

## The Relationship Between Clean Water Quality and Household Sanitation with the Incidence of Diarrhea in Toddlers

Samuel<sup>✉ 1</sup>, Retni<sup>2</sup>, Wulandari

Samuel@poltekkestasikmalaya.ac.id

DIII Nutrition Study Program Poltekkes Kemenkes, Tasikmalaya, Indonesia<sup>1</sup>  
Public Health Study Program, Universitas Dehasen, Kota Bengkulu, Indonesia<sup>2,3</sup>

### Abstract

Diarrhea in toddlers remains a major health problem in coastal areas of Indonesia, closely related to environmental determinants. The coastal area of Kualo Beach, Bengkulu Market, has specific environmental and demographic characteristics that require empirical studies to support health interventions. Objective: This study aims to analyze the relationship between clean water quality and household sanitation with the incidence of diarrhea in toddlers in the coastal area of Kualo Beach. This observational analytical study uses a cross-sectional design involving 100 toddler households selected through purposive sampling. Research instruments included questionnaires, sanitation observation sheets, and E. coli laboratory tests on drinking water. Data analysis used the Chi-Square test. Results showed a prevalence of diarrhea in children aged under five years of 35%. Laboratory results showed that 60% of drinking water samples were positive for E. coli contamination, and 55% of households had poor sanitation. Statistical tests showed a significant relationship between drinking water quality ( $p < 0.001$ ) and sanitation conditions ( $p = 0.002$ ) with the incidence of diarrhea. Conclusion: Poor microbiological water quality and inadequate household sanitation are significant risk factors for diarrhea in Kualo Beach. An integrated approach that includes improvements in clean water facilities, sanitation, and hygiene education is urgently needed.


**Keywords:** Diarrhea, Toddlers, Water Quality, E. coli, Sanitation, Coastal Areas.

Histori Artikel : Submit : 13 January 2026 Accepted : 26 February 2026 Publish : 28 February 2026

Doi : <https://doi.org/10.64146/37nf3m92>

### How to cite this article:

Samuel, Retni, & Wulandari. (2025). The Relationship Between Clean Water Quality and Household Sanitation with the Incidence of Diarrhea in Toddlers. *Health Smart : Jurnal Kesehatan Masyarakat*, 2(1), 14-27. <https://doi.org/10.64146/37nf3m92>

Copyright (c) 2026  e-issn: 3110-2131

<sup>✉</sup> Corresponding author:

Email Address: Samuel@poltekkestasikmalaya.ac.id(Samuel)

## INTRODUCTION

Diarrhea in toddlers remains a significant public health problem in many regions of Indonesia, including densely populated coastal cities such as Bengkulu. The Ministry of Health and previous studies have confirmed that diarrhea in toddlers is related to environmental and domestic behavioral factors, particularly the quality of drinking water and household sanitation. Various studies have shown that factors such as drinking water sources, microbiological contamination (e.g.,

coliform/E. coli), and limited sanitation infrastructure contribute to the incidence of diarrhea in toddlers, both in general and in specific local contexts (Arsyina et al., 2019; Fauzi & Sari, 2020; Fitrizah, 2020). Research that assesses environmental factors more broadly also finds that basic sanitation conditions, housewives' hygiene-related behaviors, and the provision of toilets have a significant relationship with the incidence of diarrhea in toddlers in several coastal and urban areas of Bengkulu (Rukmana et al., 2020). Sustained health education and promotion of healthy lifestyles have also been identified as key components in preventing diarrhea in toddlers in coastal contexts (Editia, 2023).

Promotion of Clean and Healthy Living Behaviors (PHBS) and family education related to oral health and hygiene play an important role in reducing cases of diarrhea in toddlers (Editia, 2023; D. K. Sari & Nurrohmah, 2019; I. P. Sari & Utami, 2022). The quality of household drinking water and sanitation/hygiene practices at the household level remain important focuses for reducing diarrhea morbidity in infants in coastal areas (Arsyina et al., 2019; Fitrizah, 2020).

