Public Health 244 (2025) 105750

Contents lists available at ScienceDirect

Public Health

journal homepage: www.elsevier.com/locate/puhe

Review Article

Comparative effectiveness of health literacy intervention on reducing sugar or sugar-sweetened beverage consumption in Asian populations: A systematic review

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ARTICLE INFO

Keywords:
Health literacy
Sugar
Sugar-sweetened beverage
Asia

ABSTRACT

Objective: This study evaluated the effectiveness of health literacy interventions aimed at reducing sugar and sugar-sweetened beverage (SSB) intake among Asian populations and identified the common characteristics of effective interventions through a systematic review of randomised and non-randomised studies.
Study design: Systematic review of randomised and non-randomised trials.
Methods: A systematic search of five databases identified randomised and non-randomised studies on health literacy interventions aimed at reducing sugar and SSB intake among Asian populations. Screening followed predefined criteria, and data extraction captured the intervention type, delivery, duration, and outcomes. Quality was assessed using the Cochrane Risk of Bias-2 and ROBINS-I tools for bias, and the findings were synthesised to identify effective intervention traits and research gaps.
Results: Of the eight included studies, three were face-to-face educational, one behavioural, one online, one mobile text messaging, and two front-of-pack (FOP) labelling interventions. Six out of eight studies measured sugar intake, with four assessing SSB intake. Seven studies reported significant dietary improvements. Overall, bias risk was present, with three rated high. Significant inconsistencies in the two studies were further explored.
Conclusion: The effectiveness of health literacy interventions in reducing sugar or sugar-sweetened beverage intake was positive, particularly for face-to-face interventions and FOP labels. Available evidence may inform policymaking for the implementation of health promotion for disease prevention and complement standards of care practices for disease management.

1. Introduction

Sugar is a key ingredient in food and drinks, especially in sugar-sweetened beverages (SSB) such as sodas, fruit juices, and flavoured milk, which are high in sugar and calories and low in nutrients. Sugar is consumed worldwide, with increasing trends in many low-income and middle-income countries.[1] Ranasinghe et al.[2] reviewed the prevalence of metabolic syndrome (MetS) in the Asia-Pacific region, linking it to sugar intake. Pakistan has the highest MetS rate (49 %),[3] followed by Malaysia (37.1 %).[4] The average added sugar intake in Saudi Arabia is 73 g per day, with non-Saudis, consuming more than Saudis.[5] Statistics show that Asians' sugar consumption exceeds the World Health Organization's (WHO) recommended limit.[6] Overconsumption of discretionary foods and drinks is a major lifestyle risk factor that contributes to obesity, type 2 diabetes, and cardiovascular diseases.[7] Controlling sugar levels is key to weight management and reducing disease risk. However, eliminating sugar is challenging because socioeconomic and cultural factors influence attitudes toward sugar intake.[8] Moreover, aggressive marketing practices affect consumers' perceptions of SSB, as claimed by labels on food and drink packaging.[9] Health issues such as social stratification and inequalities challenge efforts to reduce sugar consumption.[10] This is further complicated by the need for individuals to develop the intention to control their sugar intake through empowerment.[11]

Health literacy (HL) plays a key role in encouraging individuals to limit their sugar intake. Public health interventions for HL can be

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https://doi.org/10.1016/j.puhe.2025.105750
Received 2 November 2024; Received in revised form 10 February 2025; Accepted 7 April 2025
Available online 15 May 2025

categorised into traditional, art-based, technology-based, and active learning strategies. Examples include lectures, storytelling, drawings, group discussions, and mobile devices to inform communities about health concerns, raise awareness, and encourage behaviour change.[12] Numerous health education interventions have been attempted in Asia,[13–15,] but their full effectiveness remains unexplored. Effective dietary improvement approaches are essential for linking nutrition with disease prevention. This systematic review aims to evaluate the effectiveness of HL interventions in reducing sugar and SSB consumption among Asian populations, focusing on key outcome measures such as changes in sugar intake, frequency of SSB consumption, and dietary habits, as well as the comparative impact of intervention versus control groups.

2. Methods

This systematic review followed the principles of the Cochrane Handbook for Systematic Reviews of Interventions.[16] The findings adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[17] The review protocol was published and registered in the International Prospective Register of Systematic Reviews. (PROSPERO) (ID: CRD42024524366).

