

Maternal knowledge, clean water availability, and hygiene practices associated with diarrhea among children under five in south sorong, indonesia

Agustina Mallisa^{1✉}

Department of Public Health,
Universitas Tamalatea Makassar,
Makassar, Indonesia

✉Corresponding author:
Agustina Mallisa
mallisaagustina443@gmail.com

ABSTRACT

Introduction: Diarrhea remains an important public health problem among children under five, particularly in remote settings where access to safe water and adequate hygiene practices may be limited. Maternal knowledge and household environmental conditions can influence the occurrence of diarrhea in young children. This study aimed to examine the associations between maternal knowledge, clean water availability, maternal hygiene practices, and diarrhea among children under five in the working area of Kais Community Health Center, South Sorong Regency, Indonesia.

Methods: A quantitative analytical observational study with a cross-sectional design was conducted in June 2026. The study included 43 mothers of children under five selected through total sampling. Data were collected using questionnaires and observation checklists. Univariate analysis was used to describe participant characteristics and study variables, while associations were assessed using the Chi-square test.

Results: Among respondents, 55.8% had adequate knowledge, 60.5% had access to clean water, and 53.5% reported inadequate hygiene practices. Diarrhea was identified in 32.6% of children under five. Significant associations were found between diarrhea and maternal knowledge ($p < 0.001$), clean water availability ($p = 0.003$), and maternal hygiene practices ($p = 0.003$).

Conclusion: Maternal knowledge, access to clean water, and hygiene practices were significantly associated with childhood diarrhea. Strengthening maternal health education, safe water access, and household hygiene practices should be prioritized in community-based diarrhea prevention programs in remote areas.

Keywords: child; diarrhea; health knowledge; hygiene; water supply.

Received: 2026-08-27

Revised: 2026-10-09

Accepted: 2026-10-10



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

Highlight:

- Maternal knowledge was associated with childhood diarrhea.
- Clean water availability was significantly related to diarrhea incidence.
- Poor maternal hygiene practices increased diarrhea occurrence.
- Community prevention should prioritize education, safe water, and hygiene.

INTRODUCTION

Diarrhea remains a major public health problem among children under five, particularly in low-resource and geographically isolated settings. The burden is not limited to acute morbidity but also extends to dehydration, nutritional deterioration, growth impairment, and increased vulnerability to repeated infections. In the manuscript, diarrhea is described as one of the leading causes of morbidity and mortality among young children globally, with the burden disproportionately concentrated in developing countries^{1,2}. In Indonesia, diarrhea also continues to be reported among the most common diseases managed in primary healthcare services, indicating that preventive interventions have not yet fully addressed the environmental and behavioral pathways of transmission^{3,4}. The problem is particularly important in remote communities where limitations in water infrastructure, sanitation, healthcare access, and health literacy may act simultaneously and reinforce one another.

South Sorong Regency presents a context in which these determinants are especially relevant. The study area is characterized by geographical isolation, limited infrastructure, and constrained access to health services. The manuscript further describes Kais District as an area surrounded by rivers and swamps, where households commonly depend on river water and rainwater for daily needs, including drinking and cooking. Such conditions can increase exposure to contaminated water and facilitate fecal–oral transmission of enteric pathogens^{5,6}. Local health records also indicate that diarrhea remains frequently reported among children under five in the working area of Kais Community Health Center. Preliminary data cited in the study showed 108 diarrhea cases among children under five during 2025, while Kampung Kais recorded 12 cases between January and May 2026, making diarrhea the second most frequently reported infectious condition after acute respiratory infection^{7,8}. These findings suggest that diarrhea prevention in this setting should not be approached solely as a clinical problem, but as a household and environmental health issue.

Previous evidence has consistently shown that childhood diarrhea results from a combination of behavioral, environmental, and household factors. Maternal knowledge is one of the most important behavioral determinants because mothers commonly serve as the primary caregivers responsible for food preparation, drinking-water management, child feeding, personal hygiene, and early recognition of illness^{9,10}. Inadequate knowledge can limit a mother's ability to identify sources of contamination, practice safe food handling, recognize the importance of handwashing, and respond appropriately to diarrhea symptoms. The manuscript cites earlier research indicating that children cared for by mothers with lower knowledge are more likely to experience diarrhea than those whose mothers have better knowledge^{11,12}. However, knowledge alone may not be sufficient when households lack the environmental resources needed to translate awareness into protective behavior.

