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Evaluating the effectiveness of sanitation and hygiene interventions on waterborne diarrheal diseases: A literature review

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Abstract

Background: Waterborne diarrhea remains a major global public health problem closely associated with water quality, sanitation conditions, and hygiene practices. Various interventions have been implemented to reduce the incidence of diarrheal diseases; however, their effectiveness needs to be comprehensively evaluated to provide evidence for environmental health policy and program development.

Purpose: To evaluating the effectiveness of sanitation and hygiene interventions on waterborne diarrheal diseases.

Method: This study employed a literature review design using a descriptive-analytical approach. Relevant articles were retrieved from Google Scholar, PubMed, ScienceDirect, and nationally accredited SINTA-indexed journals. Articles were selected based on predefined inclusion and exclusion criteria. A total of 10 articles published between 2020 and 2025 were included and analyzed to identify the types of interventions, study findings, and the effectiveness of sanitation and hygiene programs.

Results: The findings indicated that all reviewed studies reported a significant association between sanitation and hygiene interventions and a reduction in diarrheal incidence ($p < 0.05$). Effective interventions included the provision of safe drinking water, the use of improved sanitation facilities, household waste management, handwashing with soap, and integrated Water, Sanitation, and Hygiene (WASH) programs. Integrated WASH interventions demonstrated greater effectiveness than single-component interventions.

Conclusion: Sanitation interventions and hygiene practices are effective in reducing the incidence of waterborne diarrheal diseases, particularly when implemented through an integrated WASH approach.

Suggestion: Strengthening WASH programs and promoting sustainable behavior change interventions are recommended to support long-term diarrhea prevention efforts.

Keywords: Diarrheal Disease Prevention; Hygiene; Sanitation; WASH; Waterborne Diarrhea.

INTRODUCTION

Waterborne diarrheal disease remains one of the major public health challenges, particularly in low and middle-income countries. Diarrhea is defined as the passage of loose or watery stools three or more times per day and is generally caused by bacterial, viral, or parasitic infections transmitted through contaminated water and food (UNICEF, 2025).

Diarrhea continues to be a leading cause of global morbidity and mortality. The World Health Organization (WHO) reported that diarrhea is the third

leading cause of death among children aged 1–59 months worldwide. Each year, approximately 1.7 billion cases of diarrhea occur among children, resulting in an estimated 443,832 deaths among children under five years of age globally (World Health Organization, 2023). Beyond its contribution to mortality, diarrhea is associated with malnutrition, impaired growth and development, weakened immune function, and reduced quality of life (Bauza, Ye, Liao, Majorin, & Clasen, 2023).

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In Indonesia, diarrhea remains one of the major environmentally related diseases and continues to be a public health priority. According to the 2023 Indonesian Health Survey, Indonesia ranks second in Asia after India in terms of under-five mortality attributable to diarrhea. In 2023, approximately 8,600 deaths among children under five were attributed to diarrhea, placing Indonesia twelfth among the fifteen countries with the highest under-five mortality rates worldwide and the highest in Southeast Asia. These findings indicate that diarrhea, which is closely associated with environmental conditions and hygiene-related behaviors, remains a significant challenge to national health development efforts (Ministry of Health of the Republic of Indonesia, 2023).

The occurrence of diarrheal disease is closely associated with water quality, sanitation, and hygiene conditions. Diarrheal infections often result from the consumption of water contaminated with human or animal feces containing pathogenic bacteria, viruses, and parasites (Ejemot-Nwadiaro, Ehiri, Arikpo, Meremikwu, & Critchley, 2015). The populations most vulnerable to the adverse effects of diarrhea include children under five years of age, school-aged children, low-income communities, and individuals living in areas with limited access to adequate sanitation facilities. Among these groups, diarrhea not only causes acute dehydration but also contributes to malnutrition, growth impairment, weakened immunity, and an increased risk of mortality (Darvesh, Das, Vaivada, Gaffey, Rasanathan, Bhutta, 2017; Jubayer, Islam, Nowar, & Islam, 2022).

