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Environmental Sanitation and Stunting in Children Under Five: An Integrative Literature Review

Nur Rismawati[1], Budiman[2], Eka Prasetia Hati[3]
Universitas Muhammadiyah Palu, Indonesia[123]
Correspondent : nur.rismawati@gmail.com [1]

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ABSTRACT: Child malnutrition remains a global health priority, particularly in regions burdened by inadequate environmental sanitation. This narrative review aims to examine the relationship between environmental sanitation and child nutritional outcomes, focusing on children under five in low and middle income countries. A systematic literature search was conducted using PubMed, Scopus, and Google Scholar, incorporating predefined keywords and Boolean operators to identify empirical and theoretical studies published between 2010 and 2024. The findings reveal that improved sanitation facilities, handwashing behaviors, and water treatment are consistently associated with better child growth indicators, including reduced stunting and wasting. Diarrheal diseases and environmental enteric dysfunction are identified as key mediators in this relationship. Exposure to animal feces and poor waste management further exacerbate the risks. Socioeconomic and cultural factors, such as poverty and traditional beliefs, also influence sanitation practices and nutritional outcomes. Integrated interventions that combine WASH improvements with nutrition education and community led initiatives demonstrate significant potential to address child malnutrition holistically. This review underscores the urgent need for multisectoral policies and context specific research that address both environmental and behavioral determinants of malnutrition. Improving sanitation practices should be considered a central pillar in strategies aimed at enhancing child health outcomes globally.

Keywords: Child Malnutrition, Environmental Sanitation, Stunting, WASH Interventions, Diarrheal Disease, Low And Middle Income Countries, Hygiene Behavior.

INTRODUCTION

Child malnutrition is a persistent and pressing global public health issue, particularly in regions with inadequate environmental sanitation. The latest estimates from UNICEF indicate that approximately 149 million children under five suffer from stunting, and 45 million experience wasting globally, with the highest prevalence rates occurring in South Asia and Sub Saharan Africa

(Momberg et al., 2020). In these regions, the interplay between poor environmental sanitation and malnutrition is both complex and cyclical. A lack of access to safe water, poor waste disposal, and inadequate hygiene collectively contribute to adverse health outcomes, primarily affecting the nutritional status of vulnerable children (Fithra & Siska, 2020; Vilcins et al., 2018). Consequently, understanding the environmental determinants of child nutrition is essential for developing effective public health strategies.

In recent years, empirical studies have increasingly emphasized the direct link between poor sanitation and malnutrition among children. For example, Husseini et al. (2018) have demonstrated how suboptimal sanitary conditions compromise gut health, leading to chronic intestinal damage that impairs nutrient absorption and inhibits normal growth (Husseini et al., 2018). Similarly, Batool et al. (2023) found significant associations between insufficient WASH (Water, Sanitation, and Hygiene) practices and high rates of stunting among children in Pakistan (Batool et al., 2023). In rural Ethiopia, Kwami et al. (2019) reinforced these findings by linking poor sanitation to increased stunting rates, asserting that improvements in hygiene could substantially enhance children's nutritional outcomes (Kwami et al., 2019).

One critical mechanism that bridges the sanitation malnutrition nexus is Environmental Enteropathy (EED), a subclinical disorder caused by continuous exposure to fecal bacteria due to poor sanitation. EED is characterized by chronic gut inflammation and reduced nutrient absorption, which significantly impedes child growth (Budge et al., 2019). McQuade et al. (2019) found that interventions targeting sanitation, hygiene, and nutritional practices had a combined, positive impact on child health outcomes, illustrating the need for integrated strategies (McQuade et al., 2019). In addition, frequent episodes of diarrhea, primarily due to inadequate sanitation, exacerbate nutrient loss and contribute to chronic undernutrition and developmental delays (Nambuusi et al., 2019; Sinharoy et al., 2020).