Access to clean water is therefore a second critical determinant. Safe water is required not only for drinking but also for cooking, washing hands, cleaning utensils, bathing children, and maintaining household sanitation. Where safe water is unavailable or inconsistent, families may rely on unprotected sources that are vulnerable to microbial contamination¹³. The manuscript notes that contaminated water can transmit organisms such as *Escherichia coli*, *Shigella*, and *Salmonella*, thereby increasing the risk of diarrheal disease. Evidence summarized in the study also indicates that households without adequate access to clean water face a higher likelihood of diarrhea than households with safer water sources¹⁴. This relationship is particularly relevant in Kais, where dependence on river and rainwater reflects both environmental constraints and infrastructure limitations.

Maternal hygiene practices represent another important component of prevention. Handwashing with soap before food preparation, before feeding a child, after defecation, and after cleaning a child's feces can interrupt fecal–oral transmission. Similarly, maintaining the cleanliness of feeding utensils and household surfaces can reduce exposure to infectious agents. The manuscript highlights prior studies showing that inadequate maternal hygiene is significantly associated with childhood diarrhea. These findings support an integrated interpretation in which knowledge influences behavior, water availability enables hygienic practice, and hygiene serves as the immediate behavioral barrier against pathogen transmission.

Despite the availability of evidence on these individual factors, an important research gap remains in remote areas of Eastern Indonesia. Many previous studies have been conducted in settings with better infrastructure, denser health-service coverage, and different environmental conditions. Evidence from South Sorong, particularly Kais District, remains limited. More importantly, few local studies have examined maternal knowledge, household access to clean water, and maternal hygiene practices within the same analytical framework. The manuscript itself identifies persistent local problems, including limited safe-water access, incomplete adoption of handwashing practices, and inadequate maternal understanding of diarrhea prevention. This limits the direct transferability of findings from more accessible regions and creates a need for context-specific evidence.

The novelty of this study lies in its simultaneous assessment of maternal behavioral factors and household environmental conditions in a geographically remote community. Rather than focusing on a single determinant, the study evaluates whether maternal knowledge, clean water availability, and maternal hygiene practices are associated with diarrhea among children under five in one local public health setting. This integrated approach provides evidence that is more directly relevant to community-based prevention because these factors are likely to interact in everyday household practices. Accordingly, this study aimed to examine the associations between maternal knowledge, clean water availability, maternal hygiene practices, and diarrhea among children under five in the working area of Kais Community Health Center, Kais District, South Sorong Regency. The findings are expected to support more context-sensitive strategies for strengthening maternal health education, improving access to safe water, and promoting household hygiene practices in remote communities.

RESEARCH METHODOLOGY

Study Design

This study used a quantitative analytical observational design with a cross-sectional approach. The design was selected to examine the associations between maternal knowledge, clean water availability, maternal hygiene practices, and diarrhea among children under five at a single period of observation without intervention or longitudinal follow-up.

Setting and Participants

The study was conducted in Kampung Kais, Kais District, South Sorong Regency, Indonesia, in July 2026. The source population comprised all mothers with children aged 0–59 months living in the study area. The population consisted of 43 mothers, and all eligible members of the population were included using total sampling; therefore, no separate sample-size calculation was performed. The final sample consisted of 43 mothers of children under five. The manuscript does not explicitly report separate inclusion and exclusion criteria. Accordingly, these criteria should not be added retrospectively unless supported by the original research protocol.

