 3.000 students in the quasi-experimental design. Based on the type of intervention, three types were identified: (1) EE, combined educational and environmental strategies; (2) SN, social networking-based approach; and (3) ES, purely environmental strategies. Specifically, four studies combined educational sessions with environmental modifications, such as installing water infrastructure or providing drinking bottles. Two studies applied a social networking approach through peer influence, while the remaining two employed solely environmental strategies, including providing water facilities, healthy canteen strategies, and traffic light system with assortment changes to encourage healthier beverage choices. In response to the first research question, the types of school-based intervention will be further discussed in the following section.

Intervention Type 1: Combination of Education and Environmental Strategies

Among the eight studies reviewed, four studies [Studies 1–4 in Table 3] combined educational sessions with environmental strategies. This type of intervention can be categorized as an integrated approach, as it aims to modify predisposing factors through educational sessions while strengthening enabling factors through the provision of water infrastructure. This approach aligns with findings from the *Health4Life eHealth* intervention, which emphasized that education alone is insufficient to achieve sustained behavioral change (Champion et al., 2023). However, the results of these four studies showed variation. The *Educational Curriculum & Sugar Show* [Study 4] demonstrated a statistically significant reduction in SSB consumption, two other studies showed partial effects with significant reduction in certain types of SSB [Study 1 and 2], while *Water Does Wonders* [Study 3] reported a positive effect without statistical significance.

The *Water Does Wonder* is one of the four key themes of the Ontario-wide Healthy Kids Community Challenge (HKCC), a government-funded initiative that supports local communities in promoting a healthy lifestyle for children. The intervention consisted of an educational session and the provision of water infrastructure. The Growing Chefs educational program focused on general nutrition, while the Upper Thames River Conservation Authority (UTRCA) educational program emphasized water conservation and treatment issues. Consequently, the core message about reducing SSB consumption may not have been strongly conveyed. The authors recommend aligning the educational content with the study objectives (Irwin et al., 2019).

Conversely, the *Educational Curriculum & Sugar Show* was developed organically within schools by the School Wellness Committee, involving parents, teachers, health care professionals, and students. This internal and participatory initiative likely improved acceptance among school personnel. The intervention also highlighted the adverse health effects of excessive sugar consumption through a visual demonstration (e.g., plastic bag) of sugar content. These demonstrations were compared with the daily limit recommended by the American Heart Association. This helped students to better understand the high sugar content of SSB and aligned closely with the intervention's objective to reduce SSB consumption. The students were also involved in refining the educational content through a feedback meeting, which strengthened participation and message appeal (Rauba et al., 2017).

Intervention Type 2: Social Networking-Based Approach

Two other studies [Studies 5 and 6] applied a social networking-based approach through the *Share H2O* intervention. This intervention was piloted by Smit et al., (2016) in the Netherlands in 2014 and later adapted by Franken et al., (2018) in the Caribbean Islands in 2016. This approach utilized social-network influence to modify drinking behaviors within students' social environment. Peer influence significantly impacts adolescent consumption habits, increasing the likelihood of SSB consumption by 4.1 times (Pamarta et al., 2022) and coffee consumption by 3.9 times, emerging as a dominant factor compared to individual or environmental characteristics (Ramadhiani et al., 2023).

Findings from both *Share H2O* studies reported lower SSB and higher water consumption. These findings are consistent with the Theory of Planned Behavior (TPB), particularly the construct of subjective norms, which refers to the perceived social pressure from important others (e.g., peers, parents, partners, teachers, role models) that can influence individual behavior. When individuals believe that others expect them to perform a certain behavior and they are motivated to meet those expectations, they develop a positive subjective norm (McKenzie et al., 2013). Franken et al., (2018) further demonstrated that improvement of water consumption was most evident among students with high perceived injunctive norm (PIN), suggesting that perceived peer approval plays a critical role in shaping beverage choices.

