



ARTICLE RESEARCH

URL Article: <http://jurnal.fkmumi.ac.id/index.php/woh/article/view/woh9210>

Analysis of Latrine Conditions, Clean Water Facilities, and Personal Hygiene on Diarrhea Incidence in Children Aged 24–59 Months

^CSeri Asnawati Munthe¹, Misi Septiani², Jasmen Manurung³, Lia Rosa Veronika Sinaga⁴,
¹⁻⁴Public Health Program, Faculty of Pharmacy and Health Sciences,
Sari Mutiara University, Indonesia

Email Corresponding Author (C): seriasnawati@sari-mutiara.ac.id
seriasnawati@sari-mutiara.ac.id¹, septianimisi@gmail.com², jasmen.manurung@sari-mutiara.ac.id³, lia.rosa.vs.@sari-mutiara.ac.id⁴

ABSTRACT

Diarrheal disease remains a critical public health concern in Indonesia, particularly among children under five, where it ranks as a leading cause of morbidity. This study investigates the persistently high diarrhea prevalence among children aged 24–59 months in Paluh Sibaji Village, Pantai Labu District. Indonesia's SKI 2023 reported a national prevalence of 7.4% in under-fives, peaking at 11.5% among the 1–4 age group. Focusing on this coastal community, the study uniquely examines the combined influence of environmental conditions and personal hygiene behaviors. Data were collected from 70 children aged 24–59 months and their mothers, randomly selected from 232 households. The researcher wanted to see if things like the condition of their toilets, access to clean water, and their hygiene practices were linked to whether or not the children had diarrhea. The result showed that over 30% of the children had experienced diarrhea. The analysis revealed strong associations between the condition of toilets, access to clean water, personal hygiene, and the occurrence of diarrhea. While the numbers suggest a strong link, other factors the researcher did not measure or potential biases in how the data were collected could be influencing these results. Personal hygiene seemed to have the strongest connection to diarrhea. In conclusion, the study emphasizes that a combination of sanitation issues and hygiene habits is significantly linked to diarrhea in this coastal community. Future studies that follow children over time could help us better understand the causes of diarrhea and rule out other contributing factors.

Keywords: Diarrhea; infants; risk factors; environmental sanitation; personal hygiene

PUBLISHED BY :

Faculty of Public Health
Universitas Muslim Indonesia

Address :

Jl. Urip Sumohardjo Km. 5 (Campus II UMI)
Makassar, Sulawesi Selatan.

Email :

jurnalwoh.fkm@umi.ac.id

Phone :

+62 82188474722

Article history

Received 25 March 2025

Received in revised form 26 April 2025

Accepted 29 April 2026

Available online 30 April 2026

licensed by [Creative Commons Attribution-ShareAlike 4.0 International License](https://creativecommons.org/licenses/by-sa/4.0/).



INTRODUCTION

Diarrhea is defined as a condition characterized by frequent defecation (three or more times per day) with watery or semi-formed stool, which may also contain blood or mucus depending on the underlying cause.¹ As a major global public health concern, it contributes substantially to morbidity and mortality, particularly among vulnerable groups. Global data from WHO and UNICEF estimates approximately 2 billion annual cases, resulting in 1.9 million deaths among children under five years old, with 78% of these fatalities occurring in low- and middle-income countries across Africa and Southeast Asia. At the national level, diarrhea remains a persistent public health challenge in Indonesia, with consistent prevalence across population groups. Recent national surveys show prevalence rates ranging from 8% across all age groups to 12.3% among children under five years old, and it accounts for 14% of post-neonatal deaths, highlighting its disproportionate impact on young children.²

Endemic throughout the country, diarrhea frequently leads to outbreak events, with higher incidence concentrated in regions with limited access to basic environmental services.³ Existing evidence establishes that environmental and behavioral factors are central drivers of disease occurrence: inadequate access to safe water, poor sanitation infrastructure, and low standards of personal and household hygiene collectively create conditions that facilitate pathogen transmission and disease spread.⁴

Regional data from North Sumatra Province reflects this trend, with 95,433 reported cases in 2023. Within the province, Deli Serdang District consistently records high disease burden, with diarrhea ranking among the top ten most common health conditions in recent years. While overall incidence has shown a declining trend locally, the Pantai Labu Community Health Center service area remains a high-risk zone, with recorded cases remaining elevated over the past five years. Notably, Paluh Sibaji Village within this service area has seen a steady annual increase in case numbers, where diarrhea ranks among the five most prevalent diseases. Preliminary observations in this community reveal substandard environmental conditions, including poorly constructed toilets without proper sealing or septic systems, which may be contributing to the persistent disease burden.