The quality of drinking water and sanitation as major determinants of diarrhea has been proven through various local studies. Research linking drinking water quality to coliform or total coliform contamination shows that the quality of household water sources is a major risk factor for diarrhea in toddlers, as exposure to pathogens can occur through water that does not meet hygiene standards (Pangestu & Dimjati Lusno, 2025). Another study in Bengkulu shows that the provision of clean water and household sanitation practices/behaviors are directly associated with the incidence of diarrhea in toddlers in the local health center's working area, confirming that access to clean water and proper sanitation is a prerequisite for mitigating the risk of diarrhea in coastal communities (Fauzi & Sari, 2020; Yuliana, 2025).

Densely populated coastal communities with distinctive socioeconomic and environmental characteristics, such as Kualo Beach, have been relatively under-explored empirically in studies examining the relationship between clean water quality, household sanitation, and the incidence of diarrhea in toddlers. Although there are regional studies that map the determinants of diarrhea in toddlers in Bengkulu (e.g., the city of Bengkulu and its surroundings) and the relationship between water quality and sanitation practices, the focus of these studies is often limited to one dimension (clean water or sanitation) or does not explicitly assess the context of urban coastal ecosystems with their unique socio-economic dynamics (Fauzi & Sari, 2020; Fitrizah, 2020; Rukmana et al., 2020)

Local studies integrating microbiological quality analysis of household drinking water with observations of sanitation practices in the context of Bengkulu have emerged in certain regional

research (e.g., the coastal area of Bengkulu City), but comparative studies examining the relationship between the two comprehensively at the micro-household level in urban coastal ecosystems are still rare (Fauzi & Sari, 2020; Fitrizah, 2020). The uniqueness of Kualo Beach as a coastal area within the Bengkulu Market area, with its dense population dynamics, distinctive socioeconomic details, and coastal physical environment that has the potential to modulate environmental health risks, provides an opportunity to test a more integrated hypothesis regarding how microbiological drinking water quality and household sanitation practices together shape the incidence of diarrhea in toddlers.

Methodologically, many previous studies tend to analyze drinking water quality or sanitation separately, or assess both in an unintegrated manner within a single analytical framework. Studies that integrate the analysis of household drinking water microbiological quality with simultaneous observation of sanitation and hygiene practices in coastal contexts are still relatively rare and methodologically under-tested, requiring an approach that combines laboratory measurements (e.g., *E. coli*/coliform tests) with observations and structured questionnaires at the household level to reveal the dynamic relationship between the household environment and the incidence of diarrhea in toddlers (Arsyina et al., 2019; Fitrizah, 2020; Pangestu & Dimjati Lusno, 2025).

This integrated approach is important for assessing how variables moderate each other (e.g., microbiological drinking water quality interacts with compliance with sanitation and hygiene practices) in the context of urban coastal ecosystems that have unique socioeconomic and environmental characteristics, a need that is explicitly recognized in national and regional literature (Fauzi & Sari, 2020; Fitrizah, 2020; I. P. Sari & Utami, 2022).

An integrated analysis of water quality variables (through *E. coli* laboratory testing) and sanitation-behavior variables (through structured questionnaires and observation) at the micro level of households in an urban coastal ecosystem that has not been extensively researched. This study not only confirms the relationship between clean water quality, sanitation, and the incidence of diarrhea in toddlers, but also provides location-specific empirical evidence that can be used as a basis for formulating more targeted public health interventions for coastal communities. The literature supports that drinking water quality and sanitation are important determinants of diarrhea in young children in Indonesian contexts, including the Bengkulu region, with various studies showing a relationship between access to clean water, environmental hygiene, and sanitation behavior with the incidence of diarrhea in young children (Arsyina et al., 2019; Fauzi & Sari, 2020; Rukmana et al., 2020) and that

Laboratory reporting related to indicator bacteria such as *E. coli* is key to accurately assessing water quality. Therefore, the objective of this study is to analyze the relationship between clean water

quality and household sanitation with the incidence of diarrhea in toddlers in the coastal area of Kualo Beach, Bengkulu Market, through an integrated approach that combines household drinking water microbiological testing (*E. coli*) with observations of sanitation and hygiene practices, as well as measurements of local socioeconomic variables. Through this design, the study is expected to not only confirm the general relationship, but also provide location-specific empirical evidence that can be used as a basis for formulating more appropriate coastal community health interventions.

