

Advancing WASH Interventions in Malaysia: A Systematic Review of Strategic Approaches, Behavioural Outcomes and Implementation Challenges

Mohd Roslan Rahmat ¹, Farah Diyana Ariffin ^{1,*}, Hidayatulfathi Othman ¹, Ismarulyusda Ishak ¹
and Aida Soraya Shamsuddin ²

¹ Center for Toxicology and Health Risk, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur 50300, Malaysia; p146230@siswa.ukm.edu.my (M.R.R.); hida@ukm.edu.my (H.O.); ismarul@ukm.edu.my (I.I.)

² Institute for Environment and Development (LESTARI), Universiti Kebangsaan Malaysia, Kuala Lumpur 50300, Malaysia; aidasoraya@ukm.edu.my

* Correspondence: farahdiyana@ukm.edu.my

Abstract

Objectives: Inadequate access to safe water, sanitation, and hygiene (WASH) continues to drive infectious diseases, malnutrition, and educational disparities, particularly among vulnerable populations. This systematic review examined WASH intervention strategies implemented in Malaysia between 2014 and 2025, focusing on shifts in hygiene-related knowledge, attitudes and practices (KAP), health outcomes, infrastructure improvements, and implementation challenges. **Methods:** A comprehensive search across five databases (Science Direct, PubMed, Scopus, Web of Science, and Google Scholar) identified twelve eligible studies targeting schools, healthcare settings, and rural or Indigenous communities. **Results:** Education-based interventions predominated ($n = 10$), often employing participatory and theory-driven approaches grounded in the Health Belief Model or Information–Motivation–Behavioural Skills framework. Evidence revealed significant improvements in KAP, particularly when digital, gamified, or storytelling elements were integrated. Community-led and caregiver-inclusive models demonstrated greater behavioural adoption and retention. Thematic analysis identified several implementation challenges, which include (i) sole reliance on self-reported outcomes with limited use of objective indicators, (ii) short intervention durations (<2 months) that limit long-term impact, and (iii) lack of policy and curriculum integration. **Conclusions:** Findings underscore the need for culturally tailored, longitudinal, and system-embedded interventions that combine behavioural theory with infrastructure investment. Integrating WASH initiatives into Malaysia’s health and education frameworks could advance Sustainable Development Goal 6, ensuring scalable and equitable improvements in hygiene literacy, community resilience, and public health outcomes.

Keywords: WASH intervention; hygiene practices; behavioural shift; health literacy; Malaysia



Academic Editor: Fernando Pérez-Rodríguez

Received: 29 April 2026

Revised: 8 June 2026

Accepted: 29 June 2026

Published: 1 July 2026

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1. Introduction

Access to safe water, sanitation, and hygiene (WASH) is a foundational determinant of public health and human development. Recognising its urgency, the World Health Organization (WHO) and United Nations Children’s Fund (UNICEF) launched the Joint Monitoring Programme (JMP) in 1990 to systematically track global WASH progress [1].

Despite significant global advancements, such as the reduction of open defecation and expanded access to basic services [2], gaps still exist, especially in low- and middle-income countries (LMICs). According to Ramaswamy et al. [3], inadequate WASH is directly linked to infectious disease transmission, malnutrition, child mortality, and persistent poverty. Moreover, access to WASH is closely linked to broader socio-economic outcomes, including improved school attendance, enhanced productivity, and the control of tropical diseases such as soil-transmitted helminthiasis and schistosomiasis [4].

In line with Sustainable Development Goal 6 (SDG 6), to ensure everyone has equal access to safe water and sanitation by 2030 [5], WASH has become a global development priority. Governments, non-profit organisations, and public health agencies have implemented various sanitation interventions over the years. Comparative studies show that incentive-based, financial subsidy, and construction-oriented programmes are generally more effective than education-only or community-led approaches in improving sanitation coverage [6,7]. In South-East Asia, the Water Quality Partnership (WQP), supported by the Australian Government, has introduced more than 5000 Water Safety Plans (WSPs) in urban and rural areas over the past 12 years [8]. Assessments reveal that these WSPs have improved operational efficiency, infrastructure performance, stakeholder collaboration, and water quality monitoring. Their sustainability is reinforced by regulatory frameworks, national drinking water standards, institutional training, and expert networks that strengthen sector capacity and resilience.

In Malaysia, despite the expansion of WASH initiatives via health education campaigns and the fact that over 95% of the population has access to safe drinking water, the current evidence base remains fragmented across diverse populations and settings, including Indigenous communities, low-income rural populations, healthcare facilities, and flood-prone areas. Existing studies vary significantly in intervention design, outcome measures, duration, and methodological rigour, making it challenging to identify the most effective and sustainable approaches for improving hygiene-related behaviours and health outcomes [9–11]. Furthermore, many interventions are primarily focused on short-term educational strategies and self-reported behavioural indicators [12,13], with limited evaluation of long-term behavioural sustainability, infrastructure integration, and policy alignment. To date, no systematic review has comprehensively synthesised the characteristics, effectiveness, behavioural outcomes, and implementation challenges of WASH intervention programmes conducted in Malaysia. Addressing this evidence gap is critical for developing culturally appropriate, scalable, and policy-relevant WASH frameworks that align with Malaysia's public health goals and Sustainable Development Goal 6 (SDG 6).

Therefore, this review aims to (i) identify key WASH intervention strategies implemented in Malaysia, (ii) assess behavioural shifts in hygiene-related knowledge, attitudes, and practices (KAP), and (iii) examine WASH implementation challenges. The findings will provide evidence-based insights to strengthen policy integration, inform future research, and accelerate national progress toward achieving SDG 6.

2. Methods

2.1. Study Design

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [14]. The protocol was registered on PROSPERO [CRD420251121419].

2.2. Eligibility Criteria

Inclusion Criteria:

- a. Studies conducted in Malaysia.
- b. Studies published between January 2014 and August 2025.
- c. Studies that involved participants from community, school, healthcare or vulnerable population settings, including preschool children, primary school children, caregivers, healthcare workers, Indigenous communities or flood-affected populations.
- d. Studies that evaluated WASH-related interventions, including hygiene education, sanitation promotion, behavioural change programmes, community-based interventions, or environmental health initiatives.
- e. Studies that reported at least one outcome related to hygiene knowledge, attitudes, practices (KAP), behavioural change, health outcomes, sanitation practices, water-related outcomes or infrastructure improvements.
- f. Studies that employed quantitative, qualitative, mixed-methods, quasi-experimental, interventional, randomised controlled trials, or community-based study designs.

Exclusion Criteria:

- a. Review articles, study protocols, conference abstracts, commentaries, editorials or unpublished reports.
- b. Surveillance-only or observational studies without intervention components.
- c. Studies conducted outside of Malaysia.
- d. Studies that did not report WASH-related outcomes.
- e. Articles published in languages other than English.
- f. Articles without an accessible full-text version.

