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Risk Factors Associated with Diarrhea in Infants

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ABSTRACT

Purpose: Diarrhea is one of the leading causes of death among infants in Indonesia and is a significant public health issue. This study aims to identify and analyze various risk factors associated with diarrhea in infants through a literature review approach.

Research Method: This study employed a literature review method with a content analysis approach, utilizing articles obtained from the PubMed, ScienceDirect, and Google Scholar databases. The keywords used are "Infants," "Diarrhea," and "Risk Factors." Article selection was conducted systematically using the PRISMA framework, from identification through screening to eligibility assessment. Out of 208 articles obtained, 10 articles were selected that met the criteria for further analysis.

Results and Discussion: The study's results indicate that factors closely associated with the incidence of diarrhea in infants include not being exclusively breastfed, poor personal hygiene among mothers, inadequate basic sanitation facilities at home, low maternal education, maternal employment status, and limited socioeconomic conditions within the family. These factors interact with each other and increase the risk of diarrhea in young children.

Implications: These findings are significant for preventive efforts in public health, particularly in raising awareness and knowledge among parents about maintaining optimal hygiene, sanitation, and nutrition for their children.

Keywords: infant; diarrhea; risk factors.

Introduction

Diarrhea is a medical condition characterized by an increase in the frequency of bowel movements and a change in stool consistency to a more liquid state. This condition is typically caused by consuming food or beverages contaminated with infectious agents, such as viruses, bacteria, or parasites. The most common form of diarrhea is acute diarrhea, which lasts less than two weeks. However, in some instances, diarrhea can persist for more than two weeks and is classified as chronic diarrhea (Meisenheimer *et al.,* 2022). Although diarrhea often resolves on its own, improper treatment can lead to serious complications and worsen the patient's condition. According to UNICEF and WHO (2020), diarrhea is the second leading cause of death in children under five years of age, with approximately 1.7 billion cases annually resulting in the deaths of around 760,000 children. Even in Europe, over 160,000 children die before the age of five, with diarrhea contributing to more than 4% of these deaths. In Indonesia, diarrhea is an endemic health issue with the potential to become a deadly

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outbreak (KLB). Data from 2021 recorded 18 cases of KLB diarrhea occurring in 11 provinces and 18 districts/cities, affecting 1,213 people and causing 30 deaths, with a mortality rate of 2.47%. Interestingly, only about 10% of reported diarrhea cases sought treatment at health facilities or through health workers within one year, based on the regional population. This situation further highlights the importance of understanding the risk factors that contribute to diarrhea, particularly among vulnerable groups, such as infants. Infants are particularly vulnerable to diarrhea due to their immature immune systems and the potential for rapid dehydration from excessive fluid loss, which can disrupt their growth, development, and quality of life.

Previous studies have made significant contributions to understanding the various risk factors associated with diarrhea in infants. In general, the risk of diarrhea is influenced by three main factors, namely the cause (agent), the child's physical condition (host), and the environment. The causative factors or agents include pathogenic microorganisms such as E. coli, Salmonella, and Vibrio cholerae; viruses, including Rotavirus, Adenovirus, Enterovirus, and Astrovirus; and parasites, including protozoa and fungi. Host factors such as low exclusive breastfeeding coverage and poor personal hygiene practices are significant triggers. Meanwhile, environmental conditions such as access to clean water, adequate sanitation facilities, and poor waste management also significantly contribute to the risk of diarrhea. This literature review examines the risk factors associated with diarrhea in infants in Indonesia. Poor sanitation, including inadequate access to clean water, toilets, and waste management, has consistently been identified as a significant risk factor (Iryanto *et al.,* 2021; Firmansyah *et al.,* 2021). Maternal knowledge and personal hygiene practices, such as handwashing habits, are also important determinants (Iryanto *et al.,* 2021; Firmansyah *et al.,* 2021).

Exclusive breastfeeding history and immunization status are protective factors against diarrhea (Al Hajiri & Asih, 2023; Firmansyah *et al.,* 2021). A meta-analysis revealed that children of mothers with poor personal hygiene were 3.095 times more likely to experience diarrhea. At the same time, lack of clean water and proper toilet use increased the risk by 1.954 and 1.840 times, respectively (Adani & Azizah, 2022). Poor sanitation and hygiene practices, including open defecation and inadequate handwashing, are significant contributors to diarrhea incidence (Kamiludin & Azizah, 2025; Zain, 2025). Exclusive breastfeeding, maternal education, nutritional status, and proper handwashing behavior have been identified as key predictors of diarrhea in young children (Kwaitota & Leutualy, 2024). The implementation of the Community-Based Total Sanitation Program (STBM), focusing on the five pillars of sanitation and hygiene, shows a correlation with a decrease in diarrhea cases among children (Kamiludin & Azizah, 2025). Additionally, environmental factors play a crucial role in the prevalence of diarrhea, emphasizing the need for improved sanitation facilities and increased awareness (Zain, 2025). Comprehensive and sustained education on exclusive breastfeeding, nutrition, and proper handwashing techniques for mothers is recommended to prevent and minimize diarrhea cases (Kwaitota & Leutualy, 2024).