## **METHODOLOGY**

### **Research Design**

This study used an observational analytical study design with a cross-sectional approach. This design was chosen to analyze the relationship between independent variables (clean water quality and household sanitation) and dependent variables (incidence of diarrhea in toddlers) measured simultaneously at one point in time. This approach is relevant for testing hypotheses regarding risk factors at the micro level of households in the coastal community of Kualo Beach.

### **Research Location and Time**

This study was conducted in the coastal area of Kualo Beach, which is administratively part of the working area of Pasar Bengkulu sub-district, Bengkulu City. This location was chosen based on its characteristics as a densely populated coastal area with unique socio-economic dynamics, where comprehensive studies integrating water quality and sanitation are still limited. This study will be conducted from January to March 2025.

### **Research Objectives**

The target population in this study includes all households with children under five years of age (toddlers) residing in the coastal area of Kualo Beach. The research sample was taken from a portion of the target population that met certain inclusion and exclusion criteria through purposive sampling. The inclusion criteria are households with at least one toddler aged 12-59 months, who have lived in the research location for at least the last six months, and parents or guardians who are willing to be respondents by signing an informed consent form.

This study established exclusion criteria for toddlers with a history of chronic diseases or congenital disorders of the digestive system, as well as households that objected to the collection of drinking water samples for laboratory testing. To determine a representative sample size, the sample size was calculated using a proportion estimation formula for an unknown population, with a confidence level of 95% and a margin of error of 5%.

### **Data Collection Techniques and Instruments**

The data collection process in this study was carried out through an integrated approach that combined several main methods to obtain comprehensive data. First, a structured questionnaire was used to collect demographic data on respondents, history of diarrhea in toddlers during a certain period, and in-depth information on maternal hygiene practices. Second, direct observation was conducted using observation sheets to assess household sanitation conditions, including the availability and type of toilets, sewage systems, and household waste management systems.

Primary data from respondents and physical observations, this study also involved laboratory testing to strengthen the analysis. Drinking water samples from each respondent's household will be collected and tested to analyze the content of E. coli bacteria as the main indicator of microbiological contamination. To ensure data accuracy, questionnaires and observation sheets will undergo validity and reliability testing on a population group with similar characteristics outside the research location before official field data collection is conducted.

### **Data Analysis**

The collected data will then be processed and analyzed systematically using statistical software through two main stages. The first stage is univariate analysis, which aims to describe the characteristics of each research variable, both dependent and independent, presented in the form of frequency distributions and percentages. The second stage is bivariate analysis, which is conducted to test the strength of the relationship between the independent and dependent variables. This test uses the Chi-Square statistical test, where the analysis results are considered to have a statistically significant relationship if the p-value obtained is less than 0.05 ( $p < 0.05$ ).

## **RESULTS AND DISCUSSION**

### **RESULTS**

This study was conducted in Kualo Beach, a coastal area located in Pasar Bengkulu District, Bengkulu City. This location is characterized as a densely populated settlement with the majority of heads of households working as fishermen, laborers, and small traders. The environmental conditions close to the sea and high population density create unique challenges related to the provision of clean water and environmental sanitation management, which is the main background for the relevance of

this study. Data collection was conducted over a two-month period, from January to March 2025, involving 100 households with toddlers that met the inclusion criteria.

Univariate analysis was performed to provide a descriptive overview of the frequency distribution of respondent characteristics (mothers of toddlers) and the main research variables, namely the incidence of diarrhea in toddlers, clean water quality, and household sanitation conditions. Respondent characteristics were analyzed based on age, highest level of education, and occupation. These demographic data are important for understanding the socioeconomic context of the research sample. A summary of the characteristics of the 100 respondents is presented in Table 4.1 below.