2.1. Source of data and search strategy

A comprehensive literature search was conducted using PubMed, Ovid Medline, Scopus, Web of Science, and CENTRAL for English-language publications from January 2020 to February 2024. with the search including, MeSH terms, free-text terms and Boolean operators tailored to each database to identify RCTs and observational studies evaluating health literacy approaches for reducing sugar or SSB intake. Additionally, grey literature, conference proceedings, and reference lists of relevant articles were screened. Where necessary, the authors were contacted for additional information. The detailed search algorithm for each database are provided in Appendix I.

2.2. Study selection criteria

The eligibility criteria were based on the Population, Intervention, Comparator, Outcome, and Study design (PICOS) framework and were used as the basis for selecting studies.

Population (P): Participants identified as Asian, regardless of sex or age.

Intervention (I): Any intervention utilising HL or health education targeting change in health-related behaviour.

Comparator (C): Any other intervention, usual care, or placebo.

Outcome (O): Primary outcome: Reduction in sugar or SSB consumption. Secondary outcome: Behavioural intentions or willingness to reduce sugar or SSB consumption or purchase of sugary substances or SSB.

Study design (S): RCTs, non-RCTs, and observational studies.

2.3. Exclusion criteria

Protocols, letters, feasibility studies, and pilot studies.

Studies without comparators.

Studies reporting only HL intervention without reference to sugar or SSB consumption.

2.4. Data extraction and quality assessment

Two reviewers (YY and MK) independently extracted data from the included studies, categorising them by study characteristics, participant charecteristics, and intervention characteristics, along with outcome definitions and measures, using Microsoft Excel. Each reviewer then assessed the risk of bias using the Cochrane RoB 2 tool for randomised studies and ROBINS-I for non-randomised studies.[18,19] Discrepancies were resolved through discussion or consultation with a third reviewer (DG). The limitations of self-reported outcomes (e.g., potential for reporting bias) were documented during the extraction process and factored into the synthesis of the results.

3. Results

3.1. Literature search

The initial search identified 1196 records across the five databases. After removing 538 duplicates using Zotero, 658 records remained. During title and abstract screening, 574 records were excluded as ineligible. The full texts of potentially eligible papers were retrieved, except for one due to limited library access. Of the 83 reports sought, 75 were excluded for the reasons shown in Fig. 1. Eight studies met the inclusion criteria and were selected for this review. Fig. 1 outlines the search and screening processes.

3.2. Study characteristics

This systematic review included studies conducted in Hong Kong,[20] Indonesia,[21] Malaysia,[13] Singapore (SG),[22] Bangladesh,[14,23] Iran,[15] and the Kingdom of Saudi Arabia (KSA)[24] with a total of 5076 participants, aged 5–56 years, predominantly female. HL interventions varied in design and delivery, including face-to-face education,[13–15] behavioural approaches [20] online education,[21] mobile text messaging,[23] and front-of-pack (FOP) labelling.[22,24] The majority of studies were RCTs,[23,24] and cluster RCTs,[13,14,20] while two were quasi-experiments.[15,21] and one was a crossover trial.[22] The study characteristics are mentioned in Table 1.

The key outcomes of the analysis are summarised in Table 2, providing an overview of major findings. The interventions ranged in duration from 1 week to 6 months, with varying follow-up lengths. The most effective interventions involved interactive, in-person learning, and parental or community involvement, particularly those targeting children in school-based settings.

The intervention strategies varied in scope and delivery. School-based interventions have shown promising outcomes in terms of dietary modification. Ahmed et al.'s.[14] implemented a multi-component school-based program aligned with the WHO's Health Promoting Schools (HPS) framework, including weekly lessons on physical activity and nutrition.[25] Anwar et al.[13] used a structured oral health education (OHE) program, which included teacher-led lessons, parental involvement, and dietary counselling. Ahmed et al.[14] and Anwar et al.[11] also found reductions in carbonated drink intake, although some control groups exhibited unexpected improvements, suggesting potential contamination effects. Behavioural and community-based interventions also demonstrated effectiveness. Joveini et al.[15] reported a substantial decrease in weekly sugar intake (1.10 vs. 1.70 times/week) and soft drink consumption (1.07 vs. 2.74 times/week, $p < 0.001$). Ho et al.[20] demonstrated that psychology-based interventions enhanced dietary self-regulation and promoted healthier consumption patterns.