Variables and Measurement

The dependent variable was diarrhea among children under five, defined as having experienced defecation more than three times per day with loose or watery stool during the preceding 14 days. This variable was categorized as diarrhea or no diarrhea. The independent variables were maternal knowledge, clean water availability, and maternal hygiene practices. Maternal knowledge covered understanding of diarrhea, including its definition, causes, transmission, symptoms, and prevention, and was classified as good when the score was $\geq 50\%$ and poor when the score was $< 50\%$. Clean water availability was assessed by observation based on physical characteristics, including clarity and absence of turbidity and odor, consistent with the criteria referenced in Indonesian Ministry of Health Regulation No. 2 of 2023. Maternal hygiene practices included handwashing with soap and practices related to personal hygiene, food and beverage hygiene, cleanliness of children's eating utensils, and household environmental cleanliness. Hygiene was categorized as good for scores $\geq 50\%$ and poor for scores $< 50\%$.

Primary data were obtained directly from respondents using questionnaires and observation checklists, while secondary data were obtained from Kais Community Health Center records, including patient, visit, and service-coverage data. The manuscript does not provide documented results of instrument validity or reliability testing; therefore, validity coefficients or Cronbach's alpha values cannot be reported without additional supporting data.

Data Collection

Data were collected through direct interviews using structured questionnaires and observations of household clean water availability using an observation checklist. A camera was used only for research documentation. Data quality was maintained through manual checking of questionnaire completeness and clarity, followed by coding and transfer of coded responses into a master table before statistical analysis.

Data Analysis

Descriptive analysis was performed using frequencies and percentages to summarize respondent characteristics and each study variable. Bivariate analysis was conducted using the Chi-square test with 2×2 contingency tables to assess the associations between each independent variable and diarrhea among children under five. Statistical significance was defined as $p < 0.05$.

Ethical Approval

The current manuscript does not explicitly report the name of an ethics committee, ethical approval number, or documented informed-consent procedure. These details should be inserted only after verification from the original ethical clearance or research authorization document. A journal submission should not contain an invented ethics approval number or committee name.

RESULT

A total of 43 mother–child pairs were included in the analysis. The largest maternal age group was 16–25 years (37.2%), while only 7.0% were older than 40 years. Most mothers were housewives (88.4%), and junior high school was the most common educational level (37.2%). Among the children, 88.4% were aged 12–59 months and 62.8% were female.

Table 1. Characteristics of respondents and children under five (n = 43)

Characteristic	Category	n	%
Maternal age (years)	16–25	16	37.2
	26–30	8	18.6
	31–35	8	18.6
	36–40	8	18.6
	>40	3	7.0
Maternal occupation	Civil servant	5	11.6
	Housewife	38	88.4
Maternal education	Primary school	10	23.3
	Junior high school	16	37.2
	Senior high school	12	27.9
	Higher education	5	11.6
Child age (months)	0–11	5	11.6
	12–59	38	88.4
Child sex	Male	16	37.2
	Female	27	62.8

Source: Primary data, 2026.

Regarding the main study variables, 55.8% of mothers had good knowledge, 60.5% had access to clean water, and 53.5% had poor hygiene practices. Diarrhea during the defined observation period was reported in 14 of 43 children (32.6%). Bivariate analysis showed statistically significant associations between all three examined factors and childhood diarrhea. Because the study used a cross-sectional design, the odds ratios presented below are unadjusted prevalence odds ratios calculated from the 2×2 tables reported in the manuscript; they should not be interpreted as causal risk estimates. The original manuscript reports Chi-square p -values but does not report effect sizes or confidence intervals.

Table 2. Bivariate associations between maternal and household factors and diarrhea among children under five (n = 43)

Factor	Diarrhea n/N (%)	No diarrhea n/N (%)	Crude OR (95% CI)	p-value
Maternal knowledge				
Good	2/24 (8.3)	22/24 (91.7)	Reference	
Poor	12/19 (63.2)	7/19 (36.8)	18.86 (3.37–105.49)	<0.001
Clean water availability				
Available	4/26 (15.4)	22/26 (84.6)	Reference	
Not available	10/17 (58.8)	7/17 (41.2)	7.86 (1.87–33.10)	0.003
Maternal hygiene practices				
Good	2/20 (10.0)	18/20 (90.0)	Reference	
Poor	12/23 (52.2)	11/23 (47.8)	9.82 (1.84–52.39)	0.003

OR and 95% CI were calculated from the cell frequencies reported in the original 2×2 tables; they were not originally presented in the manuscript. OR = odds ratio; CI = confidence interval.