Although various studies have identified significant risk factors for diarrhea in infants, several gaps remain that have not been thoroughly examined. Many previous studies have tended to focus their analysis on a single dimension of risk, such as environmental aspects or maternal hygiene behavior, without integrating biological factors of the child, such as immunization status and exclusive breastfeeding, into a comprehensive analytical framework (Iryanto *et al.,* 2021; Kwaitota & Leutualy, 2024). This creates limitations in understanding the complex interactions between variables that simultaneously influence the occurrence of diarrhea. Additionally, most studies remain localized and have not compared regions with differing sanitation and socioeconomic characteristics, despite the

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significant geographical disparities and variations in access to healthcare services across Indonesia (Kamiludin *et al.,* 2025; Zain, 2025). From a theoretical perspective, there have been few efforts to examine diarrhea risk factors using a systematic approach that combines epidemiological theory with a public health behavior perspective. Previous studies have also not extensively discussed the long-term effectiveness of interventions such as STBM programs or exclusive breastfeeding education in reducing diarrhea incidence rates.

Based on this gap analysis, this study offers novelty through a comprehensive literature review approach that integrates various risk factors for diarrhea in infants, encompassing biological, behavioral, and environmental aspects within a systematic analytical framework. This study also emphasizes the importance of mapping the relationships between risk factors while considering the diverse socioeconomic and geographical contexts in Indonesia, which have received limited attention in previous studies. Additionally, this study aims to critically examine the effectiveness of implemented interventions, such as the Community-Based Total Sanitation Program (STBM) and exclusive breastfeeding promotion and evaluate their contributions to preventing diarrhea in infants. With this approach, this research not only enriches the theoretical body of knowledge in child health and diarrhea epidemiology but also provides a stronger evidence-based foundation for policymakers and health practitioners in formulating more adaptive, holistic, and sustainable prevention strategies.

Literature Review and Hypothesis Development

Diare

Diarrhea is a medical condition characterized by an increase in the frequency of bowel movements accompanied by a change in stool consistency to liquid or watery, which in many cases can lead to severe dehydration, especially in infants. This condition is highly prevalent in developing countries and contributes significantly to morbidity and mortality rates among children. According to Wolf et al. (2022), diarrhea is not only caused by infections from viruses, bacteria, or parasites, but also by other factors. However, it is also closely related to the quality of the living environment, hygiene practices, and nutritional status of children. One of the main factors that exacerbate the risk of diarrhea is poor water quality and sanitation facilities. Satty *et al.,* (2024) emphasize that access to clean water and adequate waste disposal systems has a strong correlation with the low prevalence of diarrhea among young children. In environments with inadequate water systems, the risk of fecal contamination in drinking water increases significantly, making it the primary route for the spread of pathogens that cause diarrhea.

Furthermore, the practice of exclusive breastfeeding for the first six months of a child's life plays a crucial role in preventing diarrhea. The World Health Organization (WHO) and UNICEF (2023) explain that breast milk contains antibodies and essential nutrients that protect infants from various infections, including gastrointestinal infections. When children do not receive exclusive breastfeeding, they become more vulnerable to pathogens from contaminated food or water. This finding is supported by research by Ahmed *et al.,* (2023), which shows that consistent exclusive breastfeeding significantly reduces the risk of diarrhea. On the other hand, the quality of personal hygiene among mothers is also a key determinant in reducing the risk of gastrointestinal infections in children. Soe *et al.,* (2024) demonstrated that the practice of washing hands before breastfeeding, after cleaning the child, and after defecation can drastically reduce the risk of pathogen transmission to the child. Unfortunately, in

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many areas, awareness of the importance of these hygiene practices remains low, particularly among mothers with limited education.

Socioeconomic conditions and the mother's level of education are also structural factors that increase children's vulnerability to diarrhea. Kurniawati & Astutik, (2023) explain that mothers from low-income families often face limitations in accessing clean water, sanitation facilities, and health services, all of which are essential pillars in preventing diarrhea. Additionally, mothers' knowledge about safe complementary feeding practices and the appropriate timing for introducing solid foods to infants is highly dependent on their educational level. Pramuja & Candrasari, (2024) further note that in economically constrained social environments, preventive measures are often neglected, and efforts to treat sick children rely more on home remedies or purchasing over-the-counter medications rather than seeking care at health facilities. Research by Rhue *et al.,* (2023) also highlights that unsafe water conditions in households cause prolonged stress and exacerbate health impacts on children. Therefore, interventions to prevent diarrhea in infants cannot solely focus on individual behavior but must also consider the social, economic, and structural contexts in which children are raised.

These findings underscore the importance of a comprehensive approach in efforts to prevent and manage diarrhea in infants. Such efforts should include promoting exclusive breastfeeding, education on personal hygiene and food handling, providing access to clean water, improving household sanitation systems, and enhancing access to primary healthcare services. As explained by Hubbard *et al.,* (2025), successful diarrhea management strategies are those that bring together various sectors and actors, from families to policymakers. The results of Kombat & Kushitor, (2025) study show that community-based intervention programs, such as training mothers in clean water management and household sanitation, have been proven to reduce diarrhea cases among infants in the long term significantly. Therefore, in the context of Indonesia, which has significant geographical and social diversity, preventive and promotional efforts against diarrhea must be interdisciplinary and adaptable to local needs. These actions will not only contribute to reducing child morbidity and mortality rates but also serve as a long-term investment in improving the quality of life for future generations.