Waterborne diarrheal disease is influenced by multiple interrelated risk factors, including environmental, sanitation, and behavioral determinants at both individual and household levels. One of the most frequently reported factors is microbiological contamination of drinking water sources resulting from inadequate sanitation management (Luby, Halder, Huda, Unicomb, Islam, Arnold, & Johnston, 2015). In addition, limited access to improved sanitation facilities, open defecation practices, poor domestic waste management, and low compliance with handwashing with soap significantly increase the risk of diarrheal disease (Dereje et al., 2024; Ekhorgbon, 2024; Korir, Ogendi, & Donde, 2025)). These risks are further exacerbated in densely populated areas with inadequate sanitation

systems. Behavioral factors, including handwashing habits, food handling practices, and household drinking water storage, also play a critical role in the transmission pathway of diarrheal diseases (Adria, Wulandari, & Kurniasari, 2023; Prakoso, 2020).

Various preventive measures have been implemented through sanitation and hygiene interventions integrated within the Water, Sanitation, and Hygiene (WASH) framework. Sanitation interventions include the construction and use of improved latrines, management of household liquid and solid waste, and increased access to safe drinking water sources. Hygiene interventions encompass handwashing with soap at critical times, food hygiene practices, and safe drinking water storage (Pickering, Null, Winch, Mangwadu, Arnold, Prendergast, & Humphrey, 2019; World Health Organization, 2023).

Several previous studies have evaluated the effectiveness of various sanitation and hygiene interventions in reducing the incidence of diarrheal diseases. A previous review found that access to safely managed sanitation services and safe drinking water was significantly associated with a reduced risk of diarrheal disease (Wolf, Johnston, Hunter, Gordon, Medlicott, & Prüss-Ustün, 2019). Likewise, a literature review reported that consistent handwashing with soap could effectively reduce the incidence of diarrhea among children (Freeman, Stocks, Cumming, Jeandron, Higgins, Wolf, & Curtis, 2014). Meanwhile, other studies have shown that the effectiveness of Water, Sanitation, and Hygiene (WASH) programs varies across regions due to differences in socioeconomic conditions, population density, program implementation quality, and local environmental characteristics (Ross, Bick, Ayieko, Dreifelbis, Wolf, Freeman, & Cumming, 2023).

RESEARCH RESULTS

This study employed a Systematic Literature Review (SLR) design based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines as the primary framework for the identification, screening, eligibility assessment, and inclusion of articles. This method was selected because it enables researchers to collect, review, and synthesize findings from previously published studies, thereby providing a comprehensive understanding of the effectiveness of

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interventions implemented across various settings and populations. A descriptive-analytical approach was used to describe the characteristics of the selected studies and systematically analyze findings related to the effects of sanitation and hygiene interventions on the incidence of diarrheal diseases.

The literature search was conducted through several electronic databases recognized for their credibility in public health and environmental health research, including Google Scholar, PubMed, ScienceDirect, and nationally accredited SINTA-indexed journals. The search process employed a combination of keywords in both Indonesian and English that were aligned with the objectives of the study. The keywords included "sanitation," "hygiene," "WASH," "diarrhea," "clean water," "waterborne disease," "diarrheal disease," "sanitation intervention," and "hygiene intervention."

The inclusion criteria comprised studies that examined sanitation interventions or hygiene practices related to diarrheal disease incidence, employed observational study designs, systematic reviews, or meta-analyses, were published in either Indonesian or English, and were available in full-text format. The exclusion criteria included duplicate articles, studies not relevant to the research topic,

articles that did not clearly present research findings, studies with incomplete data, and non-scientific publications that had not undergone a peer-review process.

Data analysis was conducted using a descriptive-analytical approach by categorizing studies according to the type of intervention implemented and comparing findings across studies to identify patterns, similarities, and differences in outcomes. The results were synthesized and presented in the form of descriptive narratives and summary tables to provide a clearer understanding of the effectiveness of sanitation interventions and hygiene practices in reducing the incidence of waterborne diarrheal diseases. The literature search based on the inclusion and exclusion criteria resulted in nine articles that met the eligibility requirements for analysis. These articles were published between 2020 and 2025. The selected studies employed various research designs, including randomized controlled trials, cluster randomized trials, quasi-experimental studies, and cross-sectional studies, thereby providing a comprehensive overview of the effectiveness of various sanitation interventions and hygiene practices in reducing the incidence of waterborne diarrheal diseases.

