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Environmental Health and Behavioral Factors Associated with the Incidence of Diarrhea in Children: A Scoping Review

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Abstract
Introduction: *Diarrhea remains a major public health problem among children under five years of age and is closely associated with poor environmental sanitation, inadequate hygiene behavior, and limited access to clean water.* ***Objective:*** *This study aimed to identify and synthesize evidence regarding environmental and behavioral factors contributing to diarrhea incidence in infants and toddlers.* ***Method:*** *A scoping review approach was applied by searching articles in PubMed, ScienceDirect, and Scopus using keywords related to diarrhea, sanitation, hygiene, water quality, drinking water, and environmental health. Articles published from 2019 to 2025 were screened, resulting in 14 eligible studies from 6,484 identified articles.* ***Result and Discussion:*** *Environmental conditions and hygiene behavior contribute to fecal contamination pathways that increase diarrhea risk. Improving sanitation, promoting proper hygiene practices, and ensuring access to safe water are essential and interconnected prevention measures.* ***Conclusions:*** *Diarrhea incidence in children under five is influenced by environmental, behavioral, and clean water management factors.*

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Introduction

One of the diseases that remains a public health problem in the global community is diarrhea. Diarrhea is prevalent in low- and middle-income countries. According to the WHO, there are nearly 1.7 million cases of diarrhea in children each year. Diarrhea is one of the leading causes of death among children under five years of age. This disease is the third leading cause of death among children aged 1 to 59 months, accounting for more than 443,832 deaths among children under 5 years of age and 50,851 deaths among children aged 5–9 years(World Health Organization, 2024). The prevalence of diarrhea varies from year to year; in Ghana, there was a 13% decrease in the incidence of diarrhea, from 26% in 1988 to 13% in 2022(Kombat & Kushitor, 2025). By 2025, an estimated five million infant deaths are projected, with 97% occurring in developing countries due to infections caused by diarrhea.

Diarrhea is defined as the passage of loose or watery stools occurring more than three times a day. This disease is transmitted via the fecal-oral route, caused by bacterial or viral infections(Friedel et al., 2022). Diarrhea can be transmitted through the consumption of water or food contaminated with bacteria or viruses, exacerbated by poor environmental conditions and personal hygiene. Poor personal hygiene allows bacteria to easily spread to humans. Additionally, unsanitary environmental conditions can lead to the presence of bacteria in water sources or other transmission vectors(Simmone, 2023). Therefore, environmental factors and human behavior are key components in the chain of disease transmission.

According to the WHO–UNICEF Joint Monitoring Programme in 2023, more than 26% of the global population still lacks access to clean water or safe drinking water. Additionally, 40% of the global population lacks access to adequate sanitation facilities for environmental hygiene(United Nations Children's Fund (UNICEF) & (WHO), 2023). Environmental and sanitation factors play a significant role in the transmission of diarrhea. Unsanitary and inadequate sanitation conditions have an impact on the incidence of diarrhea, particularly in children. A 2023 Merid study noted that in 27 developing countries, households with limited sanitation facilities face a 24.5% higher risk of diarrhea compared to those with adequate sanitation facilities(Merid et al., 2023). A 2024 study by Kefale also stated that improper waste management, overcrowded settlements, and open drainage systems significantly influence the incidence of diarrhea in children(Kefale Mengistu et al., 2024).

The availability and management of clean water are key factors in diarrhea; water contaminated with microorganisms serves as a transmission medium for the disease. Even if the water source is from a safe location, contamination can still occur, particularly due to improper storage. Unhygienic water management and improper water storage can lead to bacterial contamination, which can cause diarrheal infections, particularly in rural areas and densely populated settlements(Boutrin et al., 2025). This aligns with the study by Wolde et al. (2025) in Ethiopia, which noted that the use of tap water and unprotected water sources for consumption increases the risk of diarrhea by 2.20 times(Wolde et al., 2025). Water sources located near sewage disposal sites can be contaminated by household waste due to improper management. Consuming this contaminated water can lead to diarrhea infections.

Individual behavioral factors, particularly personal hygiene practices, play a crucial role in preventing the transmission of diarrhea. Several studies in Asia and Africa indicate that the habit of washing hands with soap before eating, after defecation, and before preparing food can significantly reduce the incidence of diarrhea(Boutrin et al.,

2025)(Mernie et al., 2022)(Rahman et al., 2025). Low public awareness regarding environmental and personal hygiene results in an unhealthy environment and an increased risk of disease transmission at the household level.