Technology-driven interventions have mixed effectiveness. Pangestuti et al.[21] conducted an online nutrition education program, while Islam et al.[23] used daily mobile text messages to promote dietary change. However, the results from these studies indicated a limited long-term impact due to the passive nature of engagement. In contrast, policy-based approaches, such as FOP labelling, showed promise in influencing consumer behaviour. Shin et al.[22,24] found that Nutri-Score (NS) labels significantly reduced sugar per serving purchased, whereas Warning Labels (WL) had a weaker effect, suggesting differences in consumer interpretation of labelling systems.

Overall, school-based and community programs were the most effective, FOP labelling influenced choices but lacked long-term effects, and digital interventions faced engagement challenges. Effective

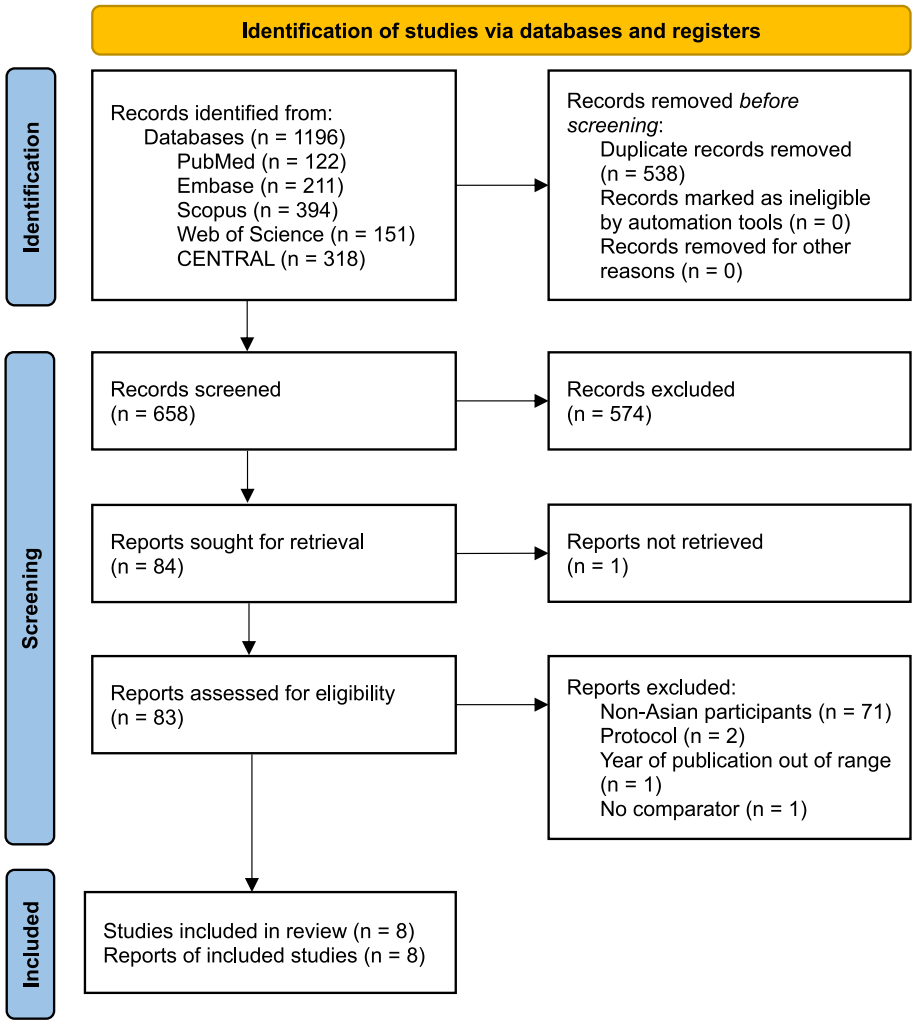

Fig. 1. The literature search process is illustrated in a PRISMA flow diagram.

interventions require structured education, interactive reinforcement, and family involvement for sustained dietary improvement.