2.3. Search Strategy

A comprehensive literature search was conducted in Science Direct, PubMed, Scopus, Google Scholar, and Web of Science between 1 June and 31 August 2025. Google Scholar was included to identify potentially relevant grey or supplementary literature not indexed in the major bibliographic databases.

The following keywords were used to conduct the search in the databases: “Water, Sanitation and Hygiene” OR “WASH” AND “Hand hygiene programs” AND “Sanitation” AND “Health Education AND “behaviour change” AND “WASH intervention” AND “Malaysia”. Detailed search strings for each database are provided in Appendix A.

Boolean operators (AND/OR) were applied to combine terms. Medical Subject Headings (MeSH) were incorporated, and search filters were applied to narrow the search results by publication years, text availability, article type and article language.

2.4. Study Selection and Data Collection Process

All retrieved articles were imported into Microsoft Excel for deduplication and screening. Titles and abstracts were screened by two co-authors, followed by full-text review against inclusion and exclusion criteria. Disagreements were resolved by consensus. The selection process was illustrated in a PRISMA flow diagram (Figure 1).

2.5. Data Items

The following data were analysed: (i) study characteristics, (ii) behavioural transition, (iii) health outcomes, (iv) infrastructure improvement, (v) effectiveness of the study outcomes before and after the intervention programmes, and (vi) implementation challenges and recommendations. Thematic analysis was utilised to generate themes pertaining to the key challenges identified in the reviewed articles. The data were clustered according to the common pattern.

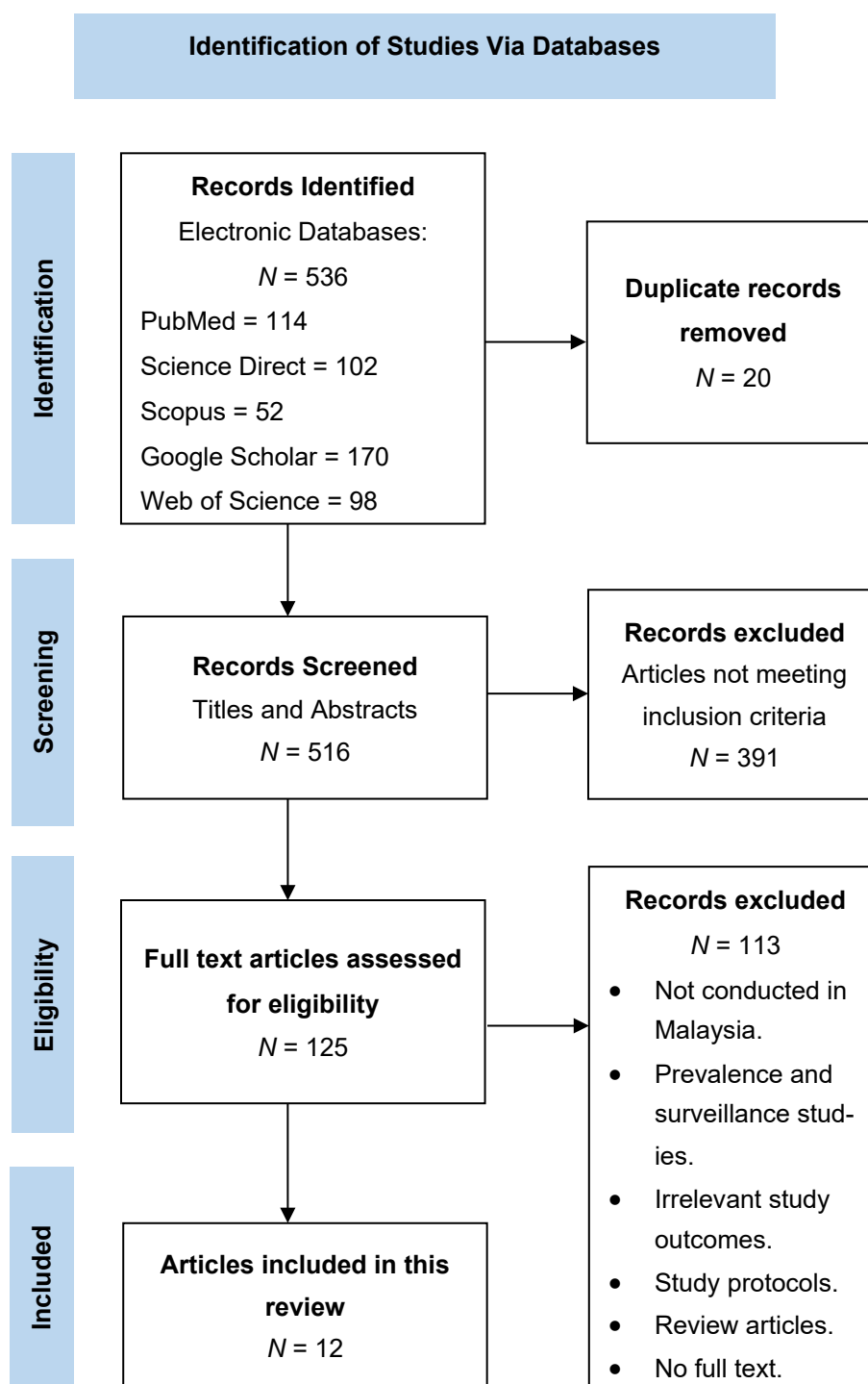


Figure 1. PRISMA flow diagram of the study selection process.

2.6. Risk of Bias in Individual Studies

The Cochrane Collaboration tool [15] and the revised risk-of-bias tool for randomised trials [16] were used to assess the risk of bias in individual study, including (i) sampling bias, (ii), performance bias, (iii) attrition bias (i.e., handling incomplete outcome data), (iv) reporting bias (i.e., selective outcome reporting), (v) measurement bias (i.e., using non-validated criteria to measure data), and (vi) analysis bias (i.e., not reporting the required statistical coefficient related to the study).

3. Results

3.1. Study Selection

A total of 536 studies were retrieved from five electronic databases. Following the removal of 20 duplicates, 516 titles and abstracts were screened for relevance. Of these, 391 articles were excluded for not meeting the inclusion criteria. Subsequently, 125 full-text articles were assessed, of which 113 were excluded due to irrelevance to WASH-related outcomes, being conducted outside Malaysia, being surveillance studies, being study protocols, being review articles, or lacking accessible full texts. In total, 12 studies met all inclusion criteria and were included in this review.

3.2. Study Characteristics

This systematic review incorporated twelve studies ($n = 12$) conducted across diverse settings in Malaysia, each evaluating water, sanitation, and hygiene (WASH) interventions targeting behavioural and health-related outcomes (Table 1). The studies represented various settings, including preschools ($n = 5$) [17–21], Indigenous communities/schools ($n = 2$) [22,23], orphanages ($n = 1$) [24], healthcare setting ($n = 1$) [25], and flood-prone or environmentally vulnerable communities ($n = 3$) [26–28]. Collectively, these studies encompassed both rural ($n = 6$) and urban locations ($n = 6$), such as Klang Valley ($n = 3$), Melaka ($n = 1$), Kelantan ($n = 1$), Penang ($n = 1$), Sarawak ($n = 1$), Perak ($n = 1$), Pahang ($n = 1$) and Selangor ($n = 3$).