Table 4.1 Frequency Distribution of Respondent Characteristics in the Kuala Coastal Area

Characteristics	Category	<i>f</i>
Age	< 20 years	8 8.0
	20 - 35 years	65 65.0
	> 35 years	27 27.0
Highest level of education	No schooling/elementary school	22 22.0
	Junior High School	35 35
	High School	38 38
	University	5 5
Occupation	Housewife	72 72
	Laborer/Fisherman	15 15
	Self-employed	10 10
	Other	3 3
Total		100 100

Based on Table 4.1, it can be seen that the majority of respondents are in the productive age group, namely 20-35 years (65.0%). In terms of education level, most respondents have a high school (38.0%) and junior high school (35.0%) educational background. This shows that basic to secondary education levels dominate the sample population. In terms of occupation, the majority of respondents were housewives (72.0%), indicating that mothers play a central role in childcare and daily household management, including the provision of drinking water and sanitation practices. The next analysis describes the dependent variable (incidence of diarrhea) and independent variables (quality of clean water and household sanitation).

Table 4.2 Frequency Distribution of Diarrhea Incidence in Toddlers

Diarrhea Incidence	<i>f</i>	
Yes	35	35.0
No	65	65.0
Total	100	100.0

Table 4.2 shows that the prevalence of diarrhea among toddlers in the Kualo Beach area during the study period was quite high. A total of 35 out of 100 toddlers (35.0%) were reported to have diarrhea.

Table 4.3 Frequency Distribution of Clean Water Quality Based on *E. coli* Testing

Clean Water Quality	<i>f</i>	%
Does Not Meet Requirements ( <i>E. coli</i> Positive)	60	60
Qualified ( <i>E. coli</i> Negative)	40	40
Total	100	100.0

From the results of laboratory tests on 100 samples of household drinking water (Table 4.3), it was found that the majority of drinking water sources were contaminated. A total of 60 samples (60.0%) were declared Not Compliant because they tested positive for *E. coli* bacteria, which is an indicator of fecal contamination.

Table 4.4 Frequency Distribution of Household Sanitation Conditions

Household Sanitation	<i>f</i>	%
Poor	55	55
Good	45	45.0
Total	100	100.0

Based on the results of observations using a sanitation checklist (Table 4.4), it was found that more than half of households, namely 55 households (55.0%), had sanitation conditions that were categorized as Poor. This category includes a combination of several factors, such as ownership of unhealthy toilets, open sewage systems, and inadequate waste management.

Bivariate analysis was performed to determine the relationship between each independent variable and the dependent variable. The statistical test used was Chi-Square ( $\chi^2$ ) with a significance level ( $\alpha$ ) of 0.05. Relationship between Clean Water Quality and Incidence of Diarrhea in Toddlers. To see the relationship between the quality of drinking water consumed and the incidence of diarrhea, the data are presented in the following cross-table.

**Relationship between Clean Water Quality and Incidence of Diarrhea in Toddlers**

To see the relationship between the quality of drinking water consumed and the incidence of diarrhea, the data are presented in the following cross-table.

Table 4.5 Relationship between Clean Water Quality and Incidence of Diarrhea in Toddlers

Clean Water Quality	Incidence of Diarrhea				<i>p-value</i>
	Yes		No		
	f	%	f	%	
Not Qualified	30	50.0	30	50	0.001
Qualified	5	12.5	35	87.5	
Total	35	35.0	65	65	

The results of the analysis in Table 4.5 show a highly significant relationship between clean water quality and the incidence of diarrhea in toddlers. The proportion of diarrhea cases among toddlers who consumed water that did not meet standards (*E. coli* positive) was much higher, at 50.0% (30 out of 60 toddlers). Meanwhile, in the group that consumed water that met standards (*E. coli* negative), the proportion of diarrhea cases was only 12.5% (5 out of 40 toddlers). The Chi-Square test resulted in a *p-value* < 0.001. Since the *p-value* is less than ( $\alpha$ ) 0.05, it can be concluded that there is a statistically significant relationship between clean water quality and the incidence of diarrhea in toddlers in the Kuala Beach area. Figure 4.1 Percentage of Diarrhea Incidence Based on Clean Water Quality.

