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Determination of Environmental Sanitation Factors as a Risk Factor for Diarrhea in KaoFe Village, Buton Regency: A Public Health Approach

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ABSTRACT

Purpose of the study: This study aimed to analyze environmental sanitation factors as determinants of diarrhea incidence in Desa KaoFe, Kecamatan Kadatua, Kabupaten Buton.

Methodology: A quantitative analytic study with a cross-sectional design was conducted among 156 randomly selected households from a population of 260 households. Data were collected through structured interviews and direct observation of sanitation facilities. Variables included access to clean water, household latrine availability, solid waste management, wastewater disposal, and diarrhea incidence within the last three months. Data were analyzed using descriptive statistics and Chi-square tests at a 95% confidence level.

Main Findings: The prevalence of diarrhea was 31.4%. Households without adequate clean water access accounted for 34.6%, unhealthy or absent latrines 43.6%, inadequate solid waste management 49.4%, and improper wastewater disposal 75.6%. All sanitation variables showed statistically significant associations with diarrhea incidence ($p < 0.05$).

Novelty/Originality of this study: This study provides a multidimensional assessment of sanitation determinants within a small island rural context, demonstrating that wastewater disposal and integrated sanitation deficiencies play a critical role in diarrhea transmission beyond water access alone.

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1. INTRODUCTION

Health development is a strategic pillar in realizing productive and competitive human resources [1]-[3]. Public health is measured not only by life expectancy but also by reducing morbidity and mortality from preventable diseases [4]-[6]. Within the framework of the national health system, promotive and preventive efforts are the main foundation, particularly in controlling environmentally-based diseases [7], [8]. One disease that continues to present a significant burden at the national and regional levels is diarrhea, which remains a public health problem, particularly in areas with inadequate sanitation.

Epidemiologically, diarrhea is closely related to environmental factors, particularly the availability of clean water, ownership of sanitary latrines, domestic waste management, and waste disposal systems [9], [10], [11]. Contamination of food and drink by pathogenic microorganisms due to poor sanitation is a major transmission route [12]-[14]. Household health survey data shows that diarrhea continues to contribute to mortality, particularly among vulnerable groups such as toddlers [15], [16], [17