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RESEARCH RESULT

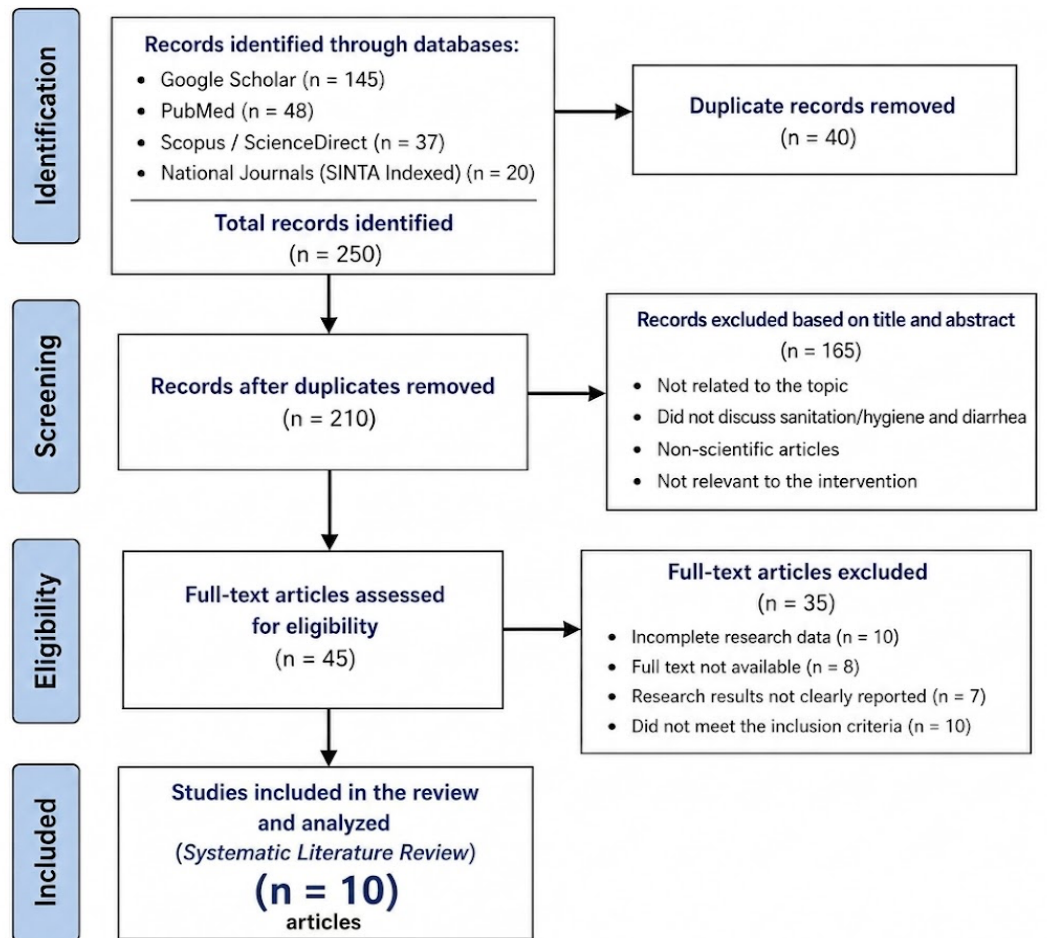


Figure 1. PRISMA Flow Diagram

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Table Summary of Selected Articles