In Indonesia itself, diarrhea ranks among the top ten diseases with the highest morbidity rates(Kementerian Kesehatan RI, 2024). The CLTS (Community-Led Total Sanitation) or STBM (Community-Based Total Sanitation) programs in Indonesia remain limited, primarily due to low community compliance with environmental hygiene practices(Dwi et al., 2022). Community hygiene behaviors also play a significant role in the transmission of diarrhea. The practice of washing hands with soap after defecation or urination and before eating can reduce the risk of diarrhea. This aligns with research by Alam and Sheoti, which explains that environmental factors, water quality, inadequate sanitation, and poor individual hygiene specifically low handwashing practices and unhygienic water storage can increase the risk of diarrhea infection(Z. Alam & Sheoti, 2024).

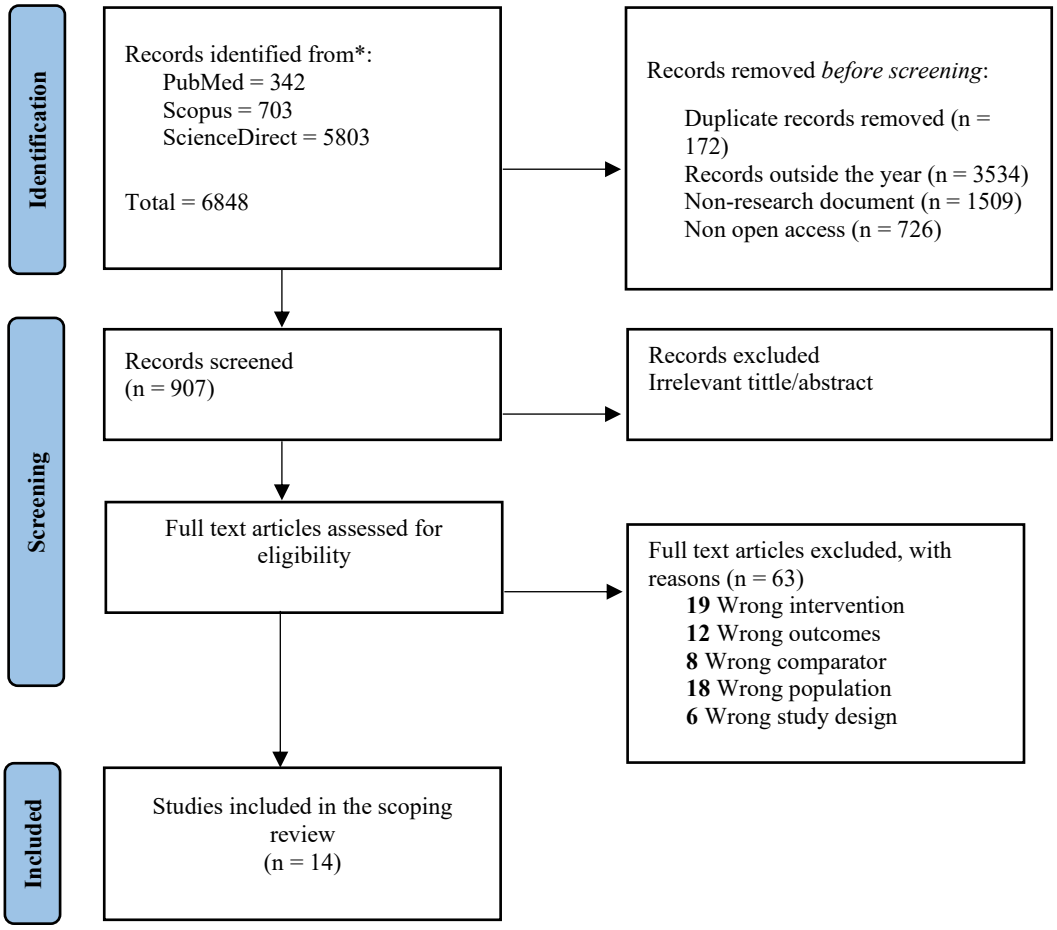
Therefore, the purpose of this scoping review is to identify, categorize, and synthesize scientific evidence regarding environmental health and behavioral factors contributing to the incidence of diarrhea in infants and toddlers based on published literature from 2019 to 2025.