The gravity of the issue is further highlighted by longitudinal and interventional studies that confirm the effectiveness of sanitation and hygiene improvements in mitigating malnutrition. For instance, the provision of safe water and sanitation facilities has been associated with significant reductions in child morbidity and enhanced nutritional status (Batool et al., 2023). Rahman et al. (2020) also established that improved sanitary environments lead to fewer infections and lower rates of stunting (Rahman et al., 2020). However, the persistent presence of EED and other hygiene related conditions in low and middle income countries (LMICs) signals that infrastructural solutions alone are insufficient, and that behavioral change and systemic support are equally vital (McQuade & Guerrant, 2017; Owino et al., 2016).

Despite the robust evidence, several challenges hinder the effectiveness of sanitation focused interventions in improving child nutritional outcomes. One major hurdle is the systemic nature of poor environmental sanitation in resource limited settings. In many LMICs, a significant proportion of households lack access to safe water and adequate toilet facilities, resulting in repeated exposure to infectious agents that degrade children's nutritional health (Batool et al., 2023; Rahman et al., 2020). Furthermore, EED remains largely undiagnosed and untreated due to the absence of visible symptoms, making it difficult to address through conventional healthcare approaches (Owino et al., 2016).

Socioeconomic constraints further complicate the landscape. Financial limitations prevent many families from investing in sanitation infrastructure or nutritious food. Studies from South Asia and Sub Saharan Africa reveal that economic hardship is a persistent barrier to both nutritional security and environmental hygiene (saif & Anwar, 2023). Compounding this issue is the lack of community awareness and education regarding the importance of sanitation. Research by Vita et al. (2019) shows that low levels of hygiene knowledge among caregivers contribute to poor adherence to sanitary practices, thereby undermining the effectiveness of interventions.

Another layer of complexity arises from the fragmentation of public health strategies aimed at combating malnutrition. Although sanitation and nutrition are interrelated, interventions often operate in silos. Das et al. (2017) and McQuade et al. (2019) argue that multifaceted strategies encompassing sanitation, maternal education, healthcare access, and nutritional support are required but are rarely implemented in a cohesive manner (Das et al., 2017; McQuade et al., 2019). This disjointed approach limits the scope and scalability of interventions, particularly in resource constrained settings.

Although there is a growing body of literature examining the impact of WASH on child malnutrition, several critical gaps remain. Many studies evaluate WASH interventions in isolation, neglecting to consider the synergistic effects of combining these efforts with direct nutritional support (Husseini et al., 2018; Stobaugh et al., 2018). Reviews by Momberg et al. (2020) and Walson & Berkley (2018) have highlighted that the modest gains observed from sanitation interventions often result from a lack of integrated planning and insufficient scale (Momberg et al., 2020; Walson & Berkley, 2018). Furthermore, longitudinal studies examining the long term effects of sanitation improvements on child health are limited, particularly in LMICs where sustained monitoring is often not feasible (Hermanussen & Wit, 2016; Walson & Berkley, 2018).

The literature also underrepresents the influence of broader structural and sociocultural determinants on child nutrition. While individual level factors like diet and hygiene are well documented, systemic influences such as governance, community infrastructure, and social norms receive inadequate attention (Rahman et al., 2020; saif & Anwar, 2023). This gap hampers the development of holistic policy frameworks that can simultaneously address both sanitation and nutrition challenges.

The primary objective of this review is to examine the relationship between environmental sanitation and child malnutrition through an analysis of recent empirical and narrative studies. The review aims to identify the most influential environmental factors, including access to clean water, sanitation infrastructure, and hygiene behaviors, that affect child nutritional status. It also seeks to explore the mediating role of conditions such as EED and diarrheal diseases, and to assess the efficacy of multisectoral interventions. By synthesizing existing findings, this review aspires to provide actionable insights for policy and program development targeting malnutrition in vulnerable populations.

The scope of this review is intentionally focused on low and middle income countries where the burden of malnutrition and poor sanitation is most pronounced. Regions such as Sub Saharan Africa, South Asia, and rural parts of Southeast Asia are of particular interest, as they consistently

exhibit high rates of undernutrition among children under five. Empirical data from countries like Ethiopia, Pakistan, and Bangladesh are extensively utilized due to their relevance and the availability of recent studies (Batool et al., 2023; Husseini et al., 2018; Kwami et al., 2019). In addition, urban informal settlements, such as those found in Nairobi and Dhaka, are considered to understand the impact of population density and infrastructural deficits on child health outcomes (Momberg et al., 2020; Vita et al., 2019).