Sample sizes varied significantly, from small-scale interventions, such as 112 nurses in Lee et al. [25], to larger trials involving over 600 participants, as seen in Anwar et al. [18]. The population focus encompassed a diverse range, including preschool children, primary school students, parents and carers, healthcare workers, Indigenous Orang Asli communities, and orphaned youth.

In terms of study design, the majority of included studies ($n = 7$) employed various forms of controlled trials, encompassing randomised controlled trials (RCTs), cluster RCTs, single- and double-blinded trials, open-label trials, non-randomised trials, and matched-pair designs. One study adopted a quasi-experimental approach [20], while another utilised a prospective multicentred design [19]. Additional methodologies included a community-controlled trial [26], an interventional study [24], and a case study framework focused on flood-related educational interventions [27]. This methodological diversity reflects efforts to adapt intervention strategies to specific population needs and contextual constraints while maintaining analytical rigour.

Across the studies, the most commonly targeted WASH domains were hygiene practices and sanitation behaviours, such as hand hygiene, oral hygiene, and personal hygiene ($n = 10$) [17–26], whereas two studies focused on flood-related health risks and water conservation/river protection [27,28].

3.3. Characteristics of WASH Interventions Programmes in Malaysia

Most of the reviewed studies used education-based interventions ($n = 10$) [17–26] to improve hygiene knowledge and daily hygiene habits (Table 2). These interventions commonly incorporated multiple delivery methods, such as health education workshops, face-to-face instruction, demonstrations, printed educational materials, digital media and teacher-led interactive activities. Children’s programmes usually employed interactive WASH education approaches, such as storytelling, mobile applications and game-based platforms [20,27].

Table 1. Summary of study characteristics.

Author	Intervention Type	Study Setting	Population	Study Design	Study Location	Sample Size	WASH Domain
Al-Delaiimy et al. [22]	Education programme	2 primary schools in rural Orang Asli communities	Orang Asli school children aged 6 to 12 years	Open-label controlled intervention trial	Lipis district, Pahang	N = 317 (172 in intervention school, 145 in control school)	Hygiene & sanitation practices
Lai et al. [28]	Education, clean-ups, forums, social media	Polluted river	Local communities (children, students, young adults, policymakers, non-governmental organisations)	Mixed-methods	Sungai Pinang River, Penang	- Water & River Educational Programme: 35 children + 20 parents. - Inter-School River Quiz: 88 students. - River Clean-Up: 55 young adults + 5 village committee members. - Public Forum: 130 participants. - Social Media Video: 40,233 views, shared by 1290 users.	Water conservation
Mohamed et al. [17]	Education programme	Preschool	Preschool children aged 5 to 6 years	Cluster randomised trial	Klang Valley	N = 146 (75 multiple interventions, 71 single interventions)	Hygiene practices (hand hygiene)
Lee et al. [25]	Education programme	Hospital	Healthcare workers, primarily nurses	Open-labelled controlled intervention trial	Sarawak General Hospital, Kuching	N = 112 nurses (57 in study arm 1, 55 in study arm 2)	Hygiene practices (hand hygiene)
Anwar et al. [18]	Education programme	Preschool	Preschool children aged 5 to 6 years and their parents/caregivers	Cluster-randomised controlled trial.	Kampar district, Perak	N = 653 (344 intervention, 309 control)	Hygiene practice (oral hygiene)
Tengku Jamaluddin et al. [19]	Education programme	Preschool	Preschool children (5 to 6 years) + parents/caregivers	Prospective multi-centre study	2 preschools in Klang Valley	N = 435 (276 in School P, 159 in School C).	Hygiene practices (hand hygiene)
Wan Mohammad et al. [26]	Education programme	Flood-prone rural communities	Adult villagers > 18 years	Non-randomised community-controlled trial	Tumpat & Bachok, Kelantan	N = 300	Hygiene & Sanitation practices

Table 1. Cont.

Author	Intervention Type	Study Setting	Population	Study Design	Study Location	Sample Size	WASH Domain
Mohamed et al. [20]	Education programme	Preschool	Preschool children (5 to 6 years)	Quasi-experimental study	Klang Valley	N = 377 (184 intervention, 193 control)	Hygiene practices (hand hygiene)
Isa et al. [27]	Game-based mobile application for health education	Urban flood-affected community	Children affected by flood	Case study	Subang, Selangor	-	Water & sanitation
Minhat & Zakaria [23]	Education programme	Orang Asli Communities	Orang Asli caregivers of toddlers (aged 6 months to 3 years)	Single-blinded clustered RCT with pre-test & post-test	Kuala Langat District	N = 166 (91 intervention, 75 control)	Hygiene practices
Shahar et al. [21]	Education programme	Preschool	Parents of 6-year-old preschoolers	Double-blind, parallel-cluster RCT	Alor Gajah, Melaka	N = 268 parents (134 intervention, 134 control) from 16 preschool clusters	Hygiene practices (hand hygiene)
Wani et al. [24]	Education programme	Orphanages	Orphans (7–17 years) residing in orphanages	Interventional study	4 orphanages in Selangor	N = 162	Personal hygiene practices

Parental and community involvement were key components of community-based interventions. They often included group discussions, role models and feedback approaches, workshops, supervised activities and reinforcement of hygiene behaviours at home to promote continuity between intervention settings and daily routines [18,19,21,23,25,28].

A wide variety of instruments was utilised in the studies, including validated KAP questionnaires ($n = 5$) [17,22–24,26], direct observation checklists ($n = 2$) [27,28], social network analyses ($n = 1$) [25], and clinical assessments like dental plaque scoring and stool sample analysis ($n = 2$) [18,22]. Two studies utilised the WHO 11-step handwashing protocol [19,25], and two studies employed structured behavioural frameworks: the Health Belief Model [21] and the Information–Motivation–Behavioural Skills model [23]. Other studies utilised the Dental Health Literacy Assessment Instrument [18], the Bacterfree questionnaire [19] and attendance logs [26] to guide intervention design and evaluation.

Various interventions were enhanced by providing tangible materials, such as soap, antiseptics, toothbrushes, flip charts, posters, educational videos, and infographics. These materials were culturally modified and distributed to reinforce messages in both home and school settings.

The duration of interventions varied from one week [17] to more than two years [21,28]. Many studies employed multi-session or phased implementation, whereas others utilised one-time, intensive sessions. Short-term interventions primarily targeted immediate behavioural changes, while longer-term programmes focused on achieving sustainable community involvement, environmental awareness, and behavioural reinforcement.

3.4. WASH Intervention Outcomes

The evaluation of WASH intervention outcomes indicates a consistent trend toward positive effects, especially in improving hygiene-related KAPs, as well as specific health and behavioural benefits (Table 3).