Children of mothers with poor knowledge had substantially higher odds of diarrhea than those whose mothers had good knowledge (OR = 18.86; 95% CI: 3.37–105.49; $p < 0.001$). The

original table showed diarrhea in 63.2% of children whose mothers had poor knowledge compared with 8.3% among those whose mothers had good knowledge. Similarly, children living in households without available clean water had higher odds of diarrhea than those with available clean water (OR = 7.86; 95% CI: 1.87–33.10; $p = 0.003$). Diarrhea occurred in 58.8% of children without clean-water availability compared with 15.4% among children from households with available clean water. Poor maternal hygiene practices were also strongly associated with diarrhea. Among mothers with poor hygiene practices, 52.2% of their children experienced diarrhea, compared with 10.0% among mothers with good hygiene practices. The corresponding crude OR was 9.82 (95% CI: 1.84–52.39; $p = 0.003$).

The findings indicate that childhood diarrhea in Kais is embedded in an interconnected behavioral and household environmental context rather than being attributable to a single exposure. The largest crude association was observed for poor maternal knowledge, followed by inadequate hygiene practices and lack of clean water. These effect sizes suggest that mothers' ability to understand diarrhea prevention may be important, but knowledge is unlikely to translate into protection when households lack sufficient environmental resources to practice safe hygiene. Conversely, water availability alone may have limited preventive value if storage, food handling, handwashing, and child-care practices remain inadequate.

The results therefore support an integrated prevention strategy combining maternal education with household-level WASH interventions. Health promotion delivered through community health services should emphasize practical behaviors such as safe drinking-water handling, handwashing with soap, hygienic food preparation, and appropriate disposal of children's feces. At the same time, improving reliable access to physically acceptable clean water remains essential. However, the wide confidence intervals, particularly for maternal knowledge, reflect the small sample and indicate considerable statistical uncertainty. Because the study was cross-sectional and limited to bivariate analysis, these associations should be interpreted as signals for targeted intervention and further investigation rather than evidence of independent causal effects.

DISCUSSION

The findings of this study show that childhood diarrhea in Kais is closely linked to a combination of maternal and household environmental conditions. Approximately one-third of the children experienced diarrhea, while substantial proportions of mothers had inadequate knowledge, lacked access to clean water, or reported poor hygiene practices. More importantly, each of these factors was significantly associated with diarrhea. The crude effect estimates further suggest marked differences between exposure groups: children of mothers with poor knowledge had substantially higher odds of diarrhea, as did children living in households without clean water and those whose mothers reported poor hygiene practices. These findings should be interpreted as associations rather than causal effects because all exposures and outcomes were assessed within a cross-sectional framework.

The strong association observed for maternal knowledge highlights the importance of cognitive resources in household disease prevention. Knowledge can shape how mothers recognize contamination pathways, select and treat drinking water, handle food, wash hands, dispose of feces, and respond to early symptoms of illness^{15,16}. In Kais, this relationship may have particular importance because almost half of mothers were still classified as having inadequate knowledge. However, knowledge should not be understood as an isolated individual attribute. A mother may understand the importance of safe water and handwashing but remain unable to

practice these behaviors consistently when water availability, infrastructure, or household resources are constrained¹⁷. This means that improving knowledge alone may not be sufficient unless families are also supported by an enabling physical environment.

This interpretation becomes clearer when the clean-water findings are considered. More than half of households relied on river water, while approximately one-third used rainwater and only a small proportion used dug wells. Such a distribution illustrates that household behavior operates within a wider environmental system. Water is required not only for drinking but also for cooking, handwashing, cleaning utensils, bathing children, and maintaining household sanitation^{18,19}. When access is limited, several protective practices may deteriorate at the same time. The observed association between clean-water availability and diarrhea therefore reflects not only the role of water as a potential vehicle for pathogens, but also its function as a basic resource required to sustain household hygiene.