**Relationship between Household Sanitation and Incidence of Diarrhea in Toddlers**

The following table presents the results of the analysis of the relationship between household environmental sanitation conditions (categorized as 'Good' or 'Poor') and the incidence of diarrhea in infants.

Table 4.6 Relationship between Household Sanitation and Incidence of Diarrhea in Infants

Household Sanitation	Diarrhea Incidence				<i>p-value</i>
	Yes		No		
	f	%	f	%	
Poor	28	50.9	27	49.1	0.002
Good	7	15.6	38	84.4	
Total	35	35.0	65	65	

From the revised Table 4.6, it can be seen that of the 55 households with 'Poor' sanitation conditions, 28 toddlers (50.9%) were reported to have diarrhea, and 27 toddlers (49.1%) did not. On

the other hand, out of 45 households with 'Good' sanitation, only 7 infants (15.6%) experienced diarrhea, with the remaining 38 infants (84.4%) in good health.

The p-value = 0.002 (less than 0.05) confirms that there is a statistically significant relationship between household sanitation conditions and the incidence of diarrhea in toddlers. Toddlers living in environments with poor sanitation have a much higher incidence of diarrhea than those living in environments with good sanitation.

## DISCUSSION

This study successfully revealed a statistically significant relationship between clean water quality and household sanitation with the incidence of diarrhea in infants in the coastal area of Kualo Beach, Bengkulu Market. These findings not only confirm established public health postulates [Prüss-Ustün et al \(2019\)](#), but also provide specific and contextual empirical evidence on the dynamics of diarrhea risk in densely populated urban coastal ecosystems, a setting that remains under-explored in the literature ([Fauzi & Sari, 2020](#); [Wolf et al., 2022](#)).

### **Clean Water Quality as a Major Determinant of Diarrhea**

Bivariate analysis results show that toddlers who consume drinking water contaminated with *E. coli* have a much higher risk of experiencing diarrhea (50.0%) compared to those who consume water that meets the requirements (12.5%). The p-value < 0.001 reinforces this finding, confirming that microbiological water quality is a crucial risk factor. These findings are consistent with many previous studies, both globally and locally. A systematic study by [Prüss-Ustün et al \(2019\)](#) confirms that fecal-contaminated drinking water is one of the main environmental risk factors for diarrhea globally. Specifically in Indonesia, research by [Pangestu & Dimjati Lusno \(2025\)](#) also states that fecal contamination in household water sources, as indicated by the presence of *E. coli*, is the dominant transmission route for enteric pathogens.

At Kualo Beach, the high percentage of water samples that tested positive for *E. coli* (60%) indicates the vulnerability of clean water infrastructure and/or unhygienic water storage and handling practices at the household level. The geographical characteristics of Kualo Beach, which is a coastal area, have the potential to affect the quality of shallow groundwater, which is often the main source of water for the community. Seawater intrusion and domestic wastewater flooding in densely populated areas can easily contaminate dug wells or other unprotected water sources ([Bain et al., 2014](#); [Daryati et al., 2026](#)). Cross-contamination from substandard septic tanks, due to high settlement density, further exacerbates this condition ([Graham & Polizzotto, 2013](#)). These findings underscore that, beyond physical access to water, the microbiological quality of consumed water is

a key indicator that must be addressed in public health interventions, as emphasized in WHO standards ([World Health Organization, 2017](#)).

### **Household Sanitation: A Key Pillar in Diarrhea Prevention**

In parallel, household sanitation conditions have also been shown to have a significant association with the incidence of diarrhea ( $p=0.002$ ). The proportion of diarrhea in toddlers living in households with "Poor" sanitation (50.9%) was more than three times higher than that of those living in "Good" sanitation environments (15.6%). These results are consistent with the growing body of evidence. Concluded in their meta-analysis that effective sanitation interventions can reduce the risk of diarrhea by 25%. At the local level, studies by [Rukmana et al. \(2020\)](#) In the coastal region of Bengkulu, and [Fitrizah \(2020\)](#) found similar patterns, emphasizing that owning a healthy toilet, a closed sewage system (SPAL), and proper waste management are the first line of defense in breaking the chain of diarrhea transmission.