Al-Delaimy et al. [22] found that a school-based, multimodal educational programme significantly reduced soil-transmitted helminth (STH) infection. Children who participated in the Health Education Learning Package (HELP) intervention had lower ascariasis rates at month two (5.8% of intervention children vs. 13.1% of control children, $p = 0.025$) and month three (14.0% vs. 23.4%, $p = 0.029$). Hookworm infection rates remained significantly low during the six-month HELP programme (39.6% and 75.5%, $p < 0.05$). Moreover, hygiene knowledge, attitudes, and practices in Orang Asli households improved significantly following the intervention. At three months post-intervention, 89.9% of HELP participants were aware of intestinal worm infections, transmission, symptoms, and prevention, compared to 78.7% of the control group (OR 1.6, 95% CI: 1.0–2.7, $p = 0.046$). Educational posters, schools, and students became important sources of information within intervention communities. With regard to behavioural improvement, the HELP group showed more awareness of the harmful health effects of intestinal worms (85.4% vs. 42.1%; OR 2.6, 95% CI: 1.9–3.6, $p < 0.001$). Significant improvements were observed in handwashing practices, including pre-meal (89.9% vs. 50.0%; OR 3.5, $p < 0.001$), post-defecation (82.0% vs. 56.6%; OR 3.5, $p < 0.001$), and soap use (67.4% vs. 23.7%; OR 6.5, $p < 0.001$). Prevention activities, such as wearing shoes outdoors (91.0% vs. 53.9%; OR 8.6, $p < 0.001$) also increased significantly, while open defecation decreased in intervention communities compared to controls (46.1% vs. 61.8%; OR 0.7, $p = 0.043$).

Table 2. Characteristics of WASH intervention programs implemented in Malaysia.

Author	Intervention	Outcome Measure	Duration	Implementation Methods	Study Instruments	Materials/Tools Included
Al-Delaimy et al. [22]	Health Education Learning Package (HELP)	a. Prevalence and intensity of STH infections (Trichuris, Ascaris, hookworm). b. KAP scores among children, parents, and teachers. c. Behavioural changes (handwashing, shoe-wearing, nail hygiene).	6 months	HELP Components: - Teacher workshop on STH infections. - Interactive sessions (storytelling, demonstrations, drawing). - Personal hygiene education & practices. - Posters displayed in schools and homes. - Weekly follow-ups. - Community & family hygiene engagement.	- Stool examination (Kato–Katz technique, Harada Mori culture). - Questionnaires for KAP assessment. - Direct observation of hygiene practices. - Drawing activities to evaluate children’s understanding.	Sanitary aid kits (slippers, soap, nail clippers), comic books, posters, music videos, puppet show props, teacher guidebooks.
Lai et al. [28]	Sungai Pinang River Community Engagement Project (SPRCEP)	a. Awareness/knowledge improvement. b. Behavioural change (e.g., reduced littering, increased participation). c. Policy engagement (forum discussions).	Two-year pilot (2016–2018)	- Outdoor learning activities. - Quiz competitions with study materials. - River clean-ups & waste categorisation. - Public forums. - Social media campaigns.	Surveys (implied), observational data (clean-up waste analysis), social media metrics (views/shares).	- Educational kits for children. - Quiz materials for students. - Waste collection/analysis tools. - Video production for social media.
Mohamed et al. [17]	Bacterfree Hand Intervention	a. Knowledge of handwashing. b. Attitude toward handwashing. c. Handwashing technique (based on WHO 11-step guidelines).	1 week (Follow-up 1-week post-intervention)	Group A (multiple intervention): - Storytelling session. - Hands-on handwashing technique. - Posters displayed at child-eye level. Group B (single intervention): - Posters only (same content as Group A).	- Face-to-face interview on knowledge and attitude of handwashing and its techniques. - Direct observation of handwashing technique.	Posters, storytelling materials, demonstration tools.

Table 2. Cont.

Author	Intervention	Outcome Measure	Duration	Implementation Methods	Study Instruments	Materials/Tools Included
Lee et al. [25]	Leadership-based hand hygiene promotion	a. Hand hygiene compliance. b. Perceived leadership styles. c. Social network connectedness.	48 to 56 days	- Study Arm 1: Peer-identified change agents (PICAs). - Study Arm 2: Management-selected change agents (MSCAs). - Both groups encouraged hand hygiene, gave feedback, and corrected non-compliance.	- Direct hand hygiene observation (WHO method). - Semi-structured Q&A sessions (audio-recorded and transcribed). - Social network analysis (NodeXLPro software, Social Media Foundation, Belmont, CA, USA).	- WHO hand hygiene observation tools. - Nomination forms for change agents.
Anwar et al. [18]	“Senyuman Indah Milik Semua” Programme (SIMSP).	a. Dental plaque score. b. Children’s oral health behaviours (toothbrushing frequency, sugary drink intake). c. Parents’ knowledge, comprehension, skills/motivation.	6 months	Preschool visits by dental therapists and oral health education for children and parents.	- Oral examinations (ICDAS for caries, Oral Cleanliness Index for plaque). - Parental questionnaire (Dental Health Literacy Assessment Instrument). - Teacher logs, toothbrushing diaries.	- Teacher’s OHE booklet (validated by experts). - Oral health infographics (sent via WhatsApp). - Free toothbrushes/fluoride toothpaste (1450 PPMF). - Caries Risk Assessment (CRA) forms.
Tengku Jamaluddin et al. [19]	Comprehensive hand hygiene education	a. Handwashing technique (11-step WHO protocol). b. Hand hygiene routine (5 crucial times).	2 months	- The test group received hand hygiene education. - The control group—no intervention. - Observed the students’ handwashing technique based on the WHO steps.	- Questionnaire adapted from Bacterfree. - Observation Checklist: 11-step handwashing technique scoring.	- Educational video on handwashing. - Soap, tissues, and dustbins provided during observation.
Wan Mo-hammad et al. [26]	Community-based health education on flood-related diseases.	a. Knowledge, attitude, and practices (KAP) scores on flood-related diseases. b. Specific practices (handwashing, drinking safe water, sanitation).	2 months	- Flood-related communicable diseases modules. - Intervention: villagers living in Tumpat affected by the 2014 flood. - Control: villagers in Bachok—no flood. - Small group health education sessions. - Distribution of public health education materials.	- Pre-validated KAP questionnaire. - Focus group discussion.	- Flip charts, PowerPoint slides, flyers, a 10 min educational video. - Public health packages (posters, Friday prayer sermon texts).

Table 2. Cont.