Intervention Type 3: Environmental Strategies

The last two studies [Studies 7 and 8] applied purely environmental strategies. Both focused on modifying the school environment without including educational components. The *SwithURsip* intervention lasted for six months (Ooi et al., 2021), but the reviewed article only evaluated its mid-intervention effects. The intervention reported limited effects, with significant changes observed only among female students (Sutherland et al., 2022). These changes may be explained by girls' tendency to engage in behaviors they consider beneficial for weight loss, which might reflect social pressures related to the ideal body types (Bodega et al., 2023).

Conversely, the traffic light system labelling combined with assortment change demonstrated significant outcomes. The proportion of red drink purchases decreased by approximately 30%, with purchases shifting toward amber and green drinks, which serve as a close proxy for actual consumption (Stamos et al., 2019). This aligns with the prior evidence, showing that combining traffic light system labelling with increased availability of healthier beverages options significantly improved healthier beverage choices (Calabro et al., 2024). The positive impact of traffic light labelling may be interpreted through the color associations; green is generally associated with health, which reinforces perceptions of healthy nutrients, while red tends to trigger associations with caution, which reinforces perceptions of unhealthy nutrients. According to the color approach-avoidance theory, colors can also lead to automatic motivational responses without requiring deep cognitive processing; where green encourages approach and red encourages avoidance (Nyilasy et al., 2016).

Table 4. Methodological Enhancement

Methodological Limitation	Future Research Recommendations
Absence of control group	Inclusion of a control group to strengthen causal inference and ensure that observed outcomes are attributable to the intervention
Self-reported survey; 24-hour recall survey; and the use of non-standardized frequency-based measures	Create a trustworthy assessment environment to reduce social desirability bias; utilize the validated and standardized instrument; and use an objective measurement

Methodological Enhancement

To answer the second research question, we synthesized the methodological limitations identified across the included studies, as shown in Table 4. Several studies lacked control group, which limits causal inferences and makes it difficult to attribute observed changes solely to the intervention. Additionally, the reliance use of self-reported surveys, 24-hour dietary recall, and relying on non-standardized frequency-based measures raise the concerns regarding bias and measurement accuracy. Addressing these limitations through more rigorous study design, along with objectives and standardized measurement tools, may enhance the internal validity of future school-based intervention study.

The studies conducted by Tatum et al., (2024) and Rauba et al., (2017) [Studies 1 and 4], which combined educational and environmental strategies, did not include a control group. This condition became a limitation in terms of internal validity, as it cannot be determined with certainty whether the changes that occurred were caused by the intervention. The study by Irwin et al., (2019) [Study 3], employed both an intervention group and a control group. However, the researchers emphasized that there was no true control group in the study. The existence of a true control group, for example, a group that only receives educational intervention or a group that only receives environmental intervention, would be very beneficial in determining the specific contribution of each intervention component to the observed behavioral changes (Irwin et al., 2019). Therefore, future experimental research is recommended to employ a control group to improve causal inference and internal validity.

Most studies reported the use of self-reported surveys and 24-hour recall specific beverage and water consumption. However, 24-hour recall may not represent participants' usual intake. In addition, these methods are prone to recall bias and social desirability bias. For further research, it is recommended to conduct multiple 24-hour recalls to accurately estimate the usual intakes (Andarwulan et al., 2021). To reduce the potential for social desirability bias, Di Lorio (2005) emphasized the importance of creating a trustworthy data collection environment, including clearly explaining the purpose of the study, explaining how the data will be used, emphasizing that there are no right or wrong answers, and ensuring the confidentiality of participants' responses.

Additionally, it is important to ensure that the survey instruments used are validated and standardized, as was done by Sutherland et al., (2022) [Study 7] using Australian Child and Adolescent Eating Survey (ACAES). Future research may also consider using more objective measurement methods as recommended by Smit et al., (2016) and Franken et al., (2018), such as flow meter or digital tracker at hydration station as used by Tatum et al., (2024) [Study 1], or beverage sales data utilized in the study by Stamos et al., (2019) [Study 8]. This combination measurement method is expected to improve measurement

accuracy, minimize bias, and strengthen the validity of findings in future school-based intervention studies.