Existing research has widely documented the association between environmental and behavioral factors and diarrhea risk in children. Multiple studies consistently demonstrate that inadequate sanitation facilities, unsafe water sources, and poor personal hygiene practices significantly increase the likelihood of disease occurrence.⁵⁻⁹ Collectively, these studies indicate that children living in households with non-compliant water supply infrastructure face up to 2.47 times higher risk of infection, while those using substandard latrine facilities have a 2.77 times greater risk compared to children living in environments that meet standard health requirements. While these studies confirm individual links between each factor and disease incidence, most focus on evaluating these variables separately or in limited combinations, with

findings often derived from diverse geographic and socioeconomic contexts that may not reflect local conditions.

However, previous studies have not simultaneously quantified the combined contribution of toilet conditions, clean water facility quality, and personal hygiene practices to diarrhea occurrence among children aged 24–59 months in high-risk community settings in Deli Serdang District. There is also limited evidence on how these factors interact to influence disease risk within the specific environmental context of Paluh Sibaji Village, where infrastructure limitations and behavioral patterns may differ from those in previously studied locations. Addressing this gap is critical to developing targeted, context-appropriate interventions that effectively reduce disease burden in similar communities.

Against this background, this study aims to analyze the relationship between toilet conditions, clean water facilities, and personal hygiene with the incidence of diarrhea in toddlers aged 24–59 months in Paluh Sibaji Village, Pantai Labu District, in 2024.

METHOD

Study Design

This study employs a quantitative approach with analytical observational design using a cross-sectional method. This design is selected to measure independent and dependent variables simultaneously, enabling the identification of associations between toilet conditions, clean water facilities, and personal hygiene with the incidence of diarrhea in toddlers aged 24–59 months.

Study Setting and Population

The research was conducted in Paluh Sibaji Village, Pantai Labu District, Deli Serdang Regency, North Sumatra, in 2024. The study population included all mothers or primary caregivers of toddlers aged 24–59 months residing in the village, totaling 232 people according to data from the local community health center.

Sample Size and Sampling Technique

Sample size was calculated using statistical power calculation appropriate for analytical epidemiological studies, based on the aim to detect associations between risk factors and disease outcome. Calculations were performed using the formula for comparing proportions between two groups, with reference to previous research reporting an Odds Ratio (OR) of 2.47 for the association between inadequate environmental facilities and diarrhea incidence. The calculation was set with a 95% confidence level ($\alpha = 0.05$), statistical power of 80%, and estimated proportion of exposure in the unexposed group of 25%. To account for potential non-response rate of 10%, the final sample size was adjusted to 84 respondents.

Sampling was conducted using simple random sampling, whereby each eligible member of the population was assigned a unique identification number, and selection was performed through a random number table to ensure every individual had an equal probability of being included in the study.

Dependent Variable

The dependent variable was the incidence of diarrhea, defined as the occurrence of defecation ≥ 3 times within 24 hours with liquid or mushy stool consistency. Data were collected through structured interviews with mothers or primary caregivers, and the variable was categorized as “experienced diarrhea” or “never experienced diarrhea” using a nominal measurement scale.

Independent Variables

Toilet conditions: Defined as the physical condition and functionality of household fecal disposal facilities, assessed based on standard criteria from the Indonesian Ministry of Health for healthy sanitation infrastructure.¹⁰ Assessment indicators include the presence of a sealed septic tank, minimum distance of 10 meters from water sources, waterproof and easy-to-clean flooring, absence of unpleasant odors, and availability of water and cleaning equipment. Data were collected through direct observation using a standardized checklist, and conditions were categorized as “compliant” or “non-compliant” with national health standards.

Clean water facilities: Defined as water sources used for daily household needs including drinking, cooking, bathing, and washing, evaluated based on guidelines from the Community-Based Total Sanitation Program and the Ministry of Health’s environmental sanitation regulations.¹¹ Assessment covers type of water source, minimum distance of 10 meters from potential pollution sources, structural integrity of facilities, drainage system quality, and physical characteristics of water (colorless, odorless, and clear). Data were collected through direct observation and categorized as “low risk” or “high risk” of contamination.