Balita

Infants, or children under five years of age, are a population group that is undergoing physiological, psychological, and immunological development and is most vulnerable to various health disorders, especially infectious diseases such as diarrhea. During this period, children's immune systems are not yet fully developed, making them more susceptible to infection when exposed to pathogens through food, drink, or environmental contact. Diarrhea in toddlers not only causes acute dehydration but can also have profound effects on children's nutritional status, growth, and brain development. Utami *et al.,* (2019) revealed that children living in households with low socioeconomic conditions are more prone to diarrhea due to limited access to clean water, nutritious food, adequate sanitation, and health services. In such conditions, resource constraints make it difficult for parents, especially mothers, to implement healthy childcare practices, such as providing hygienic food, ensuring children's hygiene, and properly managing disease symptoms. When children are exposed to contaminated water or food, their underdeveloped immune systems are more susceptible to digestive disorders. Additionally, practices such as the use of unsterilized pacifiers or the provision of inappropriate complementary foods can increase the risk of gastrointestinal infections. Therefore, understanding the vulnerability of infants

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in the context of environmental and social health is crucial for designing effective and sustainable interventions to prevent diarrhea in this age group.

The environmental conditions where children live, particularly those related to basic sanitation and hygiene practices, play a crucial role in determining the level of vulnerability of infants to diarrhea. A study conducted by Soe *et al.,* (2024) in Myanmar found that infants residing in environments with inadequate sanitation systems and inconsistent handwashing practices had a higher risk of experiencing diarrhea compared to children living in environments with cleaner sanitation systems and consistent handwashing practices. They emphasized that one simple yet highly effective step in preventing diarrhea is for mothers to wash their hands before breastfeeding and preparing food for their children. Similar research by Auma *et al.,* (2024) in Uganda also underscores the importance of providing clean toilets and adequate waste disposal systems in reducing the prevalence of diarrhea. They found that children living in households without private toilets are at higher risk of exposure to fecal contamination in their surroundings. Meanwhile, Njenga *et al.,* (2024) formulated a dynamic model that demonstrates how improvements in hygienic practices, such as soap use, drinking water treatment, and household sanitation, directly contribute to a reduction in diarrhea incidence among infants. These findings suggest that family hygiene behavior and household sanitation infrastructure are interrelated in preventing the spread of infectious agents, such as Escherichia coli and Rotavirus. Therefore, promotive interventions through education and improvement of basic infrastructure are essential in efforts to control diarrhea in young children.

In addition to environmental and behavioral factors, family socioeconomic status and maternal education level are important determinants that significantly influence infant health, including the incidence of diarrhea. Research by Kurniawati & Astutik, (2023) shows that families with low incomes face various limitations in meeting their children's basic needs, such as access to clean water, nutritious food, and appropriate medical treatment when children are sick. In such situations, mothers often lack sufficient information or resources to take optimal preventive or curative actions. Pramuja & Candrasari (2024) note that mothers with low educational levels tend to have a limited understanding of the importance of clean and healthy living practices, often neglecting simple practices such as washing hands before preparing food or boiling drinking water before giving it to children. In such families, treatment is often self-administered by purchasing over-the-counter medications from local shops, rendering diarrhea management ineffective. Kombat & Kushitor, (2025) support these findings through their longitudinal study, which found a higher prevalence of diarrhea in households with low incomes residing in areas lacking adequate health infrastructure. Meanwhile, Rego *et al.,* (2022) noted that social inequality and limited access to basic healthcare services are significant barriers in efforts to reduce diarrhea rates among infants. Therefore, in addition to medical and environmental approaches, strategies that include community-based social interventions and improvements in family economic capacity are needed to create a healthy and sustainable environment for children's growth and development.

Research Method

This method involves a systematic review, utilizing a critical evaluation of full-text articles in both Indonesian and English, sourced from the PubMed, ScienceDirect, and Google Scholar databases. The method applied in this systematic review involves a critical review of full-text articles in both Indonesian and English, obtained from the PubMed, ScienceDirect, and Google Scholar databases. The

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articles were selected in stages using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) assessment tool (8).

The search for articles using the keywords "infants," "diarrhea," and "risk factors" yielded 208 articles, including 11 from PubMed, six from Sciencedirect, and 191 from Google Scholar. After removing duplicates, 83 identical articles were obtained. These articles were then selected based on their titles and abstracts, resulting in 108 articles being excluded from the study. Exclusion criteria included articles accessible only via abstract, lacking full text, being literature reviews or other systematic reviews, not being scientific publications, or not related to diarrhea incidents. After filtering, 38 articles were analyzed in depth and summarized. Fifteen articles were found not to address diarrhea incidents specifically. The final results showed that 10 articles met the inclusion criteria and were deemed feasible for a study. All authors contributed to the literature search and selection process. From the search, ten articles were screened based on the keywords: **"Infants, Diarrhea, Risk Factors."**

The search criteria for this study are as follows:

- Only research articles published between 2020 and 2024 will be considered.
- Articles written in Indonesian and English
- This study will focus on research involving toddlers as subjects.
- Only open-access research articles will be included.
- Articles must have full text available for review..