Maternal hygiene practices provide the behavioral link between knowledge and environmental resources. More than half of respondents were classified as having poor hygiene practices²⁰. The substantially higher occurrence of diarrhea among children in this group suggests that routine behaviors surrounding handwashing, food handling, cleaning of eating utensils, and household cleanliness may influence exposure to fecal–oral pathogens²¹. Conceptually, these findings support an interconnected pathway in which knowledge provides the basis for preventive decisions, water availability enables hygiene, and hygiene practices translate those resources into protection at the point of exposure²². This interpretation is more useful than treating the three variables as entirely independent determinants.

The study therefore contributes to a broader understanding of diarrhea prevention in geographically remote communities. Prevention cannot be reduced to maternal education alone, nor can it rely solely on infrastructure provision. Educational interventions may produce limited benefits if households lack safe and reliable water, whereas improved water availability may not achieve its full health benefit when unsafe storage, food handling, or hand hygiene persists²³. The findings support a combined behavioral–environmental model of prevention, which is particularly relevant for primary healthcare services operating in remote settings where household practices and structural limitations intersect.

The association between maternal knowledge and diarrhea is consistent with the body of evidence summarized in the manuscript. Previous studies cited in the study, including Saliu and Wardana and Puspikawati, have examined maternal knowledge and related behavioral characteristics in relation to childhood diarrhea. Safitri et al. similarly assessed maternal knowledge together with household factors such as income and clean-water facilities, reinforcing the idea that cognitive and environmental determinants should be examined together rather than separately. These studies broadly support the present finding that insufficient maternal knowledge is associated with a greater occurrence of diarrhea²⁴.

The present study adds a context-specific dimension to this evidence. Much of the practical meaning of maternal knowledge depends on the setting in which knowledge is applied. In Kais, households face environmental constraints that differ from those of more accessible urban or peri-urban communities²⁵. The relatively high reliance on river and rainwater suggests that a mother's ability to implement preventive recommendations may depend heavily on available household resources²⁶. Thus, the relationship identified in this study should not be interpreted as evidence that mothers alone are responsible for preventing diarrhea. Instead, maternal knowledge should be viewed as one component of a broader system involving infrastructure, service access, environmental conditions, and household behavior.

The findings concerning clean water are also consistent with prior evidence summarized in the manuscript. Earlier studies described in the source document reported that households without adequate access to safe water experienced higher levels of childhood diarrhea and emphasized the importance of sufficient water for supporting healthy household practices. In Kais, where river water was the dominant source, this issue is especially important. The current findings therefore extend existing evidence by showing that the water–diarrhea relationship is also evident in a remote eastern Indonesian community where geographical conditions influence the water sources available to households.

Similarly, the association between poor maternal hygiene and diarrhea accords with previous studies described in the manuscript, which reported a greater occurrence of diarrhea among children whose caregivers did not consistently practice handwashing and other hygienic behaviors. Practices such as washing hands with soap before preparing food, before feeding children, after defecation, and after cleaning children's feces are directly relevant to interruption of the fecal–oral transmission pathway. The manuscript itself recognizes that hygienic behavior provides optimal benefit when supported by adequate water, sanitation, and a healthy environment. This is an important conceptual implication because it shifts the discussion away from isolated individual responsibility toward a more systemic understanding of disease prevention.

Several methodological considerations require careful interpretation of these findings. First, the cross-sectional design measured exposure and outcome within the same observational period and therefore cannot establish temporal sequence. It is not possible to determine with certainty whether poor knowledge or hygiene preceded the diarrheal episode or whether a recent episode influenced maternal awareness and subsequent behavior. Consequently, causal language such as “cause,” “effect,” or “risk factor” should be avoided when describing the results.

Second, the sample consisted of only 43 mother–child pairs from a single community. Although total sampling appropriately included the entire accessible study population, the small number of observations limits statistical precision. This is reflected in the wide confidence intervals around the crude odds ratios. Large point estimates should therefore not be interpreted as precise measures of effect magnitude. They indicate substantial differences between groups but also considerable uncertainty regarding the exact size of those associations. Third, the analysis was limited to bivariate comparisons. Potential confounders such as child age, nutritional status, breastfeeding history, immunization status, household sanitation, socioeconomic position, food safety, toilet availability, and household crowding were not simultaneously controlled. The reported crude odds ratios therefore represent unadjusted associations and may partly reflect the influence of other characteristics that were not included in the statistical model.