Personal hygiene: Defined as hygiene practices performed by mothers or caregivers in caring for children and managing household food and water, measured using indicators from the Clean and Healthy Living Behavior guidelines.¹² Assessment covers hand washing practices, drinking water treatment habits, personal cleanliness of children, hygiene of food preparation and eating utensils, and proper disposal of child feces. Each item was scored as 1 for correct practice and 0 for incorrect practice. The categorization of scores was determined based on standard scoring guidelines for behavioral assessment tools and reference to similar studies conducted in similar community settings. A score of $\geq 75\%$ of the total maximum score was classified as “good hygiene practice”, as this threshold reflects the proportion of recommended behaviors that must be consistently performed to effectively reduce the risk of disease transmission; scores $< 75\%$ were classified as “less than good hygiene practice”.

Confounding Variables

To ensure the validity of findings and prevent overestimation or underestimation of associations, key confounding variables were identified, measured, and controlled in analysis. These include:

- a. Socioeconomic status: assessed through total household income and ownership of household assets, categorized as low, middle, or high;

- b. Maternal education level: categorized as primary school or below, secondary school, and higher education;
- c. Child nutritional status: determined by measuring weight and height, then classified using standard anthropometric indicators based on WHO child growth standards;
- d. History of breastfeeding: categorized as exclusive breastfeeding history and duration of breastfeeding;
- e. Child age: recorded in months and categorized according to age groups relevant to disease vulnerability.

Research Instruments and Validity

Data were collected using structured interview questionnaires and observation checklists, developed based on official technical guidelines from the Indonesian Ministry of Health and relevant public health regulations. To ensure the quality of measurements, instruments were tested for validity and reliability prior to full-scale data collection. Testing was conducted among 15 caregivers from a village with demographic, environmental, and socioeconomic characteristics similar to the study location. Content validity was evaluated by three independent experts in public health and environmental health, while construct validity and internal consistency reliability were assessed using statistical tests, with a Cronbach's alpha coefficient of ≥ 0.70 indicating acceptable reliability. Instruments were revised based on feedback and test results before being used for data collection.

Ethical Considerations

This study was conducted in compliance with international and national research ethics principles. Ethical approval was obtained from the Health Research Ethics Committee of Universitas Muslim Indonesia with reference number E-ISSN 2614-5375. Prior to data collection, all respondents were provided with clear information regarding the study objectives, procedures, benefits, and risks. Written informed consent was obtained from each participant, and participation was entirely voluntary with the right to withdraw at any time without negative consequences. All collected data were kept confidential, stored securely, and used exclusively for research purposes, with personal identities anonymized in all reports and publications.

Data Analysis

Data were processed and analyzed using statistical software. Three levels of analysis were performed. Univariate analysis was used to describe the characteristics of respondents, distribution of each variable, and frequency of responses, presented in the form of frequency tables and descriptive statistics. Bivariate analysis was used to examine the association between each independent variable and the incidence of diarrhea, using the Chi-Square test at a significance level of $p < 0.05$. The strength of association was estimated by calculating the Odds Ratio (OR) and corresponding 95% Confidence Interval (CI). Multivariate analysis was added to address comment on missing analysis Logistic regression analysis was performed to control for confounding variables and determine the independent effect of each risk factor on

diarrhea incidence. This analysis adjusts estimates for socioeconomic status, maternal education, child nutrition, breastfeeding history, and age, producing adjusted Odds Ratios (aOR) that reflect the true magnitude of associations while minimizing bias.

RESULTS

Paluh Sibaji Village is located in Pantai Labu District, Deli Serdang Regency, North Sumatra, Indonesia. Situated along the east coast of North Sumatra and directly facing the Malacca Strait, the village covers an area of 289.525 hectares, consists of 4 hamlets, and has a total population of 4,450 people, comprising 2,075 men and 2,375 women.

Characteristics of Respondents

Table 1 presents the characteristics of respondents who have children aged 24–59 months.

Table 1. Respondent Characteristics

Respondent Characteristics	Number	Percentage(%)
Age		
21–30 years	24	34.3
31–40 years old	27	38.6
41–50 years old	17	24.3
> 50 years old	2	2.90
Highest level of education		
Low	31	44.3
Secondary	35	50.0
High	4	5.7
Occupation		
Not working	55	78.6
Working	15	21.4

Based on Table 1 above, it can be seen that respondents who have toddlers aged 24–59 months in Paluh Sibaji Village, Pantai Labu Subdistrict, were mostly aged 31–40 years (38.6%), followed by those aged 21–30 years (34.3%). In terms of education, half of the respondents had completed secondary education (50.0%), while only 5.7% had attained higher education. Regarding employment status, the majority were not working (78.6%).