Poor sanitation creates an environment conducive to the breeding of disease vectors and increases the chances of contact between humans and pathogens, a relationship described in the F-Diagram theory framework ([Lanoix & Wagner, 1958](#)). In coastal areas such as Kualo Beach, where many households may not have access to adequate sanitation or SPAL, wastewater runoff can contaminate the environment extensively, including children's play areas. This increases exposure for toddlers, who are more vulnerable due to their habit of frequently putting their hands or objects in their mouths ([Rheingans et al., 2012](#)). These findings reinforce the argument that improving access to and quality of basic sanitation should be a priority program, not only as a health issue but also as a human development and environmental issue ([World Bank, 2023](#)).

### **The Dynamic Interaction between Water, Sanitation, and Behavior in a Socio-Economic Context**

The main strength of this study lies in its integrated approach, which allows us to look at both variables simultaneously in a specific socio-economic context. Although analyzed separately in bivariate tests, water quality and sanitation are essentially two sides of the same coin in the Water, Sanitation, and Hygiene (WASH) framework. The two interact in modulating the risk of diarrhea ([Cumming et al., 2019](#)). A household with an initially adequate water source can become recontaminated due to unclean storage practices, which are often influenced by the knowledge and behavior of caregivers ([Ejemot-Nwadiaro et al., 2021](#)).

The dominance of respondents with lower secondary education (junior high school and high school reached 73%) and housewives (72%) provides an important social context. Low levels of

education and income are often associated with limited access to resources and information, which ultimately affects health practices. Although housewives play a central role in maintaining hygiene, limited knowledge and awareness of healthy and clean living practices (PHBS) can be a hindering factor. Education on the importance of handwashing with soap, safe drinking water management at home, and proper fecal disposal is crucial. A study by Editia (2023) in the Indonesian context has proven the effectiveness of intensive and sustained promotion of PHBS in reducing diarrhea rates among toddlers.

Therefore, the high prevalence of diarrhea (35%) in Kualo Beach is most likely the result of an interrelated "triple burden": (1) intrinsically poor water source quality, (2) inadequate environmental sanitation conditions, and (3) suboptimal hygienic practices, all of which are exacerbated by socio-economic factors. This interaction creates a cycle of transmission that is difficult to break without comprehensive and multidimensional interventions (Wolf et al., 2022).

The findings of this study provide clear and targeted policy messages. First, technical interventions are needed to improve the quality of clean water, such as promoting the use of simple and affordable water purification technologies (e.g., ceramic filtration, chlorination) at the household level, as well as repairing and expanding piped clean water supply infrastructure by local governments (UNICEF & World Health Organization, 2020). Second, sanitation improvement programs must be intensified, not only through toilet construction subsidies, but also through community-based approaches such as Community Led Total Sanitation (CLTS) to encourage changes in social norms and the development of communal SPALs in densely populated areas (Cameron et al., 2019). Third, and no less important, are behavioral interventions targeting mothers of young children. The promotion of healthy lifestyles needs to be designed with educational materials that are easy to understand, contextual, and utilize effective communication channels, such as integrated health service post cadres and religious study groups (Sari et al., 2022). Collaboration between community health centers, village governments, and community leaders is key to the success of this education program. The One Health approach, which integrates human, animal, and environmental health, is also relevant given the coastal characteristics that are close to marine ecosystems (World Health Organization., 2022).

This study has several limitations. The cross-sectional design used does not allow for causal conclusions. The possibility of recall bias from respondents in reporting diarrhea cases also cannot be completely avoided. In addition, this study did not measure hygienic behavior variables (such as handwashing frequency and quality) quantitatively and objectively, which are important components in the Water, Sanitation, and Hygiene (WASH) framework. Water quality was measured only once

(single sampling), so it may not fully represent water quality over time. Further research with a cohort or quasi-experimental design to test the effectiveness of integrated WASH interventions covering water, sanitation, and behavior simultaneously is highly recommended.