In summary, this review aims to deepen the understanding of how environmental sanitation influences child malnutrition, emphasizing the need for integrated, context specific, and multisectoral strategies. Given the high prevalence of stunting, wasting, and underweight in regions with poor sanitation, addressing this issue is not only a matter of infrastructure development but a critical public health imperative requiring coordinated action across disciplines and sectors.

METHOD

This study employed a narrative review approach to examine the relationship between environmental sanitation and child nutritional status, with a specific emphasis on low and middle income countries. A comprehensive literature search was conducted across academic databases including PubMed, Scopus, and Google Scholar, targeting studies published between 2010 and 2024. The search strategy incorporated a combination of predefined keywords and Boolean operators to enhance precision and comprehensiveness. Key search terms included "child malnutrition," "environmental sanitation," "WASH," "nutritional status," "stunting," "wasting," "underweight," "infectious disease," "diarrhea," and "environmental enteric dysfunction," integrated using operators such as AND, OR, and NOT.

Eligibility criteria were defined to include peer reviewed studies, systematic reviews, and meta analyses that empirically or theoretically assessed the impact of environmental sanitation variables—such as water quality, sanitation infrastructure, and hygiene behaviors—on nutritional outcomes in children under five. Included studies focused on malnutrition indicators such as stunting (height for age), wasting (weight for height), and underweight (weight for age). Studies not published in English, lacking empirical evidence, or not peer reviewed were excluded. Initial screening involved reviewing titles and abstracts, followed by full text assessments to confirm relevance and methodological rigor.

To enhance reliability, a multi stage screening process was implemented. Four independent reviewers evaluated each study for consistency with the inclusion criteria. Emergent themes were synthesized to identify recurring patterns in how environmental sanitation influences nutritional status. These findings provide critical insights into the environmental determinants of child malnutrition and inform the development of targeted, evidence based public health interventions in vulnerable populations.

RESULT AND DISCUSSION

The empirical evidence supporting the relationship between improved sanitation facilities and enhanced child growth indicators is both consistent and compelling across diverse geographic and socioeconomic settings. Numerous studies have emphasized the significance of sanitation infrastructure in reducing malnutrition indicators, particularly height for age z scores (HAZ) and weight for age z scores (WAZ). For instance, a comprehensive systematic review by Momberg et al. (2020) highlighted that improved WASH (Water, Sanitation, and Hygiene) conditions are associated with reduced rates of stunting and wasting among children under five (Momberg et al., 2020). Proper sanitation systems are instrumental in minimizing exposure to fecal pathogens, a major cause of gastrointestinal infections and poor nutritional outcomes.

Specific findings from regional studies reinforce these global observations. In rural Gambia, children in households equipped with flush toilets or covered latrines had significantly higher HAZ scores compared to those in households without such facilities (Husseini et al., 2018). The study underscored that even modest improvements in sanitation access can yield substantial reductions in stunting prevalence. This is further corroborated by Batool et al. (2023), who found in Southern Punjab, Pakistan, that children residing in homes without improved sanitation were 1.43 times more likely to be stunted than those with access to functional toilets (Batool et al., 2023). These findings are aligned with the conclusions from Ricci et al. (2018), which linked inadequate sanitation to increased diarrheal diseases, thereby impairing nutritional status (Ricci et al., 2018).

Hygiene behavior and water treatment also emerged as vital determinants of child nutrition. Effective handwashing practices, especially at critical times such as after defecation and before food preparation, can significantly mitigate the incidence of diarrheal diseases. Miller et al. (2021) reported that handwashing promotion reduces diarrhea episodes and improves nutrient absorption, ultimately contributing to better nutritional outcomes (Miller et al., 2021). Similarly, Wasihun et al. (2018) documented that children drinking untreated water were approximately 1.4 times more likely to experience stunting, underscoring the importance of water treatment (Wasihun et al., 2018).