(Author, Year)(Country)	Purpose	Design & Method	Results
(Morse et al., 2020) (Africa)	To determine the health outcomes of an integrated, behavior-based intervention related to water, sanitation, hygiene, and food safety a randomized before-after trial.	Conducted from February to December 2018 in rural Malawi, this before and after trial with a control used diarrhoeal disease as a primary outcome, to measure the impact of a food hygiene intervention (food hygiene + handwashing) relative to a food hygiene and water, sanitation and hygiene (WASH) intervention (food hygiene + handwashing + faeces management + water management). The 31-week intervention was delivered by community-based coordinators through community events (n = 2), cluster group meetings (n = 17) and household visits (n = 14).	Difference-in-differences results show a 13-percentage point reduction in self-reported diarrhoea compared to the control group. There were also significant increases in the presence of proxy measures in each of the treatment groups (e.g., the presence of soap).
Solomon et al., 2020) (Ethiopia)	To evaluate the effectiveness of drinking water disinfection by chlorination on diarrheal disease reduction among children under the age of 5 years in rural eastern Ethiopia.	A cluster randomized controlled trial was carried out in rural Dire Dawa from October 2018 through January 2019. The 405 households were randomized to intervention and control arms and intervention materials were distributed after conducting a baseline survey. This trial evaluated the effectiveness of household drinking water disinfection by chlorination in reducing incidence of diarrhea among children under the age of 5 years. Intervention households received 1.2% sodium hypochlorite with demonstration of its proper use. Participants in the control households continued with their usual habits of water collection and water	In the intervention households, in total, 281 cases of diarrhea were documented (8.7 cases per 100 person-weeks observation); in the control households, in total 446 cases of diarrhea were documented (13.8 cases per 100 person-weeks observation). A 36.0% (adjusted IRR = 0.64, 95% CI: 0.57–0.73) reduction in incidence of diarrhea was observed in the intervention arm when compared with the control arm. The highest and the lowest reductions were obtained in children of age ranges 1 to 2 years and 3 to 4 years, 42.7 and 30.4%, respectively. Adherence to the intervention was 81.3% as measured by free

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		storage. Generalized estimation equations (GEE) with log link Poisson distribution family and exchangeable correlation matrix was used to compute crude incidence rate ratio (IRR), adjusted IRR and the corresponding 95% confidence intervals.	residual chlorine test.
(Tintle et al., 2021) (Dominican Republic)	To determine Diarrhea prevalence in a randomized, controlled prospective trial of point-of-use water filters in homes and schools in the Dominican Republic.	A prospective, randomized, controlled trial whereby 16 villages were selected and randomly assigned to one of four treatment arms based on the installation location of Sawyer® pointone™ filters (filter in both home and school; filter in home only; filter in school only; control group). Water samples and self-reported information on diarrhea were collected at multiple times throughout the study.	Self-reported household prevalence of diarrhea decreased from 25.6 to 9.76% from installation to follow-up (at least 7 days, and up to 200 days post-filter installation). These declines were also observed in diarrhea with economic or educational consequences (diarrhea which led to medical treatment and/or missing school or work) with baseline prevalence of 9.64% declining to 1.57%. Decreases in diarrhea prevalence were observed across age groups. There was no evidence of a loss of efficacy of filters up to 200 days post-filter installation. Installation of filters in schools was not associated with decreases in diarrhea prevalence in school-aged children or family members. Unfiltered water samples both at schools and homes contained potential waterborne bacterial pathogens, dissolved heavy metals and metals associated with particulates. All dissolved metals were detected at levels below World Health Organization action guidelines.
(Bushen et al., 2022) (Ethiopia)	To finding the effects of Community-led Total Sanitation and Hygiene	A community-based Quasi-Experimental study was conducted among a sample of 846 households	The intervention led to decreased diarrhea prevalence [pp = -8.2, 95% CI: -15.9, -0.5],