## CONCLUSION

This study proves that poor clean water quality and inadequate household sanitation conditions are significant risk factors for diarrhea in toddlers in the coastal area of Kualo Beach. These findings, supported by extensive previous literature, confirm that an integrated WASH approach combining improvements in water and sanitation infrastructure with strong hygiene promotion and consideration of social determinants is the most targeted and sustainable strategy for reducing diarrhea morbidity in vulnerable coastal communities such as this. This evidence-based local intervention is expected to contribute to improving community health and achieving Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health) and SDG 6 (Clean Water and Sanitation).

## REFERENCES

- Arsyina, L., Wispriyono, B., Ardiansyah, I., & Pratiwi, L. D. (2019). The Relationship Between Drinking Water Sources and Total Coliform Content in Household Drinking Water. *Indonesian Journal of Public Health*. <https://doi.org/10.26714/jkmi.14.2.2019.18-23>
- Bain, R., Cronk, R., Wright, J., Yang, H., Slaymaker, T., & Bartram, J. (2014). Fecal Contamination of Drinking-Water in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis. *PLOS Medicine*, *11*(5), e1001644. <https://doi.org/10.1371/JOURNAL.PMED.1001644>
- Cameron, L., Olivia, S., & Shah, M. (2019). Scaling up sanitation: Evidence from an RCT in Indonesia. *Journal of Development Economics*, *138*, 1–16. <https://doi.org/10.1016/J.JDEVECO.2018.12.001>
- Cumming, O., Arnold, B. F., Ban, R., Clasen, T., Esteves Mills, J., Freeman, M. C., Gordon, B., Guiteras, R., Howard, G., Hunter, P. R., Johnston, R. B., Pickering, A. J., Prendergast, A. J., Prüss-Ustün, A., Rosenboom, J. W., Spears, D., Sundberg, S., Wolf, J., Null, C., ... Colford, J. M. (2019). The implications of three major new trials for the effect of water, sanitation, and hygiene on childhood diarrhea and stunting: A consensus statement. *BMC Medicine*, *17*(1), 1–9. <https://doi.org/10.1186/S12916-019-1410-X/FIGURES/2>
- Daryati, M., Hamzah, & Sari, D. L. (2026). The Relationship Between Nutrition Knowledge and Feeding Style with Nutritional Status in Early Childhood Education Institutions. *Journal of Nutrition and Food Technology: Nutrismart*, *2*(1), 1–14. <https://doi.org/10.64146/xn7mq741>