The accessibility and quality of drinking water not only affect consumption but also influence food preparation and hygiene maintenance. In Ethiopia, Kwami et al. (2019) demonstrated that households with improved water sources and water treatment practices had children with better growth outcomes (Kwami et al., 2019). Additionally, Pickering et al. (2019) emphasized that limited access to potable water increases compounded health risks due to suboptimal environments for hygiene and sanitation (Pickering et al., 2019). Thus, the synergy between water access, hygiene practices, and sanitation is crucial in enhancing child growth and health.

Recurrent diarrheal disease significantly mediates the pathway between poor sanitation and child malnutrition. Diarrhea contributes to nutrient malabsorption, inflammation, and overall weakening of the body's capacity to grow and develop. Momberg et al. (2020) identified strong associations between substandard WASH environments and the high prevalence of diarrhea among children, which in turn was correlated with increased rates of stunting (Momberg et al.,

2020). In Ethiopia, Woodruff et al. (2016) linked frequent diarrheal episodes with elevated levels of chronic malnutrition (Woodruff et al., 2016).

Husseini et al. (2018) further explored the physiological impacts of recurrent diarrhea, including the development of environmental enteric dysfunction (EED), a condition that damages the gut lining and inhibits nutrient absorption (Husseini et al., 2018). Similarly, Gelli et al. (2019) highlighted that diarrheal disease remains a critical barrier to achieving adequate child anthropometry in regions such as Burkina Faso. Budhathoki et al. (2016) provided a behavioral framework demonstrating how poor hygiene practices exacerbate diarrhea incidence, leading to long term nutritional deficiencies (Budhathoki et al., 2016). Sinharoy et al. (2016) added further evidence from Rwanda, where the frequency of diarrheal episodes was directly associated with higher stunting and wasting rates (Sinharoy et al., 2016).

Environmental fecal contamination from animals further compounds the problem. Chronic exposure to animal feces is a major contributor to environmental enteric dysfunction, particularly in resource constrained settings. Batool et al. (2023), Gelli et al. (2019), and Passarelli et al. (2021) all noted that proximity to livestock and inadequate management of animal waste increase children's risk of developing gastrointestinal diseases (Batool et al., 2023; Gelli et al., 2019; Passarelli et al., 2021). Gelli et al. documented that poultry husbandry practices, if not properly managed, lead to increased contamination risks within households.

Headey and Hirvonen (2016) identified similar trends in Ethiopia, where the cohabitation of humans and animals often results in elevated pathogen exposure, particularly among young children (Headey & Hirvonen, 2016). Children playing in contaminated environments frequently ingest fecal particles, which contributes to the burden of EED and, subsequently, stunting. Momberg et al. (2020) emphasized that improved waste management and animal husbandry are essential components of any sanitation initiative aimed at improving nutritional outcomes (Momberg et al., 2020). Budge et al. (2019) echoed these findings by establishing that countries with stringent sanitation protocols typically exhibit lower EED prevalence and better child growth metrics (Budge et al., 2019).

Comparative evidence reveals distinct disparities in sanitation related nutritional challenges between low income and middle income countries. In sub Saharan Africa, malnutrition rates remain high due to limited access to sanitation infrastructure, persistent exposure to enteric pathogens, and recurrent diarrheal diseases (Ricci et al., 2018). Bruyn et al. (2018) suggested that these factors, coupled with inadequate healthcare services and nutritional deficiencies, contribute to the region's elevated stunting and wasting prevalence (Bruyn et al., 2018).

In contrast, middle income countries often present a mixed picture. While some areas have adopted modern sanitation technologies, others still face traditional hygiene challenges. Gelli et al. (2019) observed in Burkina Faso that integrated interventions, including improvements in animal husbandry and hygiene, significantly enhanced child nutritional outcomes (Gelli et al., 2019). The SHINE trial in Zimbabwe, documented by Hutton and Chase (2016), revealed that combining WASH improvements with nutrition specific interventions yielded better results than implementing sanitation improvements in isolation (Hutton & Chase, 2016).