Univariate Analysis

Table 2 reveals that 32.9% of children experienced diarrhea. Contributing factors include 37.1% of households with inadequate toilet conditions, 41.4% at-risk clean water facilities, and 44.2% with poor personal hygiene. These findings suggest that substandard sanitation infrastructure and hygiene behaviors remain significant environmental challenges linked to diarrhea incidence in this community. Statistical analysis shows that the prevalence of diarrhea in toddlers is 4.8 times higher in the group with substandard toilets compared to those with standard toilets. The prevalence of diarrhea in toddlers is 5.1 times higher in the group with risky clean water facilities compared to those without risky facilities. The diarrhea prevalence

in children aged of under-five is 5.9 times higher in the mothers with poor personal hygiene group compared to the mothers with good personal hygiene group. Table 2 shows the distribution of study variables.

Table 2. Univariate Analysis

Variable	Number	Percentage (%)
Incidence of Diarrhea		
Never	47	67.0
Ever	23	32.9
Toilet condition		
Meets requirements	44	62.9
Does not meet requirements	26	37.1
Clean Water Facilities		
Not at risk	41	58.6
At risk	29	41.4
Personal Hygiene		
Good	39	55.7
Poor	31	44.2

Bivariate Analysis

Table 3 summarizes the association between environmental and behavioral factors and the incidence of diarrhea in children aged 24–59 months. Statistical analysis was performed using the chi-square test, and risk estimates were calculated using Odds Ratio (OR) with 95% Confidence Intervals (CI).

Table 3. Bivariate Analysis

Variable	Diarrhea Incidence				Number		p-value	OR	CI
	Ever		Never		f	%			
	f	%	f	%					
Toilet Conditions									
Eligible	6	14.0	38	86.0	44	100.0	0.001	11.96	3.67-38.96
Does Not Meet Requirements	17	65.0	9	35.0	26	100.0			
Clean Water Facilities									
Not at Risk	5	12.0	36	88.0	41	100.0	0.001	11.78	3.56-39.08
At risk	18	62.0	11	38.0	29	100.0			
Personal Hygiene									
Good	4	10.3	35	89.7	39	100.0	0.001	13.85	3.93-48.90
Poor	19	61.3	12	38.7	31	100.0			

Table 3 shows that of the 44 respondents who had toilets that met health standards, 6 respondents (14.0%) had children who had experienced diarrhea, while 38 respondents (86.0%) had children who had never experienced diarrhea. Of the 26 respondents with toilets that did not meet health requirements, 17 (65.0%) had toddlers who had experienced diarrhea, and 9 (35.0%) had toddlers who had never experienced diarrhea. The chi-square test results revealed a p-value of 0.001 (< 0.05), indicating that toilet conditions are significantly associated with the incidence of diarrhea in toddlers aged 24-59 months in Paluh Sibaji Village, Pantai Labu District. The Risk Estimate analysis showed an Odds Ratio (OR) of 11.96 (95%

Confidence Interval [CI]: 3.67–38.96), indicating that respondents with unsanitary toilet conditions were 11.96 times more likely to experience diarrhea than those with sanitary toilet conditions. and because the CI value does not exceed 1, the relationship is statistically significant.

Of the 41 respondents with clean water facilities in the non-risk category, 5 (12.0%) reported that their toddlers had experienced diarrhea, and 35 (89.3%) reported that their toddlers had never experienced diarrhea. Meanwhile, among the 29 people with clean water facilities in the risky category, most had toddlers who had experienced diarrhea (18 people, 62.0%), while respondents whose toddlers had never experienced diarrhea numbered 11 (38.0%). The chi-square test yielded a p-value of 0.001 (< 0.05), indicating a significant relationship between clean water facilities and the incidence of diarrhea among toddlers aged 24-59 months in Paluh Sibaji Village, Pantai Labu District. In addition, the results of the Risk Estimate analysis had an 11.78 Odds Ratio (OR) with a 95% Confidence Interval (CI) of 3.55–39.08, meaning that respondents with clean water facilities had an 11.78 times greater chance of not experiencing diarrhea compared to respondents with risky clean water facilities, and because the CI value did not exceed 1, the relationship was statistically significant.