- Editia, Y. V. (2023). Education on Oral Rehydration Solution and Tempeh Porridge for Toddlers with Diarrhea at the Mekar II Health Center. *Multidisciplinary Community Service Journal*. <https://doi.org/10.58705/jam.v2i1.82>
- Ejemot-Nwadiaro, R. I., Ehiri, J. E., Arikpo, D., Meremikwu, M. M., & Critchley, J. A. (2021). Hand-washing promotion for preventing diarrhea. *Cochrane Database of Systematic Reviews*, 2021(1). <https://doi.org/10.1002/14651858.CD004265.pub4>
- Fauzi, Y., & Sari, F. M. (2020). Analysis of Determinants of Diarrhea Incidence in Toddlers in the Working Area of the Nusa Indah Community Health Center, Bengkulu City. *Journal of Nursing and Public Health*. <https://doi.org/10.37676/jnph.v8i2.1206>
- Fitrizah, M. K. (2020). The Relationship Between Clean Water Supply and Toilet Use with the Incidence of Diarrhea in Toddlers at the Pasar Ikan Community Health Center in Bengkulu City. *Mitra Raflesia (Journal of Health Science)*. <https://doi.org/10.51712/mitraraflesia.v10i2.11>
- Graham, J. P., & Polizzotto, M. L. (2013). Pit Latrines and Their Impacts on Groundwater Quality: A Systematic Review. *Environmental Health Perspectives*, 121(5), 521. <https://doi.org/10.1289/EHP.1206028>
- Lanoix, J. N., & Wagner, E. G. (1958). *WHO monograph series*. World Health Organization (WHO).
- Pangestu, M. P., & Dimjati Lusno, M. F. (2025). Household Drinking Water Quality in Indonesia Based on Physical, Chemical, and Microbiological Parameters: A Cross-Sectional Study Referring to National Standards. *Innovative Research Journal*. <https://doi.org/10.54082/jupin.1534>
- Prüss-Ustün, A., Wolf, J., Bartram, J., Clasen, T., Cumming, O., Freeman, M. C., Gordon, B., Hunter, P. R., Medlicott, K., & Johnston, R. (2019). Burden of disease from inadequate water, sanitation, and hygiene for selected adverse health outcomes: An updated analysis with a focus on low- and middle-income countries. *International Journal of Hygiene and Environmental Health*, 222(5), 765–777. <https://doi.org/10.1016/J.IJHEH.2019.05.004>
- Rheingans, R., Kukla, M., Faruque, A. S. G., Sur, D., Zaidi, A. K. M., Nasrin, D., Farag, T. H., Levine, M. M., & Kotloff, K. L. (2012). Determinants of Household Costs Associated With Childhood Diarrhea in 3 South Asian Settings. *Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America*, 55(Suppl 4), S327. <https://doi.org/10.1093/CID/CIS764>
- Rukmana, Sri Wahyuning, Thohari, I., & Nurmayanti, D. (2020). Relationship Between Basic Sanitation Conditions And The Behavior Of Housewives With The Incidence Of Diarrhea In Toddlers (Case Study in Banyuanyar Village, Sampang District, Sampang Regency in 2019). *Gema Lingkungan Kesehatan*. <https://doi.org/10.36568/kesling.v18i2.1111>
- Sari, D. K., & Nurrohmah, A. (2019). Tempe Porridge Helps Treat Diarrhea in Toddlers. *Gemassika Journal of Community Service*. <https://doi.org/10.30787/gemassika.v3i1.309>
- Sari, G. M., Sutrisna, M., & Fikhri, D. (2022). Health Education on Diarrhea Prevention in Flood-Prone Areas of Bengkulu City. *Siwalima Health Works*. <https://doi.org/10.54639/kks.v1i2.825>
- Sari, I. P., & Utami, D. (2022). Effectiveness of Participatory Training Model versus Lecture in Improving Mothers' Knowledge about Early Stimulation. *Journal of Child Growth and Development*, 7(3), 201–215. <https://doi.org/10.36082/jtka.v7i3.9876>

- UNICEF, & World Health Organization. (2020). *Water, Sanitation and Hygiene (WASH) in Health Care Facilities: Global Baseline Report 2019*.
- Wolf, J., Hubbard, S., Brauer, M., Ambelu, A., Arnold, B. F., Bain, R., Bauza, V., Brown, J., Caruso, B. A., Clasen, T., Colford, J. M., Freeman, M. C., Gordon, B., Johnston, R. B., Mertens, A., Prüss-Ustün, A., Ross, I., Stanaway, J., Zhao, J. T., ... Boisson, S. (2022). Effectiveness of interventions to improve drinking water, sanitation, and handwashing with soap on risk of diarrhoeal disease in children in low-income and middle-income settings: a systematic review and meta-analysis. *The Lancet*, 400(10345), 48–59. [https://doi.org/10.1016/S0140-6736\(22\)00937-0/ATTACHMENT/FC121E19-3A28-4AF8-AAB8-02D291AB3578/MMC2.PDF](https://doi.org/10.1016/S0140-6736(22)00937-0/ATTACHMENT/FC121E19-3A28-4AF8-AAB8-02D291AB3578/MMC2.PDF)
- World Bank. (2023). *The Role of Sanitation in Human Development*.
- World Health Organization (WHO). (2017). *Guidelines for Drinking-water Quality: Fourth Edition Incorporating the First Addendum*. World Health Organization.
- World Health Organization (WHO). (2022). *One Health Joint Plan of Action (2022–2026)*.
- Yuliana. (2025). The Effectiveness of the Waste Bank Program on Clean and Healthy Living Behaviour. *Health Smart: Journal of Public Health*, 1(1), 37–51. <https://doi.org/10.64146/xva2t804>