Articles are searched for and organized, and then summarized for relevant articles. Relevance is determined by how clear the source of the article is and how well it relates to your chosen topic.

Results and Discussion

Analysis Result

The articles used as data in this study are presented in Table A1 (Appendix), which includes 10 articles from various sources on diarrhea in infants. These articles were used to investigate the risk factors associated with diarrhea in infants, employing an average cross-sectional research design to conduct quantitative research. The articles used had at least 30 respondents. The articles used respondents who were mothers of infants under the age of 5 years.

Discussion

Risk Factors Associated with Diarrhea in Infants

- The Relationship Between Exclusive Breastfeeding and Incidence of Diarrhea in Toddlers.

Exclusive breastfeeding is the practice of feeding only breast milk without any other food or drink, including water, to infants from birth until six months of age. During this period, breast milk is the sole source of nutrition that adequately meets all of an infant's nutritional needs, supporting optimal growth and development. Furthermore, breast milk contains important immune factors that protect infants from various infections, including gastrointestinal infections that can cause diarrhea. Therefore, attention to the success of exclusive breastfeeding is crucial to prevent health and growth issues in children during their early years. Research by Suyanto (2024) indicates a significant correlation between exclusive breastfeeding and the incidence of diarrhea in toddlers. These results indicate that children who do not receive exclusive breastfeeding are much more likely to experience diarrhea than children who are exclusively breastfed. In this study, the significance of this difference indicates that infants who

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are not exclusively breastfed are in a higher-risk group, with a several-fold greater likelihood of developing diarrhea compared to infants who are exclusively breastfed from birth. This finding reinforces the protective role of exclusive breastfeeding in strengthening infants' immune systems and preventing infections.

Similar findings were also reported in a study by Fitriani *et al.,* (2021), which revealed a statistically significant association between exclusive breastfeeding and the incidence of diarrhea. In this context, the low success rate of exclusive breastfeeding remains a challenge, particularly due to the perception in the community that breast milk alone is insufficient to meet the nutritional needs of infants. This perception encourages some mothers to introduce complementary foods before six months of age, which risks introducing bacteria or foreign substances that can cause digestive disorders. Furthermore, a study by Afriyani *et al.,* (2024) also demonstrated a significant association between exclusive breastfeeding practices and the risk of diarrhea in children aged 0–59 months. Statistical analysis in this study indicates that infants who were not exclusively breastfed experienced diarrhea at significantly higher rates compared to those who were exclusively breastfed. This reinforces the evidence that exclusive breastfeeding serves not only as a source of nutrition but also as natural protection against gastrointestinal infections, including diarrhea.

- The Relationship Between Personal Hygiene and Incidence of Diarrhea in Toddlers.

Personal hygiene is a series of actions taken by an individual to maintain cleanliness and prevent the spread of disease, thereby improving overall health. In the context of toddlers, personal hygiene is one of the crucial factors that influence children's health, especially in preventing infectious diseases such as diarrhea. Toddlers are a group that is very vulnerable to various infectious agents because their immune systems are not yet fully developed. In their daily lives, children often interact directly with their surroundings and remain highly dependent on their parents, especially their mothers, for self-care. Therefore, maternal hygiene is a key factor in breaking the chain of transmission of microorganisms that cause diarrhea in infants. A study conducted by Komala *et al.,* (2023) revealed a significant association between mothers' personal hygiene levels and the incidence of diarrhea in infants. The findings suggest that infants cared for by mothers with poor personal hygiene have a higher risk of developing diarrhea compared to those cared for by mothers who consistently practice good personal hygiene.

This shows that mothers' behavior in maintaining personal hygiene, such as washing their hands after certain activities or before handling food and caring for children, plays a direct role in preventing diseases in children. This is reinforced by the research results of Angelina & Lestarisa, (2024), which found a significant relationship between mothers' handwashing habits and the incidence of diarrhea in infants. The explanation for these findings suggests that simple actions, such as washing hands before breastfeeding, after defecating, or before feeding children, can significantly reduce the likelihood of transmitting diarrhea-causing agents from mothers' hands to children. Hands are the primary medium for the spread of germs, and since children cannot maintain their hygiene, the role of mothers becomes crucial.

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- Environmental sanitation factors

The Relationship Between Clean Water Supply and Incidence of Diarrhea in Toddlers.