Author	Intervention	Outcome Measure	Duration	Implementation Methods	Study Instruments	Materials/Tools Included
Mohamed et al. [20]	Hand hygiene education programme with digital tools and antiseptic cleanser	a. Absenteeism. b. Behavioural outcomes. c. Hygiene practice.	2 months	4 h education session on handwashing techniques and jingle. - Educational posters. - Access to 7.5% povidone-iodine cleanser, paper towels, bins. - Tablet-based interactive hand hygiene app.	- Attendance logs. - Android tablets with handwashing app.	BETADINE® antiseptic cleanser, hygiene posters, educational videos/songs, tablets.
Isa et al. [27]	Flood informative game	a. Knowledge of floodwater dangers among children. b. Motivation to learn about flood-related health risks.	Not mentioned	- Engage children through gamification. - Varied learning approaches. - Interactive human–machine interface.	- Interviews and observations with flood victims. - Video recordings of victim behaviour.	- Interactive game stages (e.g., emergency packing, disease prevention quizzes). - Health information pages with tips. - World map navigation and character interaction.
Minhat & Zakaria, [23]	Information–Motivation–Behavioural Skills (IMB) model targeting hygiene behaviour improvement	a. Knowledge. b. Attitude (motivation) on hygiene. c. Good hygiene practice.	3 months	- Health talks & video on disease transmission & hygiene. - Group counselling on hygiene and malnutrition. - Practical sessions on handwashing, sanitation and child faeces disposal, and food handling. - Hygiene intervention—(1 h × 3 sessions).	Pre-validated questionnaires to assess knowledge, motivation, and hygiene behaviours.	
Shahar et al. [21]	Health education module based on the Health Belief Model (HBM)	a. Parents’ perceived susceptibility, severity, benefits, and barriers related to hand, foot, and mouth disease (HFMD). b. Preschool children’s handwashing practices.	26 months	The control group received only brochures, while the intervention group received additional health talks and videos.	- Online questionnaires (pre-test, post-test). - Validated Malay and English versions of the health education module.	Brochures, recorded health talks, and videos on handwashing techniques.

Table 2. Cont.

Author	Intervention	Outcome Measure	Duration	Implementation Methods	Study Instruments	Materials/Tools Included
Wani et al. [24]	Health education programme based on the Knowledge, Attitude, and Practice (KAP) model	Knowledge, attitude, and practice (KAP) scores on personal hygiene.	Not mentioned	• Face-to-face interviews and self-administered questionnaires. • Health education sessions covering hygiene practices.	• Questionnaire assessing hygiene knowledge (13 items), attitude (6 items), practices (20 items). • Same questionnaire administered pre- and post-intervention.	Educational sessions, questionnaires.

Anwar et al. [18] observed a notable reduction in dental plaque among preschoolers who received the “Senyuman Indah Milik Semua” (SIMSP) oral health programme. At six-month follow-up, SIMSP-enrolled children had less visible plaque than those in the standard oral health promotion group (56.1% vs. 64.4%; $p = 0.031$; effect size = +0.51), indicating improved oral hygiene following programme implementation. Moreover, 99.6% of SIMSP children consumed carbonated drinks only one to three times a week, compared to 97.3% of controls ($p = 0.033$). The intervention also improved parental oral health literacy. Parents in the SIMSP group showed greater oral health knowledge compared to the control group, with a mean increase of 0.54 ± 2.75 versus 0.02 ± 2.42 ($p = 0.024$; effect size = +0.92).

Interventions that integrated interactive, theory-driven, or multi-session formats demonstrated greater improvements in hygiene behaviours. Mohamed et al. [17] showed that children exposed to multiple Bacterfree Hand interventions, which included storytelling, demonstration, and posters, exhibited significant improvements across all three domains (knowledge, attitude, and technique). In contrast, children who received only a single intervention (poster only) showed improvements in knowledge (median 10.00 vs. 11.00, $p < 0.001$) and technique (median 6.00 vs. 6.00, $p = 0.020$), but no improvement in attitude (median 6.00 vs. 6.00, $p = 0.871$). This emphasises the need for multimodal early educational programmes for young children.

Similarly, Mohamed et al. [20] reported that the hand hygiene intervention that included tablet-based education, digital tools and antiseptic use significantly reduced illness-related absences among preschoolers by 25% compared to the control group (89% absenteeism) between the pre- and post-intervention periods ($p < 0.05$).

Minhat & Zakaria [23] indicate that Information–Motivation–Behavioural Skills (IMB) model-based hygiene intervention delivered through health talks, video presentations, group counselling, and guided practical sessions on handwashing and sanitation effectively enhanced hygiene-related self-efficacy (mean difference = 1.22, 95% CI [0.36, 2.10], $p = 0.006$, effect size = 0.30 moderate) and practices (mean difference = 1.70, 95% CI [0.47, 2.93], $p = 0.007$, effect size = 0.36 moderate) among the vulnerable Orang Asli caregivers in Malaysia.

This review also shows the advantages of involving parents and caregivers in WASH behaviour change strategies. Shahar et al. [21] found that a health education module for parents of preschoolers, utilising recorded health talks, videos on handwashing, and brochures, effectively enhanced short-term parental perceptions of perceived susceptibility ($B = 0.719$, 95% CI: 0.387–1.751, $p < 0.001$), benefits ($B = 0.538$, 95% CI: 0.078–0.998, $p = 0.022$), severity ($B = 0.603$, 95% CI: 0.299–0.906, $p < 0.001$), and barriers ($B = 1.043$, 95% CI: 0.682–1.404, $p < 0.001$) related to the prevention of hand, foot, and mouth disease (HFMD); however, sustained behavioural improvement among preschool children was limited.

The hospital-based leadership and role modelling hand hygiene intervention strategy showed increased hand hygiene compliance in peer-identified and management-selected change agents, from 48% (95% CI 44–53%) to 66% (CI 63–69%) and 50% (CI 44–55%) to 65% (CI 60–69%), respectively, with no significant difference between strategies. Healthcare workers perceived peer agents as exemplifying positive, approachable, and compassionate, while management-selected agents were viewed as authoritarian. These findings suggest that both change agent models effectively improved compliance within hierarchical organisations [25].

One study focused on infrastructure and environmental change. The Sungai Pinang River Community Engagement Project by Lai et al. [28] collected over 2000 waste items and raised local environmental awareness through community clean-ups and policy dialogue. While there was limited evidence of sustained behavioural change, the intervention enhanced stakeholder engagement and increased public discussion via social media.

Table 3. WASH intervention outcomes.