Method

This study employs a *scoping review* approach to map environmental and behavioral health factors associated with the incidence of diarrhea in toddlers. The study was designed in accordance with the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) guidelines. It follows the five-step process developed by Arksey and O'Malley (2005). The research stages began with identifying the research question, followed by identifying relevant studies, selecting studies, mapping study data, and finally, collecting and reporting the results. In this study, the primary focus is on the impact of environmental health and sanitation hygiene factors on the incidence of diarrhea. The data used are secondary data obtained from several databases, namely PubMed, ScienceDirect, and Scopus. The literature search utilized the following keywords: " " "Diarrhea," "sanitation," "hygiene," "behavior," "water quality," "drinking water," and "environmental health." To broaden the search results, the researcher employed the Boolean operators "OR/AND" in the database. The keywords and Boolean operators used were ("diarrhea" OR "diarrhoea") AND ("environmental health" OR "sanitation") AND ("water quality" OR "drinking water") AND ("hygiene" OR "behavior"). The process of determining inclusion and exclusion criteria was conducted by referring to the PICO framework in this study. The inclusion criteria used in this screening process were: (1) Human population and all age groups, (2) WASH factors in households associated with diarrhea incidence, (3) Diarrhea incidence in infants and toddlers, (4) Original research published between 2019 and 2025. The exclusion criteria for this screening were: (1) literature review articles or case reports, (2) non-human populations, (3) articles without full text or full access, (4) laboratory studies without field data, and (5) studies with non-health-related outcomes.

The data collection yielded a total of 6,848 articles (5,803 from ScienceDirect, 703 from Scopus, and 342 from PubMed). The inclusion and exclusion criteria were established to facilitate the initial screening process. The initial screening process identified 172 duplicate articles, 3,534 articles with publication years that did not meet the criteria, and 726 articles without open access. The initial screening yielded 907 articles

that were briefly screened based on the journal title and abstract; 830 articles were deemed irrelevant to the criteria, leaving 77 articles to be fully screened based on the text content. A total of 77 articles were fully screened based on the text content and evaluated against the inclusion and exclusion criteria. Fourteen articles were selected for use in this scoping review. The results of the literature search ( ) were documented using the PRISMA-ScR template, which focuses on reporting trial reviews and serves as a foundation for writing other systematic reviews



Result and Discussion

1. Result

Based on the results obtained from 1 article identified during the PRISMA-ScR selection process. The researchers assessed the quality of the identified article through a critical and systematic evaluation process to determine the study's significance and relevance. The selected studies addressed environmental and behavioral factors related to the incidence of diarrhea. From the selection results, it was found that 7 studies used a cross-sectional study design, while the remainder utilized survey and observational data. The included articles originated from developing countries such as Bangladesh, India, Indonesia, Zambia, and countries in Africa. The study populations and samples ranged from 200 to 10,000 respondents, with ages ranging from 0 to 59 months or under 5 years. A total of 65% of the studies focused on environmental and sanitation factors, 55% focused on personal hygiene and behavior, and 70% focused on water availability and clean water management

Table 1
Characteristics of Included Studies

No	Author, Year, & Title	Objective	Country/Region of Study	Study Design	Sample	Result
1	(Asada et al., 2022)/ Detection of Escherichia coli, rotavirus, and Cryptosporidium spp. from drinking water, kitchenware, and flies in a periurban community of Lusaka, Zambia	relationship between water contamination, kitchen utensils, and flies and the incidence of diarrhea.	Zambia (Lusaka)	Quantitative study using a cross-sectional approach and microbiological testing of water and eating utensils	310 households with children under 5 years of age	Water and kitchen utensils contained *Escherichia coli*, *Rotavirus*, and *Cryptosporidium spp.*, increasing the risk of diarrhea. $P < 0.001$ (OR = 2.14; 95% CI 1.38–3.31).
2	(Robert et al., 2021)/ Environmental determinants of Escherichia coli, link with diarrheal diseases, and identification of vulnerability criteria in tropical West Africa (Kapore, Burkina Faso).	Identifying the relationship between environmental factors and water quality and the incidence of diarrhea	Burkina Faso (Kapore)	Field observational study	120 farming communities, households	Water and soil containing *Escherichia coli* and fecal matter were significantly associated with the incidence of diarrhea ($p < 0.05$; AOR = 1.82)
3	(Mapingure et al., 2024)/ Water, sanitation, and hygiene–specific risk	Evaluating the relationship between WASH factors and the incidence of diarrhea in	Zimbabwe	Secondary Analysis	6,780 children under 5 years of age from the 2019 MICS survey	Access to adequate sanitation and clean water significantly reduced the prevalence of diarrhea by 30%. (AOR =