Clean water plays a crucial role in maintaining the health of infants, as its quality and availability are directly linked to the risk of gastrointestinal infections, including diarrhea. Clean water is defined as water that meets physical, chemical, and microbiological requirements and is safe for consumption and use in daily activities such as cooking and cleaning children's eating utensils. Poor water quality, particularly when used for drinking or household purposes, can serve as a medium for the spread of bacteria, viruses, and parasites that can cause severe digestive disorders in children, especially infants with an underdeveloped immune system. A study conducted by Riyanto, (2023) revealed a significant association between access to unsafe water sources and an increased incidence of diarrhea among infants. This study highlights that infants who use water from sources that do not meet health standards have a significantly higher risk of experiencing diarrhea compared to those who have access to clean water that meets these standards. This means that when contaminated water is used in daily activities, such as drinking, washing utensils, or bathing, the risk of infants being exposed to diarrhea-causing microorganisms increases drastically.

Similar findings were reported by Afriyani *et al.*, (2024), who found that limited access to safe drinking water is strongly correlated with an increase in diarrhea incidence among children aged 0 to 5 years. In their explanation, children living in environments with inadequate water facilities are several times more likely to suffer from diarrhea than those with access to clean water. This highlights the importance of safe and adequate water infrastructure as a preventive measure in reducing the incidence of diarrhea among infants. Research by (Fitriani *et al.,* 2021; Pramuja & Candrasari, 2024) further reinforces the evidence that water that does not meet health standards, especially contaminated water, significantly contributes to the high incidence of diarrhea among infants. To ensure water quality, water sources should be located at least ten meters away from latrines and equipped with covers to prevent contamination from dust, waste, and pollutants. Clean water should be clear, colorless, odorless, and tasteless, as these characteristics are basic indicators of its cleanliness and safety. Therefore, the provision of clean water is not only a basic necessity but also a vital component in efforts to prevent diarrhea and maintain children's overall health.

The Relationship Between Toilet Availability and Diarrhea Incidence in Toddlers.

The availability of toilets that meet health standards is a crucial aspect of efforts to establish a proper sanitation environment and prevent the spread of infectious diseases, such as diarrhea. Types of toilets, such as squat toilets, swan neck toilets, and other variations, serve as basic facilities for the hygienic disposal of human waste. A good toilet is not merely a place for defecation. However, a sanitation system is also crucial for maintaining environmental cleanliness, preventing groundwater contamination, and inhibiting the spread of insects and disease vectors that can transmit infections such as cholera, typhoid, parasitic infections, and most commonly, diarrhea in infants. In a household context, access to safe and clean toilets is a key indicator of a healthy environment, especially for young children whose immune systems are not yet fully developed. Research conducted by Riyanto (2023) shows that many cases of diarrhea in toddlers are found in households that use toilets that do not meet sanitation standards.

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These findings suggest that the quality of toilets in homes has a significant impact on children's health risks. When toilets are not kept clean or built according to sanitation safety standards, the likelihood of disease transmission through environmental contamination increases significantly. This reinforces the understanding that poor toilet facilities are not only an indicator of low sanitation but also a source of pathogen transmission, causing diarrhea. Support for these findings also comes from a study by Afriyani *et al.,* (2024), which identified a strong association between the presence of household toilets and the incidence of diarrhea among children aged 0 to 59 months. The study found a significant association indicating that households without adequate sanitation facilities were more likely to have higher diarrhea incidence among infants. The explanation for these results suggests that without adequate sanitation facilities, family members, including children, may dispose of feces in unsanitary locations or use shared facilities that are not hygienic, thereby increasing the risk of infection transmission.

The Relationship Between Waste Disposal Facilities and Incidence of Diarrhea in Toddlers.

Proper waste disposal facilities and management are crucial components of an effective environmental sanitation system, which helps prevent the spread of various infectious diseases, including diarrhea. Household waste, if not properly managed, can become a breeding ground for harmful microorganisms and a habitat for disease vectors, such as flies, rats, and cockroaches. These animals act as carriers of disease-causing bacteria or viruses, which can be transmitted to food or drink through direct or indirect contact, thereby increasing the risk of gastrointestinal infections, particularly in infants and young children. In this context, infants are the most vulnerable group because their immune systems are still developing, making them more susceptible to health issues such as diarrhea when exposed to contaminated environments. Research conducted by Riyanto, (2023) emphasizes the importance of waste management as one of the environmental determinants influencing the incidence of diarrhea in children. The study found that infants living in areas with poor waste management were more likely to experience diarrhea compared to those living in areas with sound waste disposal systems. The significance of these findings lies in the fact that the accumulation of improperly managed waste creates conditions that support the growth and spread of pathogens through vectors, such as flies. When these vectors come into contact with food or eating utensils, the likelihood of contamination is very high, ultimately increasing the risk of diarrhea. Inadequate waste management contributes to environmental pollution and a decline in air and soil quality around residential areas. These conditions not only impact physical health but also increase the economic burden on families due to medical expenses and lost productive time caused by illness. Therefore, providing closed, organized, and separate waste disposal sites away from water sources and food is an important step in creating a healthy environment. Thus, proper waste management is not only the responsibility of local governments but also a collective responsibility of the community in creating a safe and disease-free environment, especially for infants who are still in their growth and development stages.

The Relationship Between Wastewater Disposal and Incidence of Diarrhea in Toddlers.