Author	Health Outcomes	Behavioural Outcomes	Hygiene Practice	Infrastructure Improvement	Other Outcomes
Al-Delaimy et al. [22]	Significant reduction in STH infection rates: Trichuriasis: 79.3% (HELP) vs. 83.0% (control); Ascariasis: 5.8% (HELP) vs. 13.1% (control), $p = 0.025$; Hookworm: 39.6% (HELP) vs. 75.5% (control), $p < 0.05$.	Attitude: 85.4% in HELP group recognised STH as harmful vs. 42.1% control, OR 2.6 (95% CI 1.9–3.6), $p < 0.001$.	Practices: - Handwashing before eating 89.9% (HELP) vs. 50.0% (control); OR 3.5, $p < 0.001$. - Open defecation reduced to 46.1% (HELP) vs. 61.8% (control); OR 0.7, $p = 0.043$. - Hand washing with soap: 67.4% (HELP) vs. 23.7% (control); OR 6.5, $p < 0.001$. - Wearing shoes outside: 91.0% (HELP) vs. 53.9% (control); OR 8.6, $p < 0.001$.	-	Knowledge: 89.9% of HELP group heard about intestinal worms vs. 78.7% of control, OR 1.6 (95% CI 1.0–2.7), $p = 0.046$.
Lai et al. [28]	-	-	-	Clean-Up Activity: Collected 2087 rubbish pieces (88.9% recyclable, 68.2% plastic). Identified local waste patterns.	- Improved children's/parents' awareness. - Increased students' knowledge of SPR pollution. - Multi-stakeholder consensus on pollution sources. - Social Media: 40,233 views sparked online discussions about SPR.
Mohamed et al. [17]	-	Group A (multiple interventions): Significant improvement in attitude. Group B (single intervention): No significant change—median 6.00 vs. 6.00; $p = 0.871$.	Group A (multiple interventions): Significant improvement. Group B (single intervention): Significant improvement but less pronounced than group A—median 6.00 (pre) vs. 6.00 (post); $p = 0.020$.	-	Group A (multiple interventions): Significant increase in knowledge. Group B (single intervention): Significant increase in knowledge—median 10.00 (pre) vs. 11.00 (post); $p < 0.001$.
Lee et al. [25]	-	-	Hand Hygiene Compliance: - Study Arm 1 (PICAs): Improved from 48% to 66%. - Study Arm 2 (MSCAs): Improved from 50% to 65%. - No significant difference between arms.		Leadership Perceptions: - PICAs: Led by example, approachable, team-oriented. - MSCAs: Authoritarian, goal-oriented, strict. 70% of HCWs preferred “strict attitude” for hand hygiene leaders.

Table 3. Cont.

Author	Health Outcomes	Behavioural Outcomes	Hygiene Practice	Infrastructure Improvement	Other Outcomes
Anwar et al. [18]	Significant reduction in dental plaque among SIMSP group; 6 months: 2.22 ± 3.05 (SIMSP) vs. 2.84 ± 3.09 (control), $p = 0.027$; Effect size = +0.51 (moderate).	Carbonated drinks ≤ 1 –3 times/week: Significantly higher in SIMSP at follow-up (99.6% vs. 97.3%; $p = 0.033$).	- No significant differences in toothbrushing frequency or fluoride use. - Higher parental control of tooth brushing (98.8% SIMSP vs. 96.1% control; $p = 0.043$).	-	Increased parents' oral health knowledge: Mean increase: 0.54 ± 2.75 (SIMSP) vs. 0.02 ± 2.42 (control); $p = 0.024$; ES = +0.92 (large).
Tengku Jamaluddin et al. [19]	-	Intervention school scored higher in handwashing routine (3.21 ± 1.526) vs. Control school (2.31 ± 1.769); $t = 5.364$, $p = 0.000$.	Intervention group scored higher in handwashing technique (4.56 ± 1.866) vs. Control school (3.57 ± 1.629); $t = 5.816$, $p = 0.000$.	-	- Most performed steps: Wetting hands (93.1%), rubbing palms (91%). - Least performed: Rotational rubbing of thumbs (4.8%), wrists (4.8%), fingertips (3.9%). - Only 52.6% used soap; 35.4% dried hands. - Most frequent hand hygiene: Before/after meals (83%), after toilet (66.2%). - Least frequent had hygiene: After coughing/sneezing (39.8%).
Wan Mohammad et al. [26]	-	10% improvement in preventive attitude scores ($25.0 \rightarrow 27.4$ at 1-month, $p < 0.001$).	- Significant improvements in drinking safe water ($p = 0.001$) and protective habits ($p = 0.006$). - No improvement in handwashing or sanitation practices.	-	Significant improvements across knowledge (9.4% to 52.6%) for disease types, symptoms, and risk factors from baseline to post-intervention ($p < 0.001$).
Mohamed et al. [20]	-	Improved compliance with proper hand hygiene through visual and guided instruction.	Improved practice via real-time tablet-guided handwashing and visible cues (jingles, posters).	-	- Test group: only 25% increase in absences from pre- to post-intervention vs. 89% in control group. - Significantly lower absenteeism in test group ($p < 0.05$).

Table 3. Cont.

Author	Health Outcomes	Behavioural Outcomes	Hygiene Practice	Infrastructure Improvement	Other Outcomes
Isa et al. [27]	-	Children showed increased enthusiasm for learning about flood hazards compared to traditional methods. The game effectively taught flood safety and health precautions.	-	-	-
Minhat & Zakaria [23]	-	The intervention group showed significantly higher adjusted mean scores for self-efficacy (Mean difference = 1.22, 95% CI [0.36, 2.10], $p = 0.006$, Effect size = 0.30 moderate).	The intervention group showed significantly higher adjusted mean scores for hygiene practice (Mean difference = 1.70, 95% CI [0.47, 2.93], $p = 0.007$, Effect size = 0.36 moderate).	-	- Significant improvement of knowledge and attitude within the intervention group at 3-months post-intervention. - Control group showed minimal or non-sustained changes.
Shahar et al. [21]	-	-	Higher children's handwashing practice score at immediate follow-up (T1) vs. baseline ($B = 0.359$, 95% CI: 0.223–0.495, $p < 0.001$).	-	- Higher perceived susceptibility at (T1) vs. baseline ($B = 0.719$, 95% CI: 0.387–1.751, $p < 0.001$). - Higher perceived severity at T1 vs. baseline ($B = 0.603$, 95% CI: 0.299–0.906, $p < 0.001$). - Higher benefits at T1 vs. baseline ($B = 0.538$, 95% CI: 0.078–0.998, $p = 0.022$). - Higher perceived barriers at T1 vs. baseline ($B = 1.043$, 95% CI: 0.682–1.404, $p < 0.001$).
Wani et al. [24]	-	Attitude: Significant improvement from 5.10 ± 1.18 (pre) to 5.65 ± 0.92 (post); $t = -5.97$, $p = 0.000$. Good baseline attitude overall; increased recognition that improper skin care can cause illness (63.6% → 82.1%).	Practice: - Pre-test: 52.8% bathed daily; 55.6% avoided walking barefoot. - Post-test: 82.7% brushed teeth twice daily; 24.7% improvement in key practices. - Significant improvement from 14.91 ± 3.30 (pre) to 16.94 ± 2.98 (post), $t = -8.38$, $p = 0.000$.	-	Knowledge: - Pre-test: 88.9% knew the importance of handwashing. 46.3% unaware of nail-biting harm, 45.1% unaware of ear-cleaning. - Post-test: 37.7% increase in knowledge about ear cleaning. - Significant improvement from 9.51 ± 3.26 (pre) to 12.25 ± 1.56 (post), $t = -11.08$, $p = 0.000$.