No	Author, Year, & Title	Objective	Country/Region of Study	Study Design	Sample	Result
	factors of recent diarrheal episodes in children aged under 5 years: analysis of secondary data from the multiple indicator cluster survey (MICS 2019)	children under five years of age.				0.70; 95% CI 0.56–0.87; $p < 0.005$).
4	(Musa Mohammed, 2024)/Prevalence and risk factors associated with under-five years children diarrhea in Malawi: Application of survey logistic regression.	Assessing socioeconomic and environmental risk factors for diarrhea in children.	Malawi	Logistic regression survey	2,345 children under 5 years of age	The results showed a higher prevalence of diarrhea in rural areas (25.1%); furthermore, the prevalence of diarrhea was also high in low-income households (28.9%). The logistic regression results indicated an association between diarrhea- s in infants and toddlers and fever in the past two weeks, residential area, and child age.
5	(LaPolt et al., 2025)/Environmental risk factors associated with community diarrheal disease in Ethiopia	Investigated the relationship between environmental risks and the incidence of diarrhea in Ethiopian communities.	Ethiopia	Cross-sectional study	2,436 households	81% do not treat water before using it to prepare food. 75% of households in Addis Ababa and 92.86% in Gondar do not wash their hands before preparing fruits or vegetables. Piped drinking water on the premises was protective against diarrhea from raw water [OR: 0.575, (95% CI: 0.376, 0.881)] and in the adjusted analysis [OR: 0.514, (95% CI: 0.331, 0.800)], and drinking water from unprotected wells [OR: 4.812, (95% CI: 2.026, 11.427)] was associated with

No	Author, Year, & Title	Objective	Country/Region of Study	Study Design	Sample	Result
						diarrhea in the crude analysis.
6	(Majumdar et al., 2024)/ Outbreak of waterborne acute diarrheal disease in a South District village of Tripura: A public health emergency in the Northeast region of India	Analyzing and reviewing diarrhea outbreaks caused by flooding and water system damage.	India, Tripura	Community-based retrospective descriptive study	14,371 residents affected by diarrhea in South Tripura District from December 31, 2022 – January 3, 2023. 130 cases interviewed as a sample	4 water samples from the public water distribution system showed the presence of coliform organisms (MPN = 0.5) and *Escherichia coli* was detected, which indicates fecal contamination of drinking water.
7	(Kwong et al., 2020)/ Ingestion of Fecal Bacteria along Multiple Pathways by Young Children in Rural Bangladesh Participating in a Cluster-Randomized Trial of Water, Sanitation, and Hygiene Interventions (WASH Benefits).	Analyzing fecal exposure pathways in children in rural areas	Bangladesh	Cluster randomized trial	234 children aged 3–45 months with direct and video observation, 149 children aged 3–18 months, and 30 children.	The study results indicate that the Water, Sanitation, and Hygiene (WSH) intervention in the WASH Benefits study in Bangladesh was unsuccessful in reducing the amount of *Escherichia coli* ingested by children.
8	(Juniour Nsubuga et al., 2024) /Factors associated with acute watery diarrhea among children aged 0–59 months in Obongi District, Uganda, April 2022: A case–control study	Assessing risk factors for acute watery diarrhea (AWD) in children aged 0–59 months in Obongi	Uganda	Unmatched case-control	193 cases and 386 controls	The presence of comorbidities (malnutrition, diabetes, HIV) was significantly associated with the incidence of AWD (AOR = 12; CI: 2.5–53), as was the caregiver's habit of not washing hands after using the toilet (AOR = 3.9; CI: 1.2–13) and the use of well water compared to piped water (AOR = 4.0; CI: 1.7–9.6)
9	(Prawati, 2019)Faktor Yang	This study aims to investigate the factors	Surabaya, Indonesia	Analytical observational study with	211 households	There is a significant association between environmental