Table 5. Strategic Program Recommendations

Proposed Strategies	Rationale
Participatory design approach	Involving target audiences from the early stage of intervention development aimed at enhancing contextual relevance, acceptability, and sense of ownership
Integration into school curriculum and policy	The integration of intervention components into existing school curriculum and policy frameworks to support the long-term sustainability of intervention impacts
Improve physical and social access to drinking water	To increase water consumption as a healthier choice and as a substitute for SSB, for example by improving access to drinking facilities, a supportive social environment, and a clean and safe toilet

Strategic Program Recommendations

To answer the third research question, we compiled strategic program recommendations based on a synthesis of the findings and implementation challenges identified in the included studies, as listed in Table 5. These recommendations emphasize the importance of participatory approach, structural integration within school curriculum and policy framework, and improve physical and social access to drinking water. These strategies reflect practical considerations for strengthening the effectiveness, acceptability, and sustainability of future school-based interventions.

A participatory design approach involving target audiences is recommended by Irwin et al., (2019) and Sutherland et al., (2022) [Studies 3 and 7]. Through this approach, researchers and target audiences work together at all stages, as target audiences are considered equal partners in the research process, which ultimately leads to empowerment and knowledge-building (Naidoo & Wills, 2010). This approach allows students, teachers, or school personnel to be involved in designing the program, including planning, implementation, and evaluation. Their involvement is important to identify local needs and ensure that the program is appropriate and relevant to the school context (Bottin et al., 2019). As was done by Rauba et al., (2017) [Study 4], where the educational curriculum program was developed organically by a School Wellness Committee. The results of this study also showed positive effects, which were possible because of contextual relevance, higher acceptance, and a sense of ownership of the program.

Another recommendation, as suggested by Irwin et al., (2019) and Rauba et al., (2017) [Studies 3 and 4] is to integrate intervention components into school curriculum and policy framework. This effort aims to ensure that the effects of the intervention are more sustainable and become internalized. A study found that the availability of SSB in schools was associated with high SSB consumption, which indicates the importance of regulatory measures that limit the availability of SSB in and around schools (Rocha et al., 2021). Other literature also reports that legislative or environmental regulations aimed at reducing and/or eliminating SSB in schools were among the most effective strategies for reducing SSB consumption (Vézina-Im et al., 2017). This integration effort serves as a reinforcing factor that fosters healthy and long-lasting consumption behaviors.

A study by Tatum et al., (2024) [Study 1] identified perceptions of barriers among teachers regarding bringing water bottles into classroom. Teachers tended to worry about the risk of spilled water disrupting classroom activities. Therefore, it is necessary to encourage a school culture that promotes drinking water, involving teachers, students, and all school personnel. A supportive and motivating social environment is expected to encourage the habit of consuming water as a healthier alternative to SSB (Olvera et al., 2024).

These efforts can be strengthened by improving access to adequate drinking facilities, such as providing dispensers or chilled water in every classrooms, cafeterias, or high-traffic areas; strategies to increase the appeal of drinking water, for example through the use of personalized glass or water bottles; and establishing routine opportunities for water consumption, such as during morning and afternoon breaks (Bottin et al., 2019).

In addition, studies have reported that unpleasant conditions and fear of bullying discourage children from using school toilet facilities, which may negatively affect their health. Therefore, the availability of clean and safe toilet facilities is an important component to be considered (Bottin et al., 2019). Overall, creating a supportive school environment, both physically and socially, is essential to reduce SSB consumption and promote water intake among students.

CONCLUSION

This review highlights that school-based interventions show promise in reducing SSB consumption among children and adolescents. The findings indicate that interventions combining educational and environmental strategies are generally associated with more favorable

outcomes, particularly when the messages are clearly aligned with the behavioral objectives and participants are actively involved throughout the program. Water consumption showed positive trends in some studies but was not consistently measured and thus considered a supportive outcome. Nevertheless, several limitations were identified, particularly those related to challenges in establishing causal inference and the potential for measurement bias. For further research, it is advised to adopt a participatory design approach, integrate interventions into school curriculum and policy framework, and improve physical and social access to drinking water within the school environment.

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