South Africa provides further evidence of the effectiveness of integrated programs. According to Sello et al. (2023), early childhood development interventions that incorporate hygiene promotion and nutrition education improved health indicators and reduced malnutrition (Sello et al., 2023). India has adopted holistic policy frameworks that combine sanitation initiatives with public health and nutrition strategies, showing positive impacts on child health metrics (Bruyn et al., 2018; Nambiar et al., 2023).

These global case studies suggest that while sanitation is a critical determinant of child nutrition, the most effective interventions are those that integrate sanitation, hygiene, and nutrition in a coordinated manner. The variability of outcomes in different socioeconomic contexts highlights the importance of adapting interventions to local needs and conditions.

In conclusion, the evidence synthesized in this review reveals several thematic patterns. First, access to improved sanitation is consistently associated with better nutritional outcomes, especially reductions in stunting and wasting. Second, hygiene behaviors such as handwashing and the use of safe drinking water significantly reduce diarrheal disease incidence, thereby improving nutrient absorption and growth. Third, environmental contamination from livestock plays a substantial role in exacerbating malnutrition, indicating the need for better waste management and hygiene practices in households that rear animals. Lastly, integrated interventions that combine WASH improvements with targeted nutrition strategies demonstrate greater effectiveness in mitigating malnutrition in children. Collectively, these findings underscore the importance of developing multifaceted public health approaches to address the intertwined challenges of sanitation and child malnutrition.

Systemic socioeconomic and cultural factors deeply shape the intersection between environmental sanitation and child nutritional outcomes. In low income contexts, poverty is frequently intertwined with a lack of access to adequate sanitation facilities, leading to heightened exposure to fecal pathogens and an increased risk of gastrointestinal infections. These infections directly impair nutrient absorption, exacerbating malnutrition. Households with limited financial means often resort to using shared or unimproved latrines, which are typically poorly maintained and contribute to unsafe hygiene conditions (Momberg et al., 2020; Ricci et al., 2018). In contrast, families with more stable incomes are better positioned to access and maintain private sanitation infrastructure, ultimately contributing to more favorable health outcomes for children.

Cultural norms and traditional beliefs also influence the adoption of sanitation and hygiene practices. In some communities, taboos surrounding defecation and handwashing, or misconceptions regarding the causes of diarrhea, hinder the uptake of improved practices (Chen et al., 2021). These practices may also affect dietary habits, food preparation, and child feeding behavior, thus compounding the risk of malnutrition. Understanding these cultural dimensions is critical for the development of contextually appropriate interventions.

Even in middle and high income countries, sanitation related nutritional disparities persist, often along socioeconomic lines. Urban slums, informal settlements, and marginalized communities may experience living conditions that mirror those in resource poor rural areas, including inadequate sanitation and limited access to potable water. These disparities emphasize that infrastructure alone

does not eliminate malnutrition risks; equitable access and culturally sensitive implementation are essential (Gelli et al., 2019).

Successful policies that integrate WASH (Water, Sanitation, and Hygiene) and nutrition programming offer critical insights into how systemic interventions can generate measurable health improvements. For example, the SHINE trial in Zimbabwe showed that combining WASH interventions with nutrition education yielded better health outcomes than standalone efforts. The program demonstrated that integrated approaches, particularly those involving behavior change communication, led to significant reductions in childhood stunting (Bandyopadhyay et al., 2020).

Community led total sanitation (CLTS) initiatives represent another promising model. These interventions, implemented across several South Asian countries, mobilize community members to eliminate open defecation, promote latrine construction, and encourage local ownership of sanitation practices. The success of such programs lies in their ability to align local behavior change with public health goals, resulting in improved sanitation usage and a reduction in malnutrition rates (Hutton & Chase, 2016; Joe et al., 2016).