3.3. Risk of bias

Study quality was assessed using RoB 2 for randomized studies and ROBINS-I for non-randomised studies. Four randomised studies had some concerns, while Ahmed et al.[14] was rated high-risk due to issues with randomisation and intervention deviations (Fig. 2). Islam et al.,[23] which showed potential contamination effects. Studies with a low risk of bias, such as Ho et al.,[20] and Shin et al.,[22] demonstrated stronger and more reliable intervention effects, whearas those with higher risks, such as Ahmed et al.[14] Non-randomised studies showed moderate to serious risks, Joveini et al. had issues due to confounding and selection of participants, and Pangestuti et al.,[21] which faced missing data and intervention deviations (Fig. 3). These findings highlight the critical influence of study quality on outcome reliability and the importance of rigorous methodologies and standardised reporting for future health literacy interventions. Risk of bias assessments showed that higher-quality studies such as Joveini et al.[15] and Ho et al.,[20] demonstrated greater reductions in sugar intake, whereas studies with randomisation concerns or missing data (Ahmed et al.[14] and Pangestuti et al.[21]) had less consistent findings. Overall, HL interventions were effective, particularly when delivered in structured, interactive, and community-supported formats.

4. Discussion

This systematic review indicates that HL interventions are effective in reducing SSB consumption, particularly in Asian populations. Among the reviewed approaches, health education was the most common and effective, focusing on the risks of sugar intake, reduction strategies, and associated health benefits. Many interventions also included behavioural components,[26] such as goal-setting,[27] self-monitoring,[20] and emotional reinforcement, which improved participant engagement and sustained dietary changes. Theory-driven models, such as the Multi-Theory Model (MTM) and positive psychology approaches, further enhanced intervention success by fostering motivation, confidence, and self-regulation.[15,20,23]

Cultural nuances, including dietary norms, family dynamics, and socioeconomic factors, significantly influenced intervention success. For example, rural communities may require tailored approaches that address resource limitations and cultural barriers, such as limited access to nutritious foods or healthcare facilities. Similarly, interventions targeting ethnic minorities[28] and low-income families should incorporate culturally relevant materials and accessible delivery methods, such as community-based workshops or mobile clinics.[8,11] Translating program materials into local languages is only explicitly mentioned in a few studies (for example, Ahmed et al.,[14] Anwar et al.[13]) and is critical to ensure inclusivity. Cultural competency training for intervention staff could further enhance effectiveness by ensuring that interventions are contextually appropriate and well-received.[26]

Table 1
Summary of study characteristics.