3.5. Implementation Challenges

Key implementation challenges were grouped into seven thematic clusters for clearer interpretation: (i) short intervention duration, (ii) limited involvement from teachers and parents, (iii) self-reporting and observer bias, (iv) environmental barriers, (v) small sample size, (vi) lack of objective outcome measures, and (vii) policy and curriculum integration gaps.

The majority of studies ($n = 9$) [17–26] implemented brief interventions ranging from a single session to two months, which is insufficient for fostering sustained behavioural change and limits the ability to observe long-term hygiene improvements or reductions in disease incidence. Several studies emphasised the need for extending intervention periods to 6 to 8 months, aligning implementation with peak illness seasons and incorporating regular follow-up sessions to reinforce key messages and behaviours [17,20,23].

Six studies ($n = 6$) [17,19,20,23,24] reported minimal involvement from teachers, parents, and community leaders, which hindered the reinforcement of hygiene practices beyond the intervention setting. Future programmes should embed hygiene training within school curricula, conduct caregiver workshops, and include community leaders to promote behavioural modelling and continuity.

Many studies ($n = 5$) [18,19,21,24,26] used self-reported data to measure changes in knowledge, attitudes, and practices (KAP), raising concerns about recall bias and subjective overestimation. One study [19] included direct observation of children's handwashing behaviour, which may have introduced observer bias that influenced participant behaviour. Future studies should incorporate objective indicators such as absenteeism rates, HFMD incidence, and structured observation checklists to improve data validity.

Geographical and cultural factors, including poor infrastructure, flood-prone environments, and community beliefs, were found to obstruct effective intervention delivery in four studies ($n = 4$) [22,26–28]. Lai et al. [28] and Wan Mohammad et al. [26] identified challenges related to sanitation stigma and the use of contaminated floodwater (e.g., cooking) due to survival needs outweighing hygiene priorities, while Isa et al. [27] indicated implementation challenges for the flood informative game due to lack of access to digital devices and poverty. These studies advocated for interventions that are tailored to local contexts, such as enhancing community engagement and improving access to clean water and sanitation during environmental crises.

Two studies ($n = 2$) [17,24] were constrained by small sample sizes or geographically limited populations, restricting the external validity of their findings. To address this, researchers advocated for expanding participant pools, applying cluster randomisation, and analysing subgroup outcomes to enhance applicability across diverse settings.

The absence of robust health indicators was identified in three studies [18,21,25], which weakened the ability to link interventions with measurable impacts. Future studies are called for integrating clinical data (e.g., oral health status, infection rates) and school records (e.g., absenteeism) to substantiate behavioural outcomes.

Three studies ($n = 3$) [22,25,27] identified missed opportunities for aligning interventions with national health and education policies. Isa et al. [27] and Al-Delaimy et al. [22] highlighted the lack of integration with government-led programmes. Future recommendations include expanding collaboration between the Ministry of Health and Education to integrate disaster education, embedding WASH content into the existing school curriculum and expanding inter-ministerial collaboration to support institutional uptake and sustainability.

3.6. Quality of Evidence

The evaluation of methodological quality revealed varying risks of bias across six key domains (Table 4). Sampling bias was rated as moderate in most studies, largely

attributed to non-randomised group allocation, purposive sampling, or restricted sampling frames (e.g., single geographical site, convenience-based community selection), especially in interventions targeting Indigenous populations or preschool environments. Performance bias emerged as a significant concern, with most studies exhibiting moderate to high risks due to a lack of blinding, a lack of standardised implementation protocols, or differential intervention intensity across arms, potentially affecting behavioural outcomes. Attrition bias was minimal, as the majority of the studies provided satisfactory follow-up rates and explicitly documented participant retention. Reporting bias was similarly low in the reviewed articles, with most studies transparently disclosing outcomes that aligned with their stated objectives. Measurement bias was identified as a moderate risk, particularly in studies employing non-validated instruments or heavily depending on self-reported outcomes that lacked cultural or developmental adaptation for the target population, such as preschoolers or Indigenous groups, without pilot testing or psychometric verification. The analytical bias domain showed moderate to high risks in multiple studies, where effect sizes, confidence intervals, or multivariable adjustment were either absent or inadequately reported, undermining statistical robustness and generalisability, thereby compromising statistical robustness and generalisability.

Table 4. Assessment of risk of bias in individual studies.

Studies	Sampling Bias	Performance Bias	Attrition Bias	Reporting Bias	Measurement Bias	Analytical Bias
Al-Delaimy et al. [22]	++	++	—	—	++	++
Lai et al. [28]	++	—	+++	++	+++	+++
Mohamed et al. [17]	++	++	—	—	++	++
Lee et al. [25]	—	++	—	—	—	++
Anwar et al. (2020) [18]	—	++	—	—	—	—
Tg Jamaluddin et al. [19]	++	+++	—	—	++	++
Wan Mohammad et al. [26]	++	++	—	—	—	++
Mohamed et al. [20]	—	++	—	—	++	+++
Isa et al. [27]	+++	+++	+++	++	++	+++
Minhat & Zakaria [23]	++	—	—	—	++	—
Shahar et al. [21]	++	++	—	—	—	++
Wani et al. [24]	++	—	—	++	—	—

— = Low risk of bias. ++ = Moderate risk of bias. +++ = High risk of bias.

4. Discussion

This systematic review synthesised evidence from 12 WASH intervention studies conducted across Malaysia, emphasising their effectiveness, sustainability, and contextual relevance. The findings indicate that most targeted hygiene intervention programmes can lead to measurable short-term improvements in knowledge, attitude and practice (KAP), particularly among preschool children, caregivers and healthcare workers. However, the magnitude and long-term effects of these changes varied across studies, highlighting the need for contextual and methodological considerations.

4.1. Key WASH Intervention Strategies

Several strategic intervention approaches emerged as particularly effective in improving hygiene-related outcomes across the reviewed studies. Multimodal interventions that incorporated demonstrations, storytelling, guided practice, visual aids, and digital components consistently outperformed single-component strategies. For instance, programmes incorporating hands-on practice and repeated exposure improved handwashing technique and skill retention more than passive approaches. Similar observations have been reported in previous studies where interactive learning strategies and digital storytelling contributed to improved health communication and increased participant engagement.

across multiple health domains [29,30]. These participatory delivery strategies are found to be effective, especially among children, as active participation and regular practice may improve comprehension and reinforce hygiene practice more effectively than information-based approaches presented alone.

Interventions grounded in established behavioural frameworks, such as the Information–Motivation–Behavioural Skills (IMB) model and the Health Belief Model (HBM), demonstrated stronger effects in enhancing self-efficacy and the willingness to apply newly acquired knowledge and skills on a daily basis, in contrast to solely didactic approaches. Comparable findings were observed in community-based infection prevention programmes in South Korea, where IMB-based interventions significantly improved self-efficacy and knowledge to prevent respiratory infection [31]. These findings underscore the importance of theory-driven design in aligning cultural and social contexts, as well as translating knowledge into sustained behavioural change. An effective intervention model for behaviour change requires the incorporation of systematic frameworks that address motivation, perceived risk, and behavioural skills, as knowledge alone is insufficient to promote intervention adoption and compliance [32].