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	implementation for preventing diarrhea among under-five children.	selected from intervention (kersa) and comparison (mana) districts using the four-stage random cluster-sampling method. A Semi-structured questionnaire was used to collect data. The collected data was cleaned, coded, and entered into EpiData version 3.1 and exported to SPSS version 20 for analysis. Difference-in Difference method with McNemar's tests was used to compare the prevalence of diarrhea between the intervention and comparison districts, and the significance of change between the pre-test and post-test was declared at p-value less than 0.05 with 95% confidence interval.	increased latrine ownership [pp = 5.6, 95% CI: 0.5, 10.8], and increased latrine utilization [pp = 10.7, 95% CI: 4.7, 16.6] in intervention district at post-test compared to the baseline; while the presence of handwashing facility near the latrine, home-based water treatment, and proper water storage and handling practice were decreased at post-test compared to the baseline.
(Sangalang et al., 2022) (Philippines)	To test the effects of a school WaSH intervention on children's malnutrition, dehydration, health literacy (HL), and handwashing (HW).	The trial lasted from June 2017 to March 2018 and included children, in grades 5, 6, 7, and 10, from 15 schools. At baseline 756 children were enrolled. Seventy-eight children in two clusters were purposively assigned to the control group (CG); 13 clusters were randomly assigned to one of three intervention groups: low-intensity health education (LIHE; two schools, n = 116 children), medium-intensity health education (MIHE; seven schools, n = 356 children), and high-intensity health education (HIHE; four schools, n = 206 children). The intervention consisted of health education (HE), WaSH policy workshops, provision of hygiene supplies, and WaSH facilities repairs. Outcomes were: height-for-age and body mass	None of the interventions reduced undernutrition prevalence or improved HAZ, BAZ, or overall HL scores. Low-intensity HE reduced stunting (adjusted odds ratio [aOR] 0.95; 95% CI 0.93 to 0.96), while low- (aOR 0.57; 95% CI 0.34 to 0.96) and high-intensity HE (aOR 0.63; 95% CI 0.42 to 0.93) reduced overnutrition. Medium- (adjusted incidence rate ratio [aIRR] 0.02; 95% CI 0.01 to 0.04) and high-intensity HE (aIRR 0.01; 95% CI 0.00 to 0.16) reduced severe dehydration. Medium- (aOR 3.18; 95% CI 1.34 to 7.55) and high-intensity HE (aOR 3.89; 95% CI 3.74 to 4.05) increased observed HW after using the toilet/urina.

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		index-for-age Z scores (HAZ, BAZ); stunting, undernutrition, overnutrition, dehydration prevalence; HL and HW scores. We used anthropometry to measure children's physical growth, urine test strips to measure dehydration, questionnaires to measure HL, and observation to measure HW practice.	
(Mekonnen et al., 2023) (Gambella, Ethiopia)	To determine the impact of hygiene promotion interventions on acute diarrhea in children.	A cluster-randomized controlled trial was conducted in Teirkidi and Pugnido refugee camps. Intention to treat was applied in analyses of the results of this trial. Logistic, poisson regression and generalized estimating equation (GEE) models were used to evaluate changes in cluster-level hygiene behaviors and period prevalence and incidence of diarrhea with its confidence intervals (95% CI) and $p < 0.05$ significant cutoff point.	The reported diarrhea episodes were 1,307 (15.6 episodes per 100 person-weeks observation) among the intervention households and 1,619 (18.9 episodes per 100 person-weeks observation) in the control households. Under-five children living in households that received hygiene promotion had a 15% [$p < 0.001$; adjusted IRR: 0.85, 95% CI: 0.79 0.92] and a lower incidence of diarrhea compared with children living in control households.
(Contreras et al., 2022) (Bangladesh)	To measure the long-term effects of the intervention on these outcomes between 1 and 3.5 years after intervention implementation, including periods with different intensities of behavioral promotion.	WASH Benefits Bangladesh was a cluster-randomized controlled trial of water, sanitation, hygiene, and nutrition interventions (NCT01590095). The sanitation intervention included provision of or upgrades to improved latrines, sani-scoops for feces removal, children's potties, and in-person behavioral promotion. Promotion was intensive up to 2 years after intervention initiation, decreased in intensity between years 2 to 3, and stopped after 3 years. Access to and reported use of latrines was high in	Over the entire study period, diarrheal prevalence was lower among children in the sanitation arm (11.9%) compared to the control arm (14.5%) (prevalence ratio [PR] = 0.81, 95% CI 0.66, 1.00, $p = 0.05$; prevalence difference [PD] = -0.027, 95% CI -0.053, 0, $p = 0.05$). ARI prevalence did not differ between sanitation (21.3%) and control (22.7%) arms (PR = 0.93, 95% CI 0.82, 1.05, $p = 0.23$; PD = -0.016, 95% CI -0.043, 0.010, $p = 0.23$). There were no significant differences in intervention effects between periods with high-