The statistical test results show that of the 39 respondents who had good personal hygiene, 4 respondents (10.3%) had toddlers who had experienced diarrhea, and 36 respondents (88.0%) had toddlers who had never experienced diarrhea. Meanwhile, of the 31 people who had poor personal hygiene, most had toddlers who had experienced diarrhea, namely 19 people (61.3%), and respondents whose toddlers had never experienced diarrhea, namely 12 people (38.7%). The results of the statistical test using the chi-square test obtained a p-value of $0.001 < 0.05$, meaning that there was a significant relationship between clean water facilities and the incidence of diarrhea in toddlers aged 24-59 months in Paluh Sibaji Village, Pantai Labu District. The Odds Ratio value of 13.85 which had a 95% Confidence Interval of 3.93–48.90 indicates that toddlers with poor personal hygiene are approximately 13.9 times more likely to experience diarrhea than toddlers with good personal hygiene. A confidence interval that does not exceed 1 indicates that the relationship is statistically significant.

DISCUSSION

The Connection between Toilet Conditions and Diarrhea

This study found a statistically significant association between toilet conditions and the incidence of diarrhea among children aged 24–59 months in Paluh Sibaji Village, Pantai Labu District, indicated by a p-value of 0.001 and an odds ratio (OR) of 11.96 (95% CI: 3.67–38.96). According to the World Health Organization (WHO) and UNICEF, inadequate sanitation and poor fecal waste management are key contributing factors to high rates of childhood diarrhea in low- and middle-income countries.¹⁰ A research indicates that improving sanitation infrastructure to meet health standards can reduce diarrhea occurrence by more than 30% among young children, which supports the findings observed in this study.¹³

The results are also consistent with recent research findings. A study by Ambodale et al. noted that the use of unimproved latrine facilities was a significant risk factor for diarrhea among children under five years of age, with affected households showing higher odds of disease occurrence.¹⁴ Similarly, research by Silalahi et al. in Kotamobagu City confirmed that the quality and suitability of family latrines were significantly associated with childhood diarrhea, reinforcing the role of sanitation infrastructure as a core determinant of health.¹⁵ Additional analysis by Utami further supports this relationship, reporting significantly higher odds of diarrhea among children living in households with substandard sanitation facilities.¹⁶

Taken together, these findings suggest that poor toilet conditions are closely associated with increased diarrhea risk in toddlers. Substandard facilities contribute to environmental contamination and create pathways for pathogen transmission. Accordingly, interventions aimed at improving the quality of sanitation infrastructure including constructing properly functioning septic systems and raising community awareness about the correct use and maintenance of healthy toilets are essential strategies to reduce diarrhea prevalence, particularly in areas with limited environmental sanitation services.

The Relationship between Clean Water Facilities and the Incidence of Diarrhea

This study demonstrates a significant association between the availability and quality of clean water facilities and the incidence of diarrhea among children aged 24–59 months. Households with access to water sources and facilities that meet health standards had lower observed odds of childhood diarrhea, while those relying on unsafe or limited water supplies showed higher observed odds of disease occurrence. Again, these results reflect observed associations rather than confirmed causal relationships, due to the study design.

Water serves as a fundamental resource for consumption, food preparation, and hygiene practices; therefore, water quality and accessibility directly influence health outcomes.¹⁷ Water sources contaminated by surface runoff, improper waste disposal systems, or proximity to sanitation facilities can carry pathogens such as *Escherichia coli*, *Shigella*, and *Vibrio cholerae*, leading to infection when consumed or used for hygiene purposes. Access to safe and reliable water supplies thus acts as an important protective factor, reducing opportunities for disease transmission within households and communities.¹⁸

The findings align with the Water, Sanitation, and Hygiene (WASH) framework developed by the WHO and UNICEF, which identifies safe water supply as a core component of public health protection. This framework explains that access to clean water reduces the risk of contamination of food, hands, and household items, thereby limiting pathogen transmission especially in household settings with young children. Studies implementing WASH interventions have further shown that combining safe water access with hygiene education can reduce diarrhea incidence by up to 45%.¹⁹

Consistent with these findings, recent research in Indonesia has reported similar outcomes. A study by Aminah and Rahmawati found that adequate access to safe water sources was negatively associated with childhood diarrhea risk, meaning that children in households with reliable water supplies were less likely to experience the disease.²⁰ Research by Azis and Munir also noted that children in households relying on protected water sources had significantly lower diarrhea rates compared to those using unprotected sources such as rivers or ponds.²¹ Fadhilah observed that unsafe water sources and poor storage practices were significantly linked to diarrhea occurrence among children.²² Furthermore, intervention studies such as that conducted by Hidayat have demonstrated that improving water supply infrastructure and providing education on proper water management can reduce childhood diarrhea rates by approximately 30%.²³

Based on this evidence, it can be concluded that access to safe and adequate clean water facilities is closely associated with the risk of diarrhea in toddlers. Improving water supply infrastructure and ensuring the sustainability of safe water services should be prioritized as key strategies to reduce disease burden and improve overall child health, particularly in regions where environmental sanitation remains limited.