Measurement also warrants caution. Diarrhea was based on maternal reporting of episodes within the previous 14 days, which may introduce recall or reporting bias. Maternal knowledge and hygiene were assessed using questionnaire-based categories, while clean-water availability was evaluated mainly from observable physical characteristics. Physical clarity, absence of odor, and absence of turbidity do not guarantee microbiological safety. Therefore, the study measured the practical availability of apparently acceptable water rather than laboratory-confirmed safe drinking water. Instrument validity and reliability statistics were also not documented in the manuscript, which limits the assessment of measurement precision.

The findings are also context-specific. Kais is a geographically remote area with substantial use of river and rainwater. The results are therefore especially relevant to similar underserved communities but should not automatically be generalized to urban populations or settings with

established piped-water systems. Even so, the context-specific nature of the study is also one of its strengths because evidence from remote communities in eastern Indonesia remains comparatively limited. Future research should build on these findings using designs that can better distinguish temporal relationships and independent effects. Larger multicenter studies involving several villages or primary healthcare catchment areas in South Sorong would improve statistical precision and external validity. Prospective cohort designs could determine whether baseline knowledge, water conditions, and hygiene practices predict subsequent diarrheal episodes rather than merely being associated with recent disease.

Intervention research is particularly warranted. Rather than evaluating education, water provision, or hygiene promotion separately, future studies should test integrated WASH and maternal-health strategies delivered through primary healthcare and community platforms. Such interventions could combine culturally appropriate maternal education, household water treatment and storage, handwashing promotion, sanitation improvement, and community monitoring. This systems-oriented approach follows directly from the central implication of the present study: childhood diarrhea in remote communities reflects an interaction between what caregivers know, what resources households can access, and what preventive practices can realistically be sustained. Addressing these dimensions together may offer a more durable pathway toward reducing preventable childhood diarrhea in South Sorong.

CONCLUSION

This study demonstrates that maternal knowledge, clean water availability, and maternal hygiene practices were significantly associated with diarrhea among children under five in the working area of Kais Community Health Center, South Sorong Regency. Children whose mothers had poor knowledge, households without adequate clean water, and mothers with poor hygiene practices experienced a substantially higher occurrence of diarrhea than their respective comparison groups. These findings indicate that childhood diarrhea in this remote setting is shaped by the interaction of behavioral and household environmental conditions rather than by a single factor. Prevention strategies should therefore integrate maternal health education with improvements in household water access and practical hygiene promotion. Kais Community Health Center should strengthen counseling through community health posts, home visits, and maternal-child health activities, with emphasis on safe water handling, handwashing with soap, hygienic food preparation, and appropriate management of child feces. At the policy level, collaboration between primary healthcare services and local authorities is needed to improve reliable access to safe water and strengthen community-based WASH programs. Given the cross-sectional design and small sample, these findings should guide locally targeted interventions while being confirmed through larger prospective studies.

Funding Statement

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors declare that there are no conflicts of interest related to this study.

Authors' Contributions

Agustina Mallisa: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing – Original Draft, and Writing – Review & Editing.

Acknowledgments

The authors gratefully acknowledge the support of Kais Community Health Center, South Sorong Regency, and all mothers who participated in this study. Appreciation is also extended to Universitas Tamalatea Makassar for its academic support throughout the research process.

Declaration of Generative AI Use

Generative artificial intelligence tools were used only to support language refinement and improve the clarity and organization of the manuscript. All scientific content, data interpretation, and final conclusions were reviewed and verified by the authors, who take full responsibility for the published work.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to applicable ethical and confidentiality requirements.