Study	Country	Intervention Group (n)	Control Group (n)	Age (Mean ± SD)	Follow-Up Duration	Intervention Description	Outcome Measures (Primary and Secondary)	Baseline vs Follow-Up (I vs C)	Difference (Δ)	Key Findings	Statistical Significance (p-value)
Ahmed et al., 2023[14]	Bangladesh	160	160	13.2 ± 1.4/12.8 ± 1.2	12 weeks	School-based nutrition education sessions, parental involvement, and healthy eating materials.	Primary:Reduction in SSB consumption Secondary:Increased fruit/vegetable intake	Baseline: 2.3 SSB/day (I), 2.5 (C) Follow-Up: 1.3 (I), 2.4 (C)	Δ = −1.0 (I), −0.1 (C)	Significant reduction in SSB consumption for intervention group (I). Minimal change in control group.	$p < 0.001$
Anwar et al.2020[13]	Malaysia	344	309	5–6 years	6 months	Oral health education (teachers, parents), supervised tooth brushing, and dental therapist-led interventions (SIMSP).	Primary:Sugary snack consumption Secondary:Oral health improvements	Baseline: 4.1 sugary snacks/wk (I), 4.2 (C) Follow-Up: 2.7 (I), 4.1 (C)	Δ = −1.4 (I), −0.1 (C)	Intervention significantly reduced sugary snack consumption. Control group showed negligible changes.	$p = 0.033$
Ho et al.2024[20]	Hong Kong	983 families (I)	1000 families (C)	16.1 ± 1.0/16.3 ± 0.9	3 months	Positive psychology-based intervention emphasizing gratitude, savoring, and joy to reduce sugar consumption.	Primary:Weekly SSB consumption Secondary:Self-regulation behaviors	Baseline: 3.6 SSB/wk (I), 3.5 (C) Follow-Up: 1.9 (I), 3.4 (C)	Δ = −1.7 (I), −0.1 (C)	Significant reduction in SSB in intervention group; limited change in controls. Intervention enhanced behavioral regulation.	$p < 0.001$
Pangestuti et al., 2022[21]	Indonesia	39	45	10.2 ± 2.4/10.6 ± 2.2	8 weeks	Weekly online nutrition education sessions focusing on sugar, salt, and fat consumption.	Primary:Reduction in sugary food consumption Secondary:Dietary adherence	Not available	Not available	Limited data available for follow-up outcomes.	Not available
Shin et al.2023[24]	Saudi Arabia	218	218	32.4 ± 5.2/31.9 ± 5.0	6 weeks	Front-of-pack nutrition labels (Nutri-Score and Warning Label) to encourage healthier beverage purchases.	Primary:Reduction in sugary beverage purchases Secondary: Nutritional literacy	Baseline: 4.5 servings/day (I), 4.6 (C) Follow-Up: 2.8 (I), 4.5 (C)	Δ = −1.7 (I), −0.1 (C)	Significant reduction in sugary beverage purchases with Nutri-Score labeling. Control group remained stable.	$p < 0.001$
Shin et al.2023[22]	Singapore	138	138	34.2 ± 6.0/33.8 ± 6.5	2-arm crossover trial	Nutri-Grade labeling on beverages tested using an online grocery platform.	Primary:Reduction in sugar purchased Secondary: Nutritional literacy	Not specified	Reduction of 1.51 g sugar	Nutri-Grade labels successfully reduced sugar purchased. Impact on saturated fat negligible.	$p < 0.05$
Joveini et al.2023[15]	Iran	65	63	38.5 ± 7.2/39.0 ± 6.9	6 months	Multi-theory model-based intervention (5 sessions) to empower women to reduce sugar intake and improve BMI and abdominal obesity.	Primary:Daily sugar intake Secondary:BMI and abdominal obesity	Baseline: 21 g/day (I), 20 g/day (C) Follow-Up: 15 g/day (I), 20 g/day (C)	Δ = −6.0 (I), 0.0 (C)	Intervention group significantly reduced daily sugar intake. BMI improvements observed.	$p < 0.001$
Islam et al.2021[23]	Bangladesh	118	118	45.1 ± 8.3/44.9 ± 7.8	6 months	Mobile health (mHealth) intervention: daily SMS texts focusing on dietary modifications for Type 2 Diabetes management.	Primary:Sugar beverage consumption Secondary:Dietary adherence	Baseline: 2.1/wk (I), 2.0/wk (C) Follow-Up: 1.7/wk (I), 2.0/wk (C)	Δ = −0.4 (I), 0.0 (C)	Intervention reduced sugar beverage consumption, but the difference was not statistically significant.	Not significant

Table 2
Overview of key findings.