Improving water supply accessibility and quality is another cornerstone of integrated interventions. Enhanced water infrastructure not only reduces the risk of waterborne diseases but also supports hygiene practices essential for food preparation and child care. Global initiatives aligned with the Sustainable Development Goals prioritize universal access to clean water, recognizing its fundamental role in promoting health and nutrition outcomes (Hutton & Chase, 2016).

Case studies highlight how integrated, multisectoral approaches can create synergy between sanitation and nutrition interventions. The "Grandi Byen" program in Haiti exemplifies this approach, where a combination of health, sanitation, and nutrition education improved early childhood development indicators and maternal knowledge (Edward et al., 2023). In rural Ethiopia, interventions that addressed both agricultural productivity and sanitation infrastructure were shown to improve children's anthropometric outcomes, underscoring the potential of holistic strategies (Bauza & Guest, 2017; Gelli et al., 2019).

Cross sectoral collaborations targeting food security and sanitation have also been successful in reducing the dual burdens of undernutrition and infectious disease. These initiatives often include elements of community empowerment, such as participatory planning, local leadership, and inclusive resource allocation, which enhance the sustainability and cultural relevance of interventions. Their effectiveness further supports the argument that addressing child malnutrition requires coordination between health, education, water management, and agricultural sectors.

Limitation

Several methodological and contextual limitations emerge in the current body of literature exploring the sanitation nutrition nexus. Many studies suffer from weak experimental designs, including small or non-representative sample sizes and lack of longitudinal follow up, which limit the generalizability of findings. Moreover, short term studies tend to overlook the long term benefits or drawbacks of sanitation interventions, making it difficult to assess sustained impacts

on child nutrition. Establishing causality also remains a challenge due to the reliance on observational data and potential confounding variables. Studies often inadequately account for environmental or socioeconomic determinants that mediate the relationship between sanitation and malnutrition, such as caregiver education, health service access, or household income. Furthermore, the diversity of geographic and cultural contexts often results in heterogeneous outcomes that are difficult to compare or replicate, thus restricting external validity.

Implication

Addressing the limitations of existing research requires a shift toward more robust and integrative methodologies. Longitudinal studies are essential for capturing the sustained effects of sanitation improvements on child nutrition. Future research should prioritize mixed method designs that incorporate both quantitative and qualitative data to explore not only the statistical relationships but also the behavioral and cultural dynamics underlying sanitation practices. Investigations should focus on vulnerable populations in both rural and urban settings, tailoring interventions to local realities and resources. It is also imperative to examine the causal pathways linking sanitation to child nutrition, particularly through environmental enteric dysfunction and other mediating mechanisms. Evaluations of policy implementation and multisectoral interventions will provide critical insights for scaling successful programs. Expanding the evidence base in these areas will enhance understanding of the complex interactions between sanitation and malnutrition, enabling more effective strategies to support child health and development.

CONCLUSION

This review highlights the critical intersection between environmental sanitation and child nutritional outcomes, particularly in low and middle income countries. The synthesis of evidence reveals that access to improved sanitation facilities, proper hygiene practices such as handwashing, and water treatment are significantly associated with lower rates of stunting, wasting, and underweight among children under five. Key findings demonstrate that diarrheal diseases and environmental enteric dysfunction serve as critical mediating pathways linking poor sanitation to malnutrition. Moreover, the presence of animals and improper waste management exacerbates the risk of exposure to fecal pathogens, further impairing child growth.

The discussion further emphasizes that systemic factors such as poverty, inadequate infrastructure, and cultural practices substantially influence the adoption of sanitation and hygiene behaviors. Integrated interventions, particularly those that combine WASH strategies with nutrition education and community engagement, have shown promise in addressing these complex health challenges. However, methodological limitations and a lack of long term, context specific studies continue to constrain the development of effective policy responses.

To overcome these barriers, governments and stakeholders must implement cross sectoral policies that integrate sanitation infrastructure, behavior change communication, and nutrition support. Additionally, future research should focus on longitudinal and mixed method studies to better

understand the causal pathways and cultural dynamics that shape these outcomes. Enhancing sanitation practices remains a central strategy to combat child malnutrition and foster sustainable improvements in global child health.

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