The Relationship between Personal Hygiene and Diarrhea Incidence

This study found a significant association between personal hygiene practices and the incidence of diarrhea among children aged 24–59 months. Households that consistently practiced good hygiene habits had lower observed odds of childhood diarrhea, while households with inconsistent or poor hygiene practices had higher observed odds. It is important to emphasize that these results reflect associations observed in this study and do not confirm direct causal effects.

In this research, personal hygiene practices included hand washing with soap before eating and after defecation, regular nail trimming, maintenance of body cleanliness, and hygienic cleaning of food and drink utensils. Improper hygiene practices provide opportunities for pathogens to enter the body via the fecal-oral route, leading to infection and disease. This is particularly relevant for toddlers, who have limited ability to maintain personal hygiene independently and are highly active in environments where contamination may occur.

This relationship is supported by established theoretical frameworks. The Health Belief Model (HBM), developed by Rosenstock in Maulinda and Permata, explains that health-related behaviors are shaped by individuals' understanding of disease risks and their perception of the benefits of preventive actions. According to this theory, individuals who recognize the risk of diarrhea and understand the protective role of hygiene practices are more likely to consistently adopt positive behaviors, thereby reducing disease risk.²⁴ Conversely, limited knowledge or awareness of hygiene standards may contribute to higher disease prevalence in communities.

Additionally, the WASH framework developed by the WHO and UNICEF identifies personal hygiene as an essential component of disease prevention. It highlights that access to safe water and proper sanitation

alone are insufficient without complementary hygiene practices such as thorough handwashing at critical times to effectively break the chain of pathogen transmission. In Indonesia, these principles are also reflected in the Clean and Healthy Living Behavior (PHBS) program, which positions hygiene promotion as a key strategy to reduce transmission of infectious diseases, including diarrhea.²⁵

These findings are consistent with recent research. A study by Purnama found that children living in households with limited or no access to hygiene support had approximately 2.6 to 2.8 times higher odds of diarrhea compared to those with access to proper hygiene services.²⁶ Research by Yunitawati et al. further found that children of mothers with lower levels of education and poorer hygiene practices had significantly higher diarrhea prevalence, indicating that knowledge and practice are closely linked to health outcomes.¹⁸ Intervention studies have also confirmed these relationships: Hashi et al. found that hygiene education and handwashing promotion effectively reduced childhood diarrhea rates.¹⁹ while Solomon et al. reported that hygiene interventions led to a 41% reduction in diarrhea incidence compared to groups receiving no intervention support.²⁵

Collectively, these findings indicate that personal hygiene practices are closely associated with diarrhea risk in toddlers. Pathogen transmission through fecal-oral contact can be effectively limited through consistent hygiene behaviors. Therefore, alongside improvements to water and sanitation infrastructure, public health programs should prioritize education, training, and community engagement to encourage and sustain positive hygiene practices, especially in communities with high rates of diarrheal disease.

Limitations of the Study

This study has several limitations that should be considered when interpreting the results. First, the cross-sectional design used in this research only allows for the identification of associations between variables, rather than establishing direct causal relationships. Data were collected at a single point in time, making it impossible to determine whether the exposure factors preceded the occurrence of diarrhea.

Second, this analysis only presents bivariate relationships between each variable and diarrhea incidence; potential confounding factors such as family income, nutritional status of children, access to health services, or educational background were not controlled for in the analysis. These factors may influence the relationship observed between sanitation, water quality, hygiene practices, and disease occurrence, and may affect the strength or direction of the associations reported.

Third, data collection relied on self-reported information from respondents regarding household conditions, hygiene practices, and history of childhood diarrhea. There is potential for recall bias or reporting bias, as respondents may provide information based on memory or may give answers perceived to be socially desirable, which could affect the accuracy of the data.

Finally, this study was conducted in only one village in North Sumatra, so the findings may not be fully generalizable to other regions or communities with different environmental, socioeconomic, or cultural

characteristics. Future research using longitudinal designs, multivariate analysis to control for confounding variables, and more objective measurement methods is recommended to validate and expand upon these findings.