No	Author, Year, & Title	Objective	Country/Region of Study	Study Design	Sample	Result
	Mempengaruhi Kejadian Diare Di Tambak Sari, Kota Surabaya	influencing the incidence of diarrhea		random sampling		cleaning, preparing and consuming oral rehydration solution, and handwashing with soap before meals on the incidence of diarrhea over the past 3 months
10	(Yunitawati et al., 2025)/ Diarrhea among children under-five: Comparing risk factors in urban and rural areas in Indonesia.	Identifying and comparing risk factors associated with the incidence of diarrhea in children under five living in rural and urban areas in Indonesia.	Indonesia	Cross-Sectional	64,148 children aged 0–59 months	Diarrhea was reported in 10.9% of children, with a higher prevalence in rural areas (11.53%) compared to urban areas (10.07%). Child age, low maternal education, maternal mental health issues, and younger maternal age were significantly associated with an increased risk of diarrhea in both areas ($p < 0.05$). Additionally, improper disposal of children's feces was a major risk factor in rural areas.
11	(Kamal et al., 2022)/ Individual- and Community-Level Factors Associated with Diarrhea in Children Younger Than Age 5 Years in Bangladesh: Evidence from the 2014 Bangladesh Demographic and Health Survey	Assessing the relationship between risk factors for diarrhea in children under 5 years of age	Determining the prevalence and risk factors for diarrhea in children	Logistic regression, using data from the *Bangladesh Demographic and Health Survey*	17,300 households	Children aged 6–11 months were 2.26 times more likely to experience diarrhea (OR = 2.26; 95% CI: 1.50–3.42), and children aged 12–23 months were 2.31 times more likely (OR = 2.31; 95% CI: 1.62–3.31) compared to older children. Other significant risk factors include households lacking access to safe drinking water (OR = 1.39; 95% CI: 1.03–1.88)
12	(Syahrul et al., 2020)/ Transmission media of foodborne diseases as an index	developed a predictive model for microbes (*DEC*) in feces, caused by foodborne disease	Surabaya, Indonesia	an observational analytical study with a *nested case-control* design	218 children in stage 1; in stage 2, 15 DEC-positive children and 60 DEC-	Laboratory test results showed that the proportion of children with positive *DEC* was 6.88% (15 out of 218 children), while the proportion of

No	Author, Year, & Title	Objective	Country/Region of Study	Study Design	Sample	Result
	prediction of diarrheagenic Escherichia coli: Study at elementary school, Surabaya, Indonesia	transmission in elementary school children			negative children	*Escherichia coli* O157:H7 was only 0.46%. The most significant transmission factors in the predictive model were the frequency of snacking at school and the risk classification of food frequently purchased at school
13	(M. Z. Alam & Mukarrom, 2022)/Hygiene, sanitation facility, and assessment of drinking water quality in the schools of Chattogram city, Bangladesh.	evaluated microbiological safety issues in drinking water at 50 schools in the city of Chattogram, Bangladesh, and investigated school sanitation and hygiene conditions, which are directly related to the health of thousands of students.	Bangladesh	Pour plate method and questionnaire	50 schools	A total of 46% of water samples exceeded the TVC safety limit (>500 CFU/ml), 52% contained coliforms, and 28% contained fecal coliforms. Of the 50 schools studied, the highest TVC (67%) and TCC (83%) levels were found in urban schools. 143 students and soap was rarely available (only 14%), whereas in private English-language schools , one toilet was used by 30 students and soap was available in all schools (100%).
14	(Demoze et al., 2024)/Under five children diarrhea prevalence and associated factors in slum areas of Gondar City Northwest Ethiopia: a community based cross-sectional study	Determined the prevalence and factors associated with diarrhea in children under five	Gondar, Ethiopia	Cross-sectional	836 participants	Analysis results showed a prevalence of diarrhea of 24.64% (CI 21.71–27.56). Factors significantly associated with the incidence of diarrhea included: mother/caregiver age <25 years (AOR=1.88), low maternal education or no formal education (AOR=3.18), low household income (AOR=1.81), household size >5 people (AOR=1.54), the presence of flies

No	Author, Year, & Title	Objective	Country/Region of Study	Study Design	Sample	Result
						around the house (AOR=2.27), a dirty play area (AOR=2.70), and the behavior of not washing hands before preparing food (AOR=2.31) and after using the toilet (AOR=1.60). Conversely, children who were breastfed for ≥1 year had a lower risk of developing diarrhea (AOR=0.63).

2. Discussion

Environmental Quality Factors and the Incidence of Diarrhea

Findings from various studies analyzed in this review consistently indicate that poor sanitation conditions are not merely an additional risk factor, but rather a primary structural determinant of diarrhea incidence among infants and young children. This pattern is observed across contexts, ranging from rural communities in sub-Saharan Africa to densely populated settlements in South and Southeast Asia, with the same characteristics inadequate access to toilets, open sewage systems, and poor household waste management consistently associated with high rates of diarrhea.(Asada et al., 2022; LaPolt et al., 2025; Musa Mohammed, 2024; Robert et al., 2021).