Sewage disposal systems (SPAL) are an important component of environmental sanitation systems that aim to drain domestic wastewater from households to safe storage or treatment facilities. SPAL includes sewage pipes from various household activities such as washing clothes, washing dishes, bathing, and other kitchen activities. If not disposed of through a system that meets hygiene and

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technical standards, this wastewater can contaminate the surrounding environment, create puddles, and become a breeding ground for microorganisms and disease vectors. In the context of child health, particularly in infants, inadequate wastewater sanitation can increase the risk of exposure to infectious agents that cause diarrhea. Research conducted by Riyanto, (2023) confirms that infants living in households with inadequate wastewater disposal systems have a higher risk of experiencing diarrhea compared to infants with adequate disposal systems. The findings indicate that untreated or improperly managed domestic wastewater can serve as a contamination source for the surrounding environment, especially if open drainage systems allow direct contact with children. Wastewater contaminating yards or nearby waterways can carry various pathogens, which, if ingested by infants through contaminated hands or unclean food, can trigger digestive tract disorders such as diarrhea. This is supported by research by Angelina & Lestarisa, (2024), which demonstrated a significant association between SPAL systems and diarrhea incidence in infants. This study explains that inadequate drainage systems can increase the risk of cross-contamination between wastewater and clean environments, mainly when wastewater from kitchens and bathrooms is not managed separately from sewage systems. If wastewater drainage systems are constructed without covers, proper drainage channels, or adequate absorption areas, the risk of bacterial spread in the home environment increases significantly.

- The Relationship Between Maternal Education and Incidence of Diarrhea in Toddlers.

Education is a fundamental aspect in shaping a person's knowledge, attitudes, and behavior, including their personal and family health. Good education serves as a means to raise individual awareness of the importance of clean and healthy living behaviors, including preventive measures such as hand washing, maintaining food hygiene, and understanding the importance of exclusive breastfeeding and immunization. In the context of child health, particularly among infants, the mother's educational level significantly influences the child's health condition, as the mother serves as the primary caregiver and decision-maker regarding daily behaviors at home. Research confirms that maternal education is significantly associated with children's health status, including the risk of diarrhea. This study shows that children tend to be healthier when their mothers have higher levels of education. This is due to mothers' ability to understand health information, access health services, and apply better hygiene and sanitation practices in their daily lives. Conversely, mothers with low levels of education generally have limited knowledge about disease prevention, so they tend to neglect hygienic behaviors such as washing their hands before eating or maintaining environmental cleanliness. Support for these findings can also be seen in the study by Fitriani *et al.,* (2021), which states that mothers with low education have more children who suffer from diarrhea. The implications of these results suggest that low educational attainment is correlated with a lack of awareness among mothers regarding the importance of prioritizing their children's hygiene and health. In some cases, mothers with low educational attainment also find it more difficult to understand health messages from medical personnel or health campaign materials disseminated through the media. This hinders the behavioral change process necessary to prevent diarrhea.

- The Relationship Between Mothers' Employment Status and Incidence of Diarrhea in Toddlers.

Mothers play a central role in the family, which extends beyond fulfilling domestic needs to include caregiving, protection, and basic education for their children. In practice, mothers are typically the primary caregivers for toddlers, responsible for their health, hygiene, and diet. However, with the passage of time and increasing economic demands on families, many women have decided to work

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outside the home just like men. This decision is typically driven by the increasing financial needs of the household, allowing women to contribute to meeting the family's economic requirements. This change in roles has an impact on childcare patterns, especially for toddlers. A study conducted at the Plaju Health Center in Palembang in 2023 revealed a significant association between a mother's employment status and the incidence of diarrhea in infants. The findings suggest that working mothers tend to have infants with a higher incidence of diarrhea. This implies that mothers who are busy outside the home are more likely to entrust childcare to others, such as caregivers or other family members. In practice, not all caregivers understand the hygiene standards and appropriate care practices for infants. Simple mistakes, such as not cleaning milk bottles properly or providing food that is not prepared correctly, can create significant opportunities for diarrhea-causing bacteria to enter a child's body (Ernawati *et al.,* 2023). The study emphasizes the importance of working mothers continuing to educate caregivers on how to care for children hygienically for example, ensuring that bottles are cleaned with hot water before use, or making it a habit to prepare food for infants safely and cleanly. This can be an important preventive step in reducing the risk of diarrhea in children cared for by someone other than their mother. However, the study also found that mothers who do not work also have infants who suffer from diarrhea. Other factors cause this phenomenon, primarily family economic constraints. Homemakers with limited financial resources often lack access to information and health services. When a child experiences diarrhea, the typical response is to give medication from a local store without first consulting a health facility. Additionally, economic constraints lead to inadequate nutrient intake, thereby weakening children's immune systems and increasing their susceptibility to infections, including diarrhea. In such circumstances, economic barriers hinder the implementation of optimal care practices for infants (Ernawati *et al.,* 2023).

- Socioeconomic Factors Associated with Diarrhea in Infants.