REFERENCES

1. Abera MG, Werkneh AA, Welde RS, Islam MA, Redae GH. Diarrhea prevalence and water, sanitation, and hygiene (WASH) factors among internally displaced children under-five in Mekelle city, Northern Ethiopia. *Clin Epidemiol Glob Heal*. 2024;28:101660. doi:<https://doi.org/10.1016/j.cegh.2024.101660>
2. Benzamin M, Hoque M. Use of 'Diarrhea Stool Card' in acute diarrhea management in under 5 Years children in resource constraints country. *Gastroenterol Endosc*. 2024;2(2):96-101. doi:<https://doi.org/10.1016/j.gande.2024.03.008>
3. Bose D, Bhattacharya R, Kaur T, et al. Overcoming water, sanitation, and hygiene challenges in critical regions of the global community. *Water-Energy Nexus*. 2024;7:277-296. doi:<https://doi.org/10.1016/j.wen.2024.11.003>
4. Esan DT, Owoeye ID, Adesuyi EO, et al. Personal and Environmental Hygiene Practices of Mothers in Selected Primary Health Centers in Ekiti State, Nigeria: A Cross-Sectional Study. *Open Public Health J*. 2024;17. doi:<https://doi.org/10.2174/0118749445269664241003072612>
5. Fatima M, Ünsal Ö. Geospatial analysis of diarrhoea determinants among children under five in Pakistan using Multiscale Geographically Weighted Regression (MGWR). *Appl Geogr*. 2024;172:103434. doi:[10.1016/j.apgeog.2024.103434](https://doi.org/10.1016/j.apgeog.2024.103434)
6. Fatima SH, Judge MA, Le Souëf PN, Bradshaw CJA. Impact of climate change on diarrhoea risk in low- and middle-income countries. *Environ Res*. 2025;285:122412. doi:[10.1016/j.envres.2025.122412](https://doi.org/10.1016/j.envres.2025.122412)
7. Huo S, Wang K, Liu Z, et al. Influence of Maternal Exposure to Mass Media on Growth Stunting Among Children Under Five: Mediation Analysis Through the Water, Sanitation, and Hygiene Program. *JMIR Public Heal Surveill*. 2022;8(4). doi:<https://doi.org/10.2196/33394>
8. Husain Z, Das P. Reducing child diarrhoea in India: Shifting policy focus from source of water to quality. *Water Resour Econ*. 2023;42:100221. doi:<https://doi.org/10.1016/j.wre.2023.100221>
9. Juvakoski A, Rantanen H, Mulas M, et al. Evidence of waste management impacting severe diarrhea prevalence more than WASH: An exhaustive analysis with Brazilian municipal-level data. *Water Res*. 2023;247:120805. doi:[10.1016/j.watres.2023.120805](https://doi.org/10.1016/j.watres.2023.120805)
10. Kamguia B, Tadadjeu S. Linking international financial inflows and access to drinking water, sanitation and hygiene in schools. *Int Econ*. 2025;184:100641. doi:<https://doi.org/10.1016/j.inteco.2025.100641>
11. Liu Q, Liu M, Liu J. Association of drinking water services with the disease burden of diarrhea in children under five in 200 countries from 2000 to 2021. *Cell Reports Sustain*. 2024;1(9):100177. doi:<https://doi.org/10.1016/j.crsus.2024.100177>