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		both arms, and latrine quality was significantly improved by the intervention, while use of child feces management tools was low. We enrolled a random subset of households from the sanitation and control arms into a longitudinal substudy, which measured child health with quarterly visits between 1 to 3.5 years after intervention implementation.	intensity versus low-intensity/no promotion.
(Mwishingo et al., 2024) (Democratic Republic of the Congo)	To evaluate the effectiveness of PICHA7 program delivery in increasing handwashing with a cleansing agent at stool/vomit- and food-related events in a healthcare facility setting among diarrhea patients and patient attendants.	A pilot of the PICHA7 program was conducted among 284 participants in 27 healthcare facilities from March 2020 to November 2021 in urban Bukavu in the South Kivu Province of the DRC. The standard arm received the standard message provided in the DRC to diarrhea patients on the use of oral rehydration solution and a basic WASH message at healthcare facility discharge. The PICHA7 arm received the PICHA7 WASH pictorial module delivered by a health promoter focused on handwashing with a cleansing agent at the bedside of the diarrhea patient in the healthcare facility and provision of a soapy water bottle (water and detergent powder).	These findings demonstrate that delivery of the PICHA7 WASH pictorial module and provision of a soapy water bottle to diarrhea patients and their attendants presents a promising approach to increase handwashing with a cleansing agent among this high-risk population in healthcare facilities in the eastern DRC.
(Nasrullah et al., 2024) (Indonesia)	To examine the relationship between basic household sanitation and diarrheal diseases.	Descriptive-analytical and employs a cross-sectional design. The population consists of 27,907 households, with a proportional sampling technique applied to select 100 respondents.	The results indicate significant effects of clean water source sanitation (P-value= 0.001), SPAL sanitation (wastewater drainage systems)(P-value= 0.003), waste disposal sanitation (P-value= 0.010), and toilet sanitation (P-value= 0.001) on

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(Irlayanti et al., 2024) (Indonesia)	To manage risk factors for diarrhea in toddlers.	This was an observational quantitative study using a case-control study approach. The population consisted of all toddlers with diarrhea who visited the North Jayapura Community Health Center in July-August 2022, with a sample size of 60 toddlers (case and control groups were 1:1). The study used a questionnaire and a total plate count (ALT) method for measuring the number of germs on eating/drinking utensils. Data were analyzed using bivariate analysis with the chi-square test and multivariate analysis using binary logistic regression.	diarrheal diseases in Samalanga Subdistrict, Bireuen Regency, in 2024. Toddlers without diarrhea had the most poor waste management (80%) than toddlers with diarrhea (50%), while for other variables, the requirements were met in both the case and control groups. Statistical tests showed a relationship between food/drink sanitation hygiene (p-value = 0.015, OR = 5.211) and waste management (p-value = 0.015, OR = 0.250) with the incidence of diarrhea and no relationship between the presence of germs on eating/drinking utensils (p-value = 0.598, OR = 1.321), hand washing behavior (p-value = 0.592, OR = 0.750), floor type (p-value = 0.612, OR = 0.310), clean water facilities (p-value = 0.145, OR = 0.235), and feces disposal facilities (p-value = 1.000, OR = 1.000) with the incidence of diarrhea. Multivariate analysis showed that the dominant factor was food/drink sanitation hygiene (p-value = 0.024, OR = 5.460).
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DISCUSSION

Based on the findings from the 10 articles analyzed, all studies demonstrated a significant association between sanitation interventions and hygiene practices and the reduction of waterborne diarrheal diseases. According to the type of intervention, the first pattern identified was the effectiveness of drinking water quality interventions. Another studies conducted showed that drinking water treatment through chlorination and the use of household water filters significantly reduced the incidence of diarrhea. These findings indicate that microbiological contamination of drinking water remains one of the primary transmission pathways of diarrheal diseases. Therefore, interventions focused on providing safe drinking water play a substantial role in interrupting the transmission of diarrhea-causing pathogens (Solomon, Robele, Kloos, & Mengistie, 2020; Tintle, Van De Griend, Ulrich, Wade, Baar, Boven& Best, 2021).