Author	Sugar/SSB consumption	Intervention		Control		Effectiveness	Conclusion
		Baseline	Last available follow-up	Baseline	Last available follow-up		
Anwar et al.[13]	Number of children with sugar intake ≤4 × /day	222	225	221	231	Not effective	Intervention was only effective for reducing consumption of carbonated drinks.
	Number of children with carbonated drinks intake	119	131	134	136	Not effective	
	Number of children with carbonated drinks intake ≤1 - 3 × /week	256	257	256	252	Effective	
Joveini et al.[15]	Sugar (time/week) Mean ± SD	1.56 ± 1.16	1.10 ± 0.41***	1.74 ± 1.16	1.70 ± 1.22	Partially effective	Intervention was partially effective for reducing sugar consumption, but effective for soft drink consumption.
	Soft drinks (time/week) Mean ± SD	2.57 ± 1.35	1.07 ± 0.25***	2.63 ± 1.43	2.74 ± 1.40	Effective	
Ahmed et al.[14]	Carbonated soft drinks (time/day) Mean ± SD	3.11 ± 1.14	2.48 ± 1.41***	2.85 ± 1.06	2.88 ± 1.20	Partially effective	Intervention was partially effective for reducing consumption of carbonated soft drinks.
Ho et al.[20]	Total sugar (g) consumed from SSB per day	19.37 ± 0.89	14.48 ± 0.71***	18.06 ± 0.82	16.47 ± 0.66*	Effective	Intervention was effective for promoting low-sugar diet.
Islam et al.[23]	Teaspoon of sugar added to tea/coffee per week Mean ± SD	0.2 ± 0.4	0.2 ± 0.6	0.2 ± 0.5	0.1 ± 0.3	Effective	Intervention was not effective in reducing sugar/SSB intake.
	SSB in serves/week Mean ± SD	0.2 ± 0.6	0.1 ± 0.7	0.4 ± 1.3	0.2 ± 0.9	Not effective	
Pangestuti et al.[21]	Sweet food consumption Mean ± SD	2.4 ± 1.2	2.7 ± 1.0	2.5 ± 1.1	2.9 ± 0.8*	Not effective	Intervention was not effective in reducing sweet food consumption.
Shin et al.[24] (KSA)	Sugar (g) per serving Mean ± SD	Difference between NS and control for food and beverages: 2.1 ± 0.4** beverages only: 6.3 ± 2.0**				Effective	NS label was effective for reducing sugar (g) per serving purchased from food and drinks, but WL was not effective.
	Sugar (g) per serving Mean ± SD	Difference between WL and control for food and beverages: 0.5 ± 0.4 beverages only: 5.0 ± 1.7**				Partially effective	
Shin et al.[22] (SG)	Sugar per serving in grams Mean, 95 % CI	Difference between NG and control for food and beverages: 0.33 (95 % CI: 0.73, 1.40) beverages only: 1.51* (95 % CI: 2.68, - 0.34)				Effective	NG label was effective for reducing sugar (g) per serving purchased from food and drinks.

SSB: sugar-sweetened beverages.
CI: confidence interval; SD: standard deviation; *p < 0.05; **p < 0.01; ***p < 0.001.

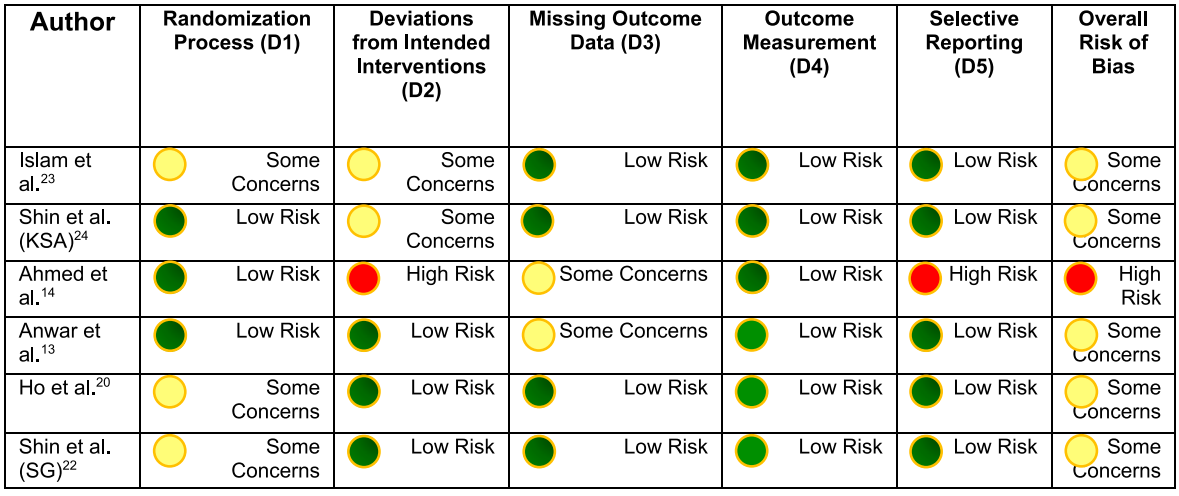

Fig. 2. Summary of risk of bias assessment for randomised studies.

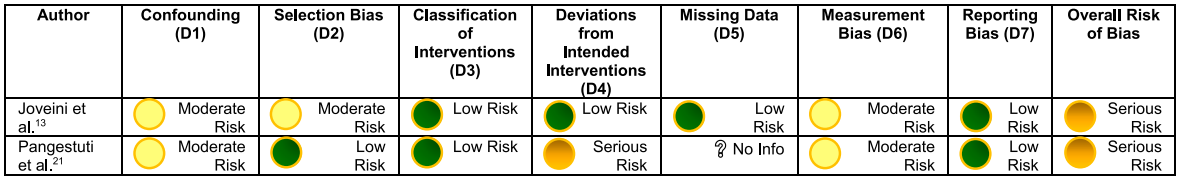

Fig. 3. Summary of risk of bias assessment for non-randomised studies. NI: no information.