The primary mechanism linking sanitation conditions to the incidence of diarrhea is cross-contamination between waste sources and the surrounding environment. Open sanitation systems, including open defecation and unmanaged waste disposal, allow pathogenic bacteria particularly Escherichia coli to spread via rainwater runoff, flies, and animals to drinking water sources as well as eating and cooking utensils (Asada et al., 2022; Robert et al., 2021). Under these conditions, substandard toilets and uncovered trash bins serve as the starting point of the environmental contamination chain. A study (Mapingure et al., 2024) notes that children living in households without adequate sanitation have a 1.8 times higher risk of diarrhea compared to children living in households with good sanitation, a figure that is epidemiologically significant and consistent with similar findings from (Robert et al., 2021) which documented Escherichia coli contamination in community water sources in Burkina Faso due to open drainage and unmanaged waste disposal.

Housing density is a variable that significantly exacerbates the situation described above. Dense settlements increase the pollution load per unit area, reduce the distance between waste sources and water sources, and hinder collective waste management. (LaPolt et al., 2025) found that infants living in densely populated areas with poor sanitation and unmanaged waste piles are more vulnerable to diarrhea compared to infants in more organized settlements. (Demoze et al., 2024) reinforces these findings from the context of refugees in Ethiopia, where extreme housing density combined with limited sanitation infrastructure creates conditions highly conducive to the spread of enteric

pathogens. Housing density is not directly linked to the incidence of diarrhea but rather through the poor sanitation conditions resulting from population pressure on a given space. Thus, interventions that focus solely on providing physical infrastructure such as building toilets without adequate waste management and waste disposal systems are unlikely to yield optimal results.

Another aspect worthy of attention is the availability of sanitation facilities relative to the number of residents and toilet users. Study form (M. Z. Alam & Mukarrom, 2022) in Bangladesh noted that a single toilet unit is shared by more than 100 students in some schools, far exceeding the STBM standard requiring one toilet for every 25 people. These conditions create usage pressures that not only degrade the physical cleanliness of the facilities but also increase the risk of pathogen transmission among users. (Kamal et al., 2022) also confirms, based on data from Bangladesh, that inadequate sanitation facilities are associated with the incidence of gastrointestinal diseases, particularly among children under five years of age. Thus, both the quality and quantity of sanitation facilities are relevant in determining the risk of diarrhea, not merely the presence or absence of access.

Behavioral Hygiene Factors

If environmental sanitation creates conditions that determine a community's level of pathogen exposure, then individual hygiene behaviors particularly handwashing with soap (HWS) act as factors determining whether such exposure leads to a case of diarrhea or not. This means that in environments with relatively high contamination levels, individuals who consistently practice HWS still have a lower likelihood of becoming infected. Theoretically, this relationship can be understood through the Health Belief Model framework, which explains that individuals are more likely to adopt preventive behaviors such as HW when they have an adequate perception of disease risk, understand the benefits of preventive actions, and do not face significant barriers(Wicaksono & Dzikrullah, 2023). However, the gap between knowledge about the importance of hand hygiene and hygiene practices in the field remains a consistent challenge.

The effectiveness of handwashing as a preventive intervention for diarrhea and other infectious diseases remains strong. (Robert et al., 2021) indicates that handwashing can reduce the incidence of diarrhea by up to 40%, noting that handwashing is one of the preventive interventions with the best cost-effectiveness ratio in the field of environmental health. A similar study from (Demoze et al., 2024) reports that caregivers who do not wash their hands regularly have a 2.5 times higher risk of their children contracting diarrhea compared to caregivers who practice CTPS.

However, the effectiveness demonstrated in the studies mentioned above contrasts sharply with the low uptake of handwashing practices in the field. (Juniour Nsubuga et al., 2024) found that only 47% of respondents in Uganda consistently wash their hands with soap, while the majority do not despite being aware of the benefits. In the context of educational institutions, (M. Z. Alam & Mukarrom, 2022) reported that only 14% of schools in Bangladesh provide soap at handwashing stations; this indicates that barriers to handwashing are not only related to individual awareness but also to the availability of facilities. This finding underscores that awareness campaigns alone will not be effective if not accompanied by the provision of adequate supporting infrastructure.