The second pattern indicated that environmental sanitation interventions had a positive impact on reducing diarrhea incidence. Another Studies demonstrated that access to improved sanitation facilities, proper household waste management, and the reduction of open defecation practices were associated with lower rates of diarrheal disease. This pattern suggests that adequate sanitation can reduce environmental contamination by human feces, thereby decreasing the risk of water source contamination and other routes of disease transmission (Bushen, Merga, & Tessema, 2022; Contreras, Islam, Mertens, Pickering, Arnold, Benjamin-Chung, & Ercumen, 2022; Nasrulah, Junaidi, Syahrizal, & Kartini, 2024; Irjayanti, Irmanto, & Wibowo, 2024).

The third pattern identified was the importance of hygiene practices as a protective factor against diarrhea. Previous studies conducted by showed that improved handwashing with soap, food hygiene practices, and personal hygiene significantly contributed to reducing the incidence of diarrheal diseases (Mekonnen, Alemu, Gebrie, Kloos, & Legesse, 2023; Mwishingo, Endres, Bisimwa, Sanvura, Banywesize, Bisimwa, & George, 2024; Sangalang, Lemence, Ottong, Valencia, Olaguera, Canja, & Kistemann, 2022).

The fourth pattern revealed that integrated interventions based on the Water, Sanitation, and

Hygiene (WASH) approach produced more comprehensive outcomes than single interventions alone. Previous studies demonstrated that combining improvements in water quality, sanitation, and hygiene resulted in greater reductions in diarrhea incidence compared with programs focusing on only one type of intervention (Morse et al., 2020; Mwishingo et al., 2024). This finding suggests that diarrhea is a multifactorial health problem influenced by multiple risk factors simultaneously and therefore requires an integrated prevention approach

Based on the synthesis of the reviewed articles, sanitation interventions and hygiene practices were found to be effective in reducing the incidence of waterborne diarrheal diseases. The most effective interventions were integrated programs that combined access to safe drinking water, improved sanitation facilities, and hygiene behavior change through the WASH approach. These findings indicate that diarrhea prevention and control efforts cannot be implemented in isolation but require a comprehensive strategy involving both environmental infrastructure improvements and the promotion of healthy hygiene behaviors within communities.

he synthesis of the 11 reviewed articles demonstrated that sanitation interventions and hygiene practices consistently contribute to reducing the incidence of waterborne diarrheal diseases. Analysis of the research findings revealed that interventions aimed at improving drinking water quality had a significant impact on reducing diarrheal incidenc. Another studies conducted found that water chlorination and the use of household water filters significantly reduced diarrheal cases (Solomon et al., 2020; Tintle et al., 2021). These findings can be explained by the multiple barrier approach theory, which posits that drinking water treatment serves as a primary barrier against the entry of bacteria, viruses, and parasites into the human body (Marron, Mitch, von Gunten, & Sedlak, 2019). The World Health Organization (WHO) has identified fecally contaminated water as the main medium for the transmission of enteric pathogens such as *Escherichia coli*, *Salmonella* spp., *Shigella* spp., rotavirus, and various intestinal parasites. Therefore, improving drinking water quality directly contributes to breaking the transmission chain of diarrheal diseases (World Health Organization, 2023).