Interventions that incorporate peer influence, role models, or leadership support have been associated with increased hand hygiene compliance in healthcare settings. The findings imply that organisational culture and observable behavioural reinforcement may influence compliance with hygiene practices among healthcare workers. Research indicates that healthcare workers often conform their behaviours to those of their peers and supervisors; for instance, resident physicians tend to follow the compliance patterns observed among attending physicians [33]. Similarly, hospital leadership also plays a critical role in shaping team practices [34]. The findings support Bandura’s Social Cognitive Theory, which states that observation, social reinforcement, and perceived expectations within a group environment impact behavioural learning [35].

The participation of the community, parents, and caregivers emerged as a significant factor influencing the adoption of interventions. Global evidence indicates that local ownership, participatory design, and community leadership substantially enhance hygiene practices and sustain behaviour change. The study by Afzal et al. [36] suggests that the integration of follow-up and monitoring into community-led sanitation programmes results in more lasting improvements. Models such as Community-Led Total Sanitation (CLTS) and Community Health Clubs (CHC) promote collaborative action while strengthening community trust, both of which are essential for long-term behavioural change [37,38]. These findings suggest that shared responsibilities among households and communities may facilitate the adoption of new behaviours, ensure sustained adherence to hygiene practices, and provide communities with collective coping mechanisms to tackle persistent WASH challenges.

Digital and game-based learning tools have shown favourable outcomes for children, particularly in enhancing engagement and interest in hygiene education. Interactive platforms provide opportunities for repeated exposure to health information in accessible and age-appropriate ways. A systematic review by Ancona et al. [39] supports the belief that serious games can improve health literacy and promote behavioural change across multiple health domains. They are effective and scalable methods for creating immersive, child-centred WASH learning environments because they can integrate hygiene content, real-time feedback, and decision-making into interactive formats. However, the current evidence is limited to small-scale studies with short follow-up periods, necessitating further assessment to determine long-term effectiveness and scalability across diverse contexts.

4.2. Sustainability of WASH Interventions

Educational WASH interventions typically result in noticeable short-term enhancements in hygiene-related behaviours following the interventions. However, the sustainability of these changes is limited, especially in short-term programmes that emphasise knowledge transfer. This pattern is consistent with previous research, which indicates that behavioural improvements decline in the absence of follow-up or reinforcement. A quasi-experimental study by Kitsanapon and Yamarat [40] showed that improvements in hand hygiene diminished within three months following the “Germ-Free Hands” intervention without continued participation. From the perspective of behavioural psychology, habit formation requires contextual inputs, reinforcement, and repetition. Hence, in the absence of embedded cues or social reinforcement, hygiene routines are likely to deteriorate. This is especially relevant in hygiene contexts, where behavioural routines are strongly habitual and shaped by environmental factors. A longitudinal study conducted by Arise et al. [41] demonstrated that sustained hand hygiene compliance was achieved over a five-year period through the implementation of direct observation and periodic feedback. Therefore, programmes that extend beyond one-off educational initiatives, such as phased reinforcement strategies, visual prompts, community engagement, and periodic retraining, may result in sustainable outcomes in WASH interventions.

Although most of the included Malaysian studies focused mainly on educational and behavioural interventions with limited evidence directly addressing infrastructural or environmental changes, broader WASH literature indicates that adequate access to clean water, proper sanitation facilities and supportive environmental conditions is necessary to sustain hygiene behaviours over time [42,43]. Currently, the evidence base in Malaysia is insufficient for assessing the independent impact of infrastructure improvements on the long-term sustainability of WASH practices. This highlights a significant research gap, as sustainable hygiene behaviour is likely influenced by the interaction between behavioural capability and conducive environmental conditions.

4.3. Policy Implications and Recommendations

To advance towards Sustainable Development Goal 6, Malaysian stakeholders need to move beyond isolated educational WASH campaigns. Policymakers may consider incorporating evidence-based WASH modules into national educational curricula and community health programmes. Moreover, fostering collaboration across multiple sectors, connecting health, education, and digital innovation, can improve outreach, contextual relevance, and facilitate technological integration. Implementing supportive infrastructural measures is also important for improving the sustainability of interventions, particularly in underserved or environmentally vulnerable communities. However, these measures must be combined with behaviour change strategies, community participation and accountability to enhance both the effectiveness and sustainability of WASH programmes.

4.4. Limitations of This Review

There are several limitations to this review. First, there was a scarcity of research publications on the implementation of WASH intervention in Malaysia. The search period was continued until August 2025, but no additional studies fulfilling the inclusion criteria were identified beyond 2023. This may reflect a temporary lack of research activity or delays in publication within this field, rather than a deficiency in the search strategy. Future updates to this review may capture emerging evidence as new studies become available. Second, the review was limited by restricted access to full-text articles and the exclusion of grey literature, such as government reports, non-governmental organisation (NGO) assessments, and unpublished theses. This limitation reduced the comprehensiveness

and contextual understanding of the findings. Finally, the heterogeneity in study designs, outcome measures, and evaluation periods limited meta-analysis and direct comparisons among interventions. These factors highlight the need for standardised reporting and the incorporation of a wider range of evidence in future reviews.

5. Conclusions

This systematic review demonstrates that WASH interventions in Malaysia are generally effective in promoting hygiene-related behaviours, particularly when they are culturally appropriate, multimodal, participatory, and theoretically informed. However, short intervention durations and limited long-term institutional support were consistently identified as barriers to sustainability. Evidence regarding the role of infrastructure integration within Malaysian WASH interventions remains limited, highlighting the need for future studies to evaluate how environmental and infrastructure improvements may complement behavioural strategies for sustaining hygiene practices.

Funding: The authors received no financial support for the research.

Institutional Review Board Statement: This study is a systematic review that synthesised findings from previously published studies. As no primary data were collected and no human participants were directly involved, ethical approval and participant consent were not required.

Data Availability Statement: Data supporting the findings of this study are available upon request from the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Full database-specific search strategies:

PubMed

("Water Supply" OR "Sanitation" OR "Hygiene" OR WASH OR "hand hygiene") AND ("Health Education" OR intervention* OR "behaviour change") AND (Malaysia)

Scopus

("water sanitation hygiene" OR WASH OR "hand hygiene") AND ("health education" OR intervention* OR "behaviour change") AND (Malaysia)

Web of Science

("water sanitation hygiene" OR WASH OR "hand hygiene") AND ("health education" OR intervention* OR "behaviour change") AND (Malaysia)

Google Scholar

("water sanitation hygiene" OR WASH OR sanitation OR hygiene OR "hand hygiene") AND (Malaysia) AND (intervention OR "health education" OR "behaviour change")

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