Socioeconomic status has a significant influence on the health of young children, including the incidence of diarrhea. Household income adequacy is one of the leading indicators in determining parents' ability to meet their children's needs, both basic needs such as nutritious food, clean water, and sanitation, as well as additional needs such as access to health services and education on clean and healthy living behaviors (Ulpa *et al.,* 2018). When family income is sufficient, parents have greater flexibility in choosing more hygienic products and services. They can take appropriate preventive measures when their children show signs of illness. A study conducted at the Pakuan Baru Community Health Center in Jambi City in 2020 showed a significant relationship between family socioeconomic status and the incidence of diarrhea in infants. These findings indicate that families with low income tend to face barriers in preventing and addressing infectious diseases, including diarrhea. The implications of these results suggest that low income not only limits families' ability to meet their children's nutritional needs but also restricts access to adequate sanitation facilities, such as clean toilets and clean water, as well as access to formal healthcare services for treatment when children fall ill. In such conditions, self-medication by buying drugs indiscriminately or delays in seeking medical treatment are often standard practices. These results are reinforced by the findings of (Kurniawati & Astutik, 2023; Pramuja & Candrasari, 2024), which both show that children from families with low socioeconomic status are at higher risk of experiencing diarrhea. One of the causes is the living environment, which is not conducive to clean and healthy living practices, such as cramped houses without proper sewage systems or living in areas close to pollution sources. Additionally, the nutritional status of children from low-income families is often poorer due to limitations in providing sufficient and

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quality food. Poor nutrition weakens children's immune systems, making them more susceptible to diseases like diarrhea. Conversely, families with better socioeconomic status typically have access to healthier environments and adequate basic facilities. They are more likely to have access to clean water, private toilets, and maintain cleanliness in their surroundings, including food storage areas and livestock pens, if they have them. These conditions naturally reduce the risk of children being exposed to infectious agents that cause diarrhea.

Conclusion

This study aims to identify and examine various risk factors associated with diarrhea in toddlers. Based on an analysis of several literature and empirical studies, it was found that several main determinants are interrelated and significantly increase the vulnerability of toddlers to diarrhea. These factors include a lack of exclusive breastfeeding, poor personal hygiene, low access to clean water, inadequate sanitation facilities, inadequate waste and sewage management, and poor domestic sewage disposal. Additionally, low maternal education levels, maternal employment status that disrupts childcare patterns, and family socioeconomic limitations also increase the risk of diarrhea. These findings provide a comprehensive picture, showing that diarrhea in infants is influenced not only by biological factors but also by environmental, social, and behavioral conditions.

Scientifically, this study contributes to the expansion of our understanding of the complex, multifactorial relationship between diarrhea in infants. The originality of this study lies in its integrative and holistic approach, which combines biological, behavioral, social, and environmental aspects to provide a comprehensive understanding of the topic. Practically and managerially, the results of this study can serve as a basis for policymakers to formulate integrated intervention programs, such as improving health education for mothers, providing adequate sanitation at the household level, and strengthening health promotion and nutrition services. For health workers, the results of this study can serve as a reference for conducting more targeted promotive and preventive approaches.

The limitations of this study lie in the limited generalizability of the findings, as most of the literature reviewed was from specific regions in Indonesia with varying social and environmental characteristics. Additionally, this study did not delve deeply into cultural, psychological, and gender dynamics, which may also influence health practices within households. Therefore, it is recommended that future research adopt a qualitative or mixed-methods approach to explore mothers' and families' perspectives in a more contextualized manner. Further studies should also consider community-based intervention variables and cross-sectoral collaboration to provide more effective and applicable policy recommendations for preventing diarrhea in infants in a sustainable manner.

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APPENDIX

Table A1. Risk Factors Associated with Diarrhea in Infants.

Author's name, Year	Research Design	Sample	Purpose	Conclusion
Sari Komala, Yessi Marlina, Aslis Wirda Hayati, Yola Humaroh. (2023) (Komala *et al.*, 2023)	Cross-sectional	48 mothers with babies aged 6 to 24 months	Exploring the relationship between complementary food hygiene (MP-ASI) and maternal hygiene practices in relation to the incidence of diarrhea in young children in designated areas in community health centers.	This study concludes that there was an indication of diarrhea in 65% of cases, while the indicator for no diarrhea in children was 35%. It is recommended that community health centers increase their educational activities regarding risk factors for diarrhea in children under five years of age.
Rika Afriyani , Lilis Suryani , Ali Harokan. (2024) (Afriyani *et al.*, 2024)	Cross-sectional	90 mothers with infants aged 0-59 months	Analyzing cases of diarrhea in infants aged 0-59 months.	A relationship exists between parental education, nutritional status, hand washing habits, exclusive breastfeeding, access to clean water sources, and adequate sanitation facilities that can influence the incidence of diarrhea in children aged 0-59 months in the Jayapura Health Center area, Ogan Komering Ulu Timur District, in 2024. Among all these factors, the primary factor influencing the occurrence of diarrhea in young children in that area is the condition of household latrines.
Miftahatur Rizqiyah Kurniawati, Erni Astutik. (2023) (Kurniawati & Astutik, 2023)	IDHS two-stage sampling, proportional probability , then randomized in each cluster	13,830 women aged 15-49 with children under five years of age	To determine whether there is a relationship between the financial and social status of a family and the incidence of diarrhea in children under 5 years of age.	Children from families with low levels of education and socioeconomic status are at higher risk of diarrhea. Therefore, efforts to prevent and control diarrhea require improvements in economic welfare, quality of education, and community understanding, especially regarding children's health.
Jessica Florencia Angelina , Trilianty Lestarisa , Nawan.	cross sectional	61 mothers with toddlers	Investigating how environmental hygiene and maternal hygiene affect the incidence of diarrhea in young	Hand washing habits of mothers were found to be. A significant relationship was found between diarrhea and young children in Sungai Lunuk Village. On the other hand, the village's sewage