Regarding transmission routes, findings from (Syahrul et al., 2020) offer the perspective that Escherichia coli contamination in school snacks in Surabaya stems not only from raw materials or production processes but also from the hands of sellers and buyers who do not wash their hands before handling food. This confirms that human

hands serve as active vectors linking contaminated environments to consumed food. (Prawati, 2019) further underscores that 28% of diarrhea cases in Surabaya are linked to not washing hands after defecation, and 38% are linked to not washing hands before eating. In addition to handwashing, the management of kitchen utensil hygiene and food safety practices at the household level also contribute to the risk of diarrhea, although evidence from the analyzed studies is more focused on handwashing as the key behavior. This indicates that HWCP is indeed the most measurable behavioral intervention with the strongest evidence, and in the context of resource constraints, prioritizing HWCP can yield the greatest preventive impact.

Factors Related to the Availability and Management of Drinking Water

The WHO estimates that 74% of diarrhea cases in low-income countries result from fecal contamination of drinking water (Mapingure et al., 2024). A study (Asada et al., 2022) in Zambia found that Escherichia coli was detected not only in water from open sources but also in stored tap water and even on the surfaces of drinking glasses used daily. This research indicates that contamination is progressive, water that is relatively clean at the source can become repeatedly contaminated during collection, transport, and storage. Study (Gärtner et al., 2021) from Uganda identified direct contact between hands and water during the process of drawing water from jerrycans or storage containers as one of the primary points of recontamination.

(Demoze et al., 2024) found that children whose caregivers stored water for more than seven days had a higher risk of diarrhea compared to those whose water was stored for less than three days, even after controlling for other variables. This indicates that water stored for too long, especially without additional treatment such as chlorination or reboiling, becomes a breeding ground for bacteria. (Prawati, 2019) also emphasizes that water storage containers that are not cleaned regularly at least every three days can become a source of contamination in their own right, even when the initial water source is clean.

A study from (Yunitawati et al., 2025) indicates that the type of water source has no significant association with diarrhea incidence among infants in both urban and rural areas a finding that warrants further scrutiny. Even water from protected sources, such as municipal water or bottled water, can become hazardous if stored in open containers, not consumed promptly, or collected in ways that may cause contamination. Conversely, water from unprotected sources can be safer if treated before consumption. These findings reinforce the argument that clean water supply programs that focus solely on improving access to water sources without accompanying education on water management at the household level will have a limited impact on reducing diarrhea rates.

(Robert et al., 2021) indicates that water source conditions near human waste disposal sites and open drainage systems are associated with significant Escherichia coli contamination. Meanwhile, (Majumdar et al., 2024) notes that flooding exacerbates water source contamination acutely by damaging drainage infrastructure and expanding the scope of pollution. These two factors geographical proximity to pollution sources and vulnerability to disasters indicate that the risk of water contamination is not static but varies based on environmental conditions. Therefore, water quality monitoring must be conducted regularly, particularly during the rainy season or following flood events, rather than merely as a baseline assessment.

(Juniour Nsubuga et al., 2024) found that households storing water in closed containers had a significantly lower risk of diarrhea compared to those using open containers. This simple finding underscores that water management interventions do not always require advanced technology or high costs; basic behavioral modifications such as using closed storage containers, boiling water before consumption, or using household disinfectants can have a tangible impact on reducing the risk of diarrhea

Conclusion

This scoping review identified that the incidence of diarrhea in infants and toddlers is primarily influenced by three main groups of determinants: environmental and sanitation factors, individual hygiene behaviors, and the availability and management of clean water. Regarding environmental and sanitation factors, households with poor sanitation conditions, lacking access to proper toilets, and having open sewage systems face a higher risk of diarrhea. Environmental contamination by *Escherichia coli* and other enteric pathogens is commonly found in water, soil, and kitchen utensils in densely populated residential areas.

Regarding individual hygiene behaviors, handwashing with soap, maintaining clean eating utensils, and safe food handling have been shown to be significantly associated with a reduction in the incidence of diarrhea. Low levels of knowledge and poor hygiene practices in the community remain a major challenge, particularly in rural areas. Meanwhile, the availability and management of clean water show the most consistent association with the incidence of diarrhea. Households that use unprotected water or store water in open containers are at higher risk of fecal contamination. Proper water management practices, such as boiling, filtration, or the use of household disinfectants, have been proven effective in reducing the risk of diarrhea.

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