Community involvement has emerged as a key success factor, particularly for interventions targeting children. Parents, educators, and peers play crucial roles in shaping dietary behaviours. School-based programs that engaged parents, such as Ahmed et al.[14] and Anwar et al.,[13] showed stronger outcomes, as parents reinforced healthy behaviours at home. These results are in line with the report by Marsigliante et al.[29] Recognising the long-term benefits of early life interventions, prioritising school-based strategies as part of public health initiatives could have outsized impacts on lifelong dietary habits, reducing the risk of chronic diseases.[30]

The delivery format and duration of the interventions also influenced their effectiveness. Face-to-face programs were more effective than online or text-based interventions, as they fostered two-way communication and greater engagement. Offline interventions often incorporate visual tools, peer discussions, and role-playing, enhancing behaviour change.[26] In contrast, online and text-messaging strategies showed limited effectiveness, likely due to their reliance on one-way communication and self-motivation.[31] Furthermore, longer intervention durations (>6 months) were associated with greater reductions in sugar intake, as sustained exposure allowed participants to form lasting habits.[32,33] Future digital interventions should integrate interactive elements, such as real-time feedback and personalised coaching, for a longer time to improve efficacy.

Policy recommendations include integrating HL programs into school curricula, public health campaigns, and workplace wellness initiatives. For instance, school-based programs[34–36] combine nutrition education with other activities. Ahmed et al.,[14] combined school-based programme with physical activity that could be scaled up as part of national health initiatives. Similarly, front-of-pack (FOP) nutrition labels, such as the Nutri-Score (NS) and Warning Labels (WL) studied by Shin et al.[22,24] were effective in nudging healthier purchases and improving dietary behaviours, especially when combined with consumer education campaigns. Governments could also implement mass media awareness campaigns to promote sugar reduction and healthier eating habits.[30,37]

Although the results of this review are promising, several limitations must be addressed. The reliance on self-reported dietary data introduces a potential reporting bias, as participants may have underreported sugar consumption. Short follow-up periods further limit the ability to assess the long-term sustainability of behavioural change. The small sample size (n = 8) of the included studies also restricted the ability to perform fine-grained analyses of intervention patterns. Expanding the publication window to include pre-COVID studies could provide additional insights into intervention effectiveness across diverse settings while addressing pandemic-related disruptions.[39]

Future studies should incorporate objective measures (e.g. biomarkers and digital tracking) to validate self-reported data and evaluate interventions over extended periods.[38] Expanding the publication window to include pre-COVID studies could provide additional insights into intervention effectiveness across diverse settings while addressing pandemic-related disruptions.[39] Studies to explore interventions in urban vs. rural communities, test program scalability across different demographic groups, and integrate mobile health technologies, such as apps for dietary tracking or gamified health education, will be useful to enhance engagement. In addition, combining multi-component interventions incorporating education, behaviour change strategies, and policy measures could provide a more holistic understanding of intervention effectiveness. Standardised evaluation tools should also be developed to ensure comparability across studies and facilitate meta-analyses.

4.1. Conclusion

This systematic review highlights the effectiveness of HL interventions in reducing sugar and SSB consumption, particularly through school-based programs, face-to-face engagement, and FOP nutrition labels. However, the findings also highlight the importance of rigorous study designs, cultural tailoring, and long-term evaluations to ensure reliable and generalisable results. Refining and scaling HL interventions can significantly contribute to disease prevention and health promotion across diverse populations in Asia.

Author statements

Ethical approval

Ethical approval was not required for this study, as it was a systematic review and did not involve primary data collection or interaction with human participants.

Funding

No specific funding was received for this study.

Competing interests

The authors declare that they have no competing interests related to this research.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this manuscript, the author(s) used PAPERPAL to check the grammar and improve clarity, structure, and readability. After using this tool, the author(s) reviewed and edited the content as needed and took (s) full responsibility for the content of the publication.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2025.105750.

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