(2024). (Angelina & Lestarisa, 2024)			children in Sungai Lunuk Village, Murung Raya District. .	system did not meet the required standards, as no significant relationship was found between the sewage system and cases of diarrhea in young children in Sungai Lunuk Village.
Murdiyani , Purwati. (2024). (Suyanto, 2024)	retrospective case-control	Sampling was conducted using simple random sampling with a population of 970 toddlers.	Analyzing the Relationship between Exclusive Breastfeeding and the Frequency of Diarrhea in Toddlers in the Kesugihan I Community Health Center Area.	Based on the results of the chi-square test, exclusive breastfeeding was found to have a strong association with the occurrence of diarrhea in young children, with a p-value of 0.001 ($p < 0.05$). Therefore, children who did not receive exclusive breastfeeding were 3.631 times more likely to suffer from diarrhea compared to those who did receive exclusive breastfeeding. (p-value 0.001 OR 3.631 CI 1.915-6.886).
Abdi Rosianur Rahman, Meilya Farika Indah, Abdullah, (2020)	cross-sectional study	61 families with young children in Gambut Barat Village	Studying the relationship between access to clean drinking water, access to toilets, and diarrhea in young children.	Statistical analysis results indicate that in 2024, there is a clear relationship between the availability of clean water and family toilets and the likelihood of young children in Gambut Barat Village suffering from diarrhea. This is supported by the p-values ($p = 0.005$ for clean water and $p = 0.000$ for toilets) being below the significance level ($\alpha = 0.05$), which leads to the rejection of the null hypothesis (H0) and the acceptance of the alternative hypothesis (H1).
Ramona Agustiani Pramuja, Anika Candrasari, 2024 (Pramuja & Candrasari, 2024)	Cross-sectional.	30 patients with diarrhea and 30 patients without diarrhea.	Investigate the relationship between the occurrence of diarrhea and environmental and socioeconomic factors.	After analyzing and discussing the results, researchers have determined that water quality is closely related to the incidence of diarrhea. However, no relationship was found between environmental factors related to waste disposal facilities and the incidence of diarrhea. Additionally, a strong relationship exists between socioeconomic factors, such as income, and the incidence of

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				diarrhea. However, factors related to education do not appear to influence the incidence of diarrhea.
Nurul Fitriani, Armaidi Darmawan, Anggelia Puspasari, (2021) (Fitriani *et al.*, 2021)	control case	This study involved 100 children under the age of two. Half of the children experienced diarrhea, while the other half did not.	Understanding how factors such as exclusive breastfeeding, vaccination history, age and gender of the child, maternal hand hygiene practices, water supply, household sanitation facilities, maternal education and employment status, and socioeconomic status can influence the likelihood of diarrhea in young children.	The findings of this study indicate that infants aged 0–12 months who are not exclusively breastfed, are not fully vaccinated, have poor hand hygiene, use unsafe water sources, and have mothers with limited education and socioeconomic status are more likely to experience diarrhea. Further analysis reveals that poor handwashing practices and incomplete vaccination schedules are the primary causes of diarrhea in infants.
Wahyu Ernawati, Reffi Dhamayanti, Putu Monna Frisca Widiastini (2023) (Ernawati *et al.*, 2023)	cross sectional	In 2023 and 2024, a total of 310 mothers who brought their children to the Plaju Palembang Community Health Center were included in the research sample.	Investigating the relationship between the level of education and employment status of mothers in 2023 and the likelihood of young children suffering from diarrhea was studied at the Plaju Community Health Center.	Research conducted in 2023 at the Plaju Community Health Center examined the relationship between maternal education and employment, as well as the incidence of diarrhea in children. The results showed a clear relationship between these factors and the incidence of diarrhea. Statistical analysis using the Chi-square test yielded a p-value of 0.045, which is lower than the standard α value of 0.05. This suggests that maternal employment has a significant impact on the incidence of diarrhea among children in the Plaju Health Center's service area in 2023.
Agus Riyanto, 2023 (Riyanto, 2023)	control case	This study involved 44 young children, divided into 22 cases (young children with	To determine whether inadequate household sanitation can cause diarrhea in young children in Banjaran, Bandung Regency.	The lack of clean water sources, an inadequate number of toilets, and poor waste disposal methods are known to be factors contributing to diarrhea in young children. Therefore, it is recommended that the Bandung District Health Center enhance

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	diarrhea) and 22 controls (neighbors of cases without diarrhea) matched for gender and age with the cases.	its health education initiatives to increase public awareness of the importance of maintaining proper sanitation at home and preventing diarrhea in young children.