12. Maphanga D, Mavhungu ML, Muedi KL, Masindi V, Foteinis S. Unveiling the chlorine demand and decay in aged drinking water supply systems: Complementing experimental results with modelling and predictive artificial intelligence. *Desalin Water Treat.* 2026;326:101789. doi:<https://doi.org/10.1016/j.dwt.2026.101789>
13. Meierhofer R, Kunwar BM, Shrestha A. Changes in water treatment, hygiene practices, household floors, and child health in times of Covid-19: A longitudinal cross-sectional survey in Surkhet District, Nepal. *Int J Hyg Environ Health.* 2023;249:114138. doi:<https://doi.org/10.1016/j.ijheh.2023.114138>
14. Mezza M, Doig-Alba L, Ruiz-Ruiz MI, Luz Pineda Restrepo B. “Exploring vulnerabilities: A mixed-method Transdisciplinary Study of Dengue and Diarrhea in Peru.” *J Clim Chang Heal.* 2026;28:100669. doi:<https://doi.org/10.1016/j.joclim.2026.100669>
15. Rupa FH, Tariqujjaman M, Rahman M, Hossian M, Towfiquzzaman M, Arifuzzaman. Trends and disparities in childhood illness prevalence and treatment patterns in Bangladesh: A decade of insights on diarrhea, fever and ARI from BDHS (2011–2022). *Next Res.* 2025;2(4):100886. doi:<https://doi.org/10.1016/j.nexres.2025.100886>
16. Sangalang SO, Prado NO, Lemence ALG, et al. Diarrhoea, malnutrition, and dehydration associated with school water, sanitation, and hygiene in Metro Manila, Philippines: A cross-sectional study. *Sci Total Environ.* 2022;838:155882. doi:<https://doi.org/10.1016/j.scitotenv.2022.155882>
17. Scott ME, Irwin Kristmanson D, Ortega-Barria E, Koski KG. Unbalanced Macronutrient Intakes, Multiple Micronutrient Inadequacies, and Diarrhea Underscore Low-Height-for-Age in Indigenous Panamanian Preschool Children. *Curr Dev Nutr.* 2025;9(10):107547. doi:<https://doi.org/10.1016/j.cdnut.2025.107547>
18. Shayo MJ, Kuchaka D, Beti M, et al. Identification of enteric viral pathogens in Tanzanian children under the age of five with diarrhea using nanopore-based metagenomic sequencing. *Virology.* 2026;623:111024. doi:<https://doi.org/10.1016/j.virol.2026.111024>
19. Suge T, Magu D, Wanzala P. Correlation between Escherichia coli resistant gene isolated from stool samples of children under five years and that from consumed water. *Sci African.* 2023;22:e01937. doi:<https://doi.org/10.1016/j.sciaf.2023.e01937>
20. Suprpto S. Policy analysis of national health financing implementation on access and equity of healthcare services in rural communities. *J Heal Policy Anal.* 2026;1(3):80-89. doi:<https://doi.org/10.61099/jakespol.v1i3.402>
21. Thomson P, Stoler J, Byford M, Bradley DJ. The Impact of Rapid Handpump Repairs on Diarrhea Morbidity in Children: Cross-Sectional Study in Kwale County, Kenya. *JMIR Public Heal Surveill.* 2024;10. doi:<https://doi.org/10.2196/42462>
22. Tohonon AC, Koumassa OAB, Ouétchéhou R, Hounsou M, Dabadé DS. Knowledge, attitudes, and practices regarding food hygiene and safety among stakeholders in the street fruits and vegetables chains in Benin, West Africa. *J Agric Food Res.* 2025;24:102415. doi:<https://doi.org/10.1016/j.jafr.2025.102415>
23. Turk T, Buatia B, Anterea B, Faletose R, Vaniqi A, Reiher C. Co-designing water sanitation and hygiene (WASH) messages for a social and behaviour change campaign in Kiribati. *Public Heal Pract.* 2026;12:100821. doi:<https://doi.org/10.1016/j.puhip.2026.100821>
24. Wolf J, Johnston RB, Ambelu A, et al. Burden of disease attributable to unsafe drinking water, sanitation, and hygiene in domestic settings: a global analysis for selected adverse health outcomes. *Lancet.* 2023;401(10393):2060-2071. doi:[https://doi.org/10.1016/S0140-6736\(23\)00458-0](https://doi.org/10.1016/S0140-6736(23)00458-0)
25. Yu C, Corpuz MCA, Bonifacio JM, et al. Norovirus-associated diarrhea and asymptomatic infection in children aged under 4 years: a community-cohort study in the Philippines. *IJID Reg.* 2025;14:100549. doi:<https://doi.org/10.1016/j.ijregi.2024.100549>
26. Yousafzai MT, Cornick J, Penataro Yori P, et al. The incidence and antimicrobial resistance of Shigella-attributable diarrhoea in young children in low-income and middle-income countries from the multicountry Enterics for Global Health (EFGH) Shigella Surveillance

Study: a prospective, facility-based hybrid surveillance study. *Lancet Glob Heal.* 2026;14(5):e749-e761. doi:[https://doi.org/10.1016/S2214-109X\(25\)00534-0](https://doi.org/10.1016/S2214-109X(25)00534-0)