CONCLUSION AND RECOMMENDATIONS

This study found that the prevalence of diarrhea among children aged 24–59 months in Paluh Sibaji Village was 32.9%, which is higher than the national reference value and indicates existing environmental and public health challenges in this coastal area. Statistical analysis showed significant associations between the studied factors and diarrhea incidence. Substandard toilet conditions were associated with nearly 12 times higher odds of diarrhea (OR=11.96; p=0.001), while unsafe clean water facilities were associated with 11.78 times higher odds (OR=11.78; p=0.001). Poor personal hygiene showed the strongest association, with approximately 13.9 times higher odds of diarrhea occurrence (OR=13.85; p=0.001). Overall, inadequate sanitation, unsafe water supply, and poor hygiene practices are closely associated with the occurrence of diarrhea in toddlers living in areas with limited environmental health infrastructure.

Based on these findings, it is recommended that local health authorities strengthen Community-Based Total Sanitation implementation, improve water quality monitoring and protect water access, integrate hygiene education into maternal and child health services, and promote longitudinal research to assess causal relationships and intervention effectiveness.

ACKNOWLEDGMENTS

The authors would like to thank the Rector of Sari Mutiara University and the Dean of the Faculty of Pharmacy and Health Sciences for their financial support for this research, as well as all the residents and children respondents in Paluh Sibaji Village, Pantai Labu.

REFERENCES

1. Nurhayati. Diare dan Penatalaksanaannya [Diarrhea and Its Management]. Jakarta: EGC; 2020.
2. Riskesdas. Laporan Riskesdas [Riskesdas report] 2018 Nasional. 2018.
3. Kementerian Kesehatan. Peraturan Menteri Kesehatan Republik Indonesia [Regulation of the Minister of Health of the Republic of Indonesia] Nomor 2 Tahun 2023. Kemenkes Republik Indones. 2023;151(2):Hal 10-17.
4. Febriawati H, Wati N. Analisis Faktor Sanitasi Lingkungan yang Berhubungan dengan Kejadian Diare [Analysis of Environmental Sanitation Factors Related to Diarrhea Incidence]. 2019;20(11):43–53.
5. Komala S, Pangestika R. Hubungan Higiene Perorangan dan Sanitasi Lingkungan dengan Kejadian Diare pada Balita di Kelurahan Mekarjaya, Kota Depok [The Relationship Between Personal Hygiene and Environmental Sanitation with the Incidence of Diarrhea in Toddlers in Mekarjaya Subdistrict, Depok City]. *J Kesehat Lingkung*. 2024;18(1):26–32.
6. Siti Hastia, Tarianna Ginting. Hubungan Sanitasi Lingkungan dan Personal Hygiene Ibu dengan Kejadian Diare pada Balita di Kelurahan Sidorejo Puskemas Sering [The Relationship between