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In addition to drinking water quality, the synthesis findings indicated that environmental sanitation improvements are a critical factor in diarrhea prevention. Previous studies showed that access to improved sanitation facilities, proper household waste management, and reduced open defecation practices were associated with lower diarrhea incidence (Bushen et al., 2022; Contreras et al., 2022; Nasrullah et al., 2024; Irijayanti et al., 2024). These findings support the F-Diagram theory developed by Wagner and Lanoix, which explains that sanitation acts as a primary barrier to pathogen transmission through fluids, fields, flies, fingers, and food. When sanitation conditions are inadequate, environmental contamination increases, thereby elevating the risk of exposure to diarrhea-causing microorganisms. Conversely, the provision of adequate sanitation facilities can reduce environmental pollution and decrease the likelihood of disease transmission (de Wit, Luseka, Bradley, Brown, Bhagwan, Evans, & Chandler, 2024; Liu, Liu, & Liu, 2024).

The findings also demonstrated that hygiene practices are a crucial determinant of successful diarrhea prevention efforts. Previous studies reported that handwashing with soap, food hygiene, and personal hygiene were associated with lower rates of diarrheal disease. These findings suggest that the availability of sanitation facilities alone is insufficient to achieve optimal health outcomes without corresponding behavioral changes among community members (Mekonnen et al., 2023; Sangalang et al., 2022; Mwishingo et al., 2024). From the perspectives of the Health Belief Model and the Theory of Planned Behavior, health-related behaviors are influenced by knowledge, risk perception, attitudes, and prevailing social norms. Therefore, interventions focusing solely on infrastructure development often produce less substantial outcomes than those that incorporate behavior change strategies (Aristi & Sulistyowati, 2020; Rahim, Juliana, Liambana, Lisna, Naningsi, Saing, & Ahmad, 2025).

One of the most important findings of this literature review is that integrated interventions based on the Water, Sanitation, and Hygiene (WASH) approach are more effective than single-component interventions. Another studies demonstrated that combining improvements in water quality, sanitation, and hygiene generated greater reductions in diarrheal

incidence than programs focusing on only one intervention component. These findings indicate that diarrhea is a multifactorial health problem that cannot be adequately addressed through a single approach (Morse et al., 2020; Mwishingo et al., 2024). The WASH framework works simultaneously to reduce contamination sources, limit exposure pathways, and promote preventive behaviors at both individual and household levels (Wolf, J., Johnston, Hunter, Gordon, Medicott, & Prüss-Ustün, 2019).

Overall, the findings of this literature review strengthen the evidence that sanitation interventions and hygiene practices are effective strategies for reducing the incidence of waterborne diarrheal diseases. The WASH approach, which integrates safe drinking water provision, improved sanitation, and hygiene behavior change, has been shown to produce the most comprehensive and sustainable outcomes. These findings have important implications for environmental health policy development, particularly in supporting the achievement of the Sustainable Development Goals related to access to clean water, adequate sanitation, and the reduction of the global burden of diarrheal diseases.

CONCLUSION

Based on the findings of the literature review of 10 research articles, it can be concluded that sanitation interventions and hygiene practices are effective in reducing the incidence of waterborne diarrheal diseases. Interventions such as the provision of safe drinking water, the use of improved sanitation facilities, proper household waste management, and handwashing with soap have been shown to contribute significantly to reducing the risk of diarrheal disease. Furthermore, the Water, Sanitation, and Hygiene (WASH) approach, which integrates clean water, sanitation, and hygiene components, demonstrated greater effectiveness than single-component interventions. These findings highlight that diarrhea prevention requires a comprehensive approach through improvements in sanitation infrastructure, increased access to safe water, and the sustained promotion of hygiene behaviors within communities.

SUGGESTION

Based on the findings of this study, governments and relevant stakeholders should strengthen the implementation of Water, Sanitation, and Hygiene

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(WASH) programs by improving access to safe drinking water, adequate sanitation facilities, and community education on healthy and hygienic behaviors. Health professionals are encouraged to enhance health promotion activities related to hygiene practices, particularly handwashing with soap and food hygiene, as key strategies for diarrhea prevention. Furthermore, future research is recommended to employ systematic review and meta-analysis methods with a broader range of articles to generate stronger evidence regarding the effectiveness of various sanitation and hygiene interventions in reducing the incidence of waterborne diarrheal diseases.

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