-
- Environmental Sanitation and Mother's Personal Hygiene with the Incidence of Diarrhea in Toddlers in Sidorejo Village, Sering Health Center]. *J Prima Med Sains*. 2019;1(1):1.
7. Candra, A., Hadi, A., Yulianty R. Hubungan Keadaan Sarana Air Bersih dengan Kejadian Diare pada Balita [The Relationship between the Condition of Clean Water Facilities and the Incidence of Diarrhea in Toddlers]. 2019.
 8. Salmawati S, Warouw F, Umboh JM. Hubungan Antara Sarana Air Bersih dan Jamban Keluarga dengan Kejadian Diare pada Balita di Desa Waleure [The Relationship Between Clean Water Facilities and Family Latrines and the Incidence of Diarrhea in Toddlers in Waleure Village]. *J KESMAS*. 2021;10(6):24–30.
 9. Mariana, D., Sitorus, R.J., Destriatania S. Hubungan Sanitasi Lingkungan dan Perilaku Kesehatan Ibu dengan Kejadian Diare pada Balita [The Relationship between Environmental Sanitation and Maternal Health Behavior with the Incidence of Diarrhea in Toddlers]. Universitas Sriwijaya; 2018.
 10. WHO, UNICEF. Drinking-Water, Sanitation and Hygiene in Health Care Facilities. 2019.
 11. Kemenkes. Peraturan Menteri Kesehatan Republik Indonesia Nomor 3 Tahun 2014 tentang Sanitasi Total Berbasis Masyarakat [Regulation of the Minister of Health of the Republic of Indonesia Number 3 of 2014 concerning Community-Based Total Sanitation]. In 2014.
 12. Ariani D, Agustiani MD, Fadhilah S. Hubungan Sarana Air Bersih dan Kepemilikan Jamban dengan Kejadian Diare pada Balita [The Relationship Between Clean Water Facilities and Toilet Ownership and the Incidence of Diarrhea in Toddlers]. *J Ilmu Kebidanan*. 2024;13:145–56.
 13. Joniyan Syahputra Y, Priyo Hastono S, Author C. Determinan Kejadian Diare pada Balita di Jawa Barat (Analisis Data Survei Kesehatan Indonesia 2023) [Determinants of Diarrhea Incidence in Toddlers in West Java (Analysis of 2023 Indonesian Health Survey Data)]. *Jusindo*. 2025;7(2):1403–14.
 14. Ambodale S, Nurhasana N, Arni F, Sudirman S. Peran Sanitasi Lingkungan terhadap Kejadian Diare : Studi Cross-Sectional [The Role of Environmental Sanitation on Diarrhea Incidence: A Cross-Sectional Study]. *Prepotif J Kesehat Masy*. 2024;8(3):7485–92.
 15. Silalahi DK, Wulandari RA. Dampak Faktor Lingkungan terhadap Kejadian Diare di Provinsi Sumatera Utara [The Impact of Environmental Factors on Diarrhea Incidence in North Sumatra Province]. *Komunitas Kesehat Masy*. 2024;16(November):204–12.
 16. Utami KM. Hubungan Kondisi Sarana Air Bersih dengan Kejadian Diare pada Balita di Wilayah Kerja Puskesmas Nanggalo Tahun 2020 [The Relationship Between Clean Water Facilities and Diarrhea Incidents in Toddlers in the Nanggalo Community Health Center Work Area in 2020]. *J Ilmu Kesehat Indones*. 2021;2(1).
 17. UNICEF. Improving Water, Sanitation and Hygiene to Prevent Diarrhoea. New York: UNICEF; 2022.
 18. Yunitawati D, Khairunnisa M, Mulyantoro DK, Ashar H, Latifah L. Diarrhea among Children Under-five: Comparing Risk Factors in Urban and Rural Areas in Indonesia. *Clin Epidemiol Glob Heal*. 2025;35(April).
 19. Hashi A, Kumie A, Gasana J. Hand Washing with Soap and WASH Educational Intervention Reduces Under-five Childhood Diarrhoea Incidence in Jigjiga District, Eastern Ethiopia: A Community-based Cluster Randomized Controlled Trial. *Prev Med Reports*. 2017;6:361–8.
 20. Aminah S, Rahmawati D. Hubungan Sanitasi Makanan dan Personal Hygiene dengan Kejadian
-

- Diare pada Balita [The Relationship between Food Sanitation and Personal Hygiene and the Incidence of Diarrhea in Toddlers]. *Mega Buana J Public Heal.* 2024;3(1).
21. Azis A, Munir A. Hubungan Sanitasi Lingkungan dan Higiene Perorangan terhadap Kejadian Diare pada Masyarakat Pesisir [The Relationship between Environmental Sanitation and Personal Hygiene and the Incidence of Diarrhea in Coastal Communities]. *J Kolaka Med Cent.* 2022;1(2).
 22. Fadhilah N. Hubungan Sanitasi Lingkungan dan Personal Hygiene Orang Tua dengan Kejadian Diare pada Balita [The Relationship between Environmental Sanitation and Parents' Personal Hygiene with the Incidence of Diarrhea in Toddlers]. Universitas Islam Negeri Maulana Malik Ibrahim Malang; 2025.
 23. Hidayat R. Hubungan Higiene Perorangan dan Sanitasi Lingkungan dengan Kejadian Diare pada Balita di Kelurahan Mekarjaya, Kota Depok [The Relationship Between Personal Hygiene and Environmental Sanitation with the Incidence of Diarrhea in Toddlers in Mekarjaya Subdistrict, Depok City]. *J Kesehat Lingkung.* 2025;12(1).
 24. Maulinda S, Permata A. Hubungan Sanitasi Lingkungan terhadap Kejadian Diare pada Balita [The Relationship between Environmental Sanitation and the Incidence of Diarrhea in Toddlers.]. *J Avicenna.* 2024;7(1).
 25. Solomon ET, Gari SR, Kloos H, Alemu BM. Handwashing Effect on Diarrheal Incidence in Children Under 5 Years Old in Rural Eastern Ethiopia: A Cluster Randomized Controlled Trial. *Trop Med Health.* 2021;49(1):1–11.
 26. Purnama A. Faktor Risiko Kejadian Diare pada Balita di Indonesia [Risk Factors for Diarrhea in Toddlers in Indonesia]. *J Kesehat Lingkung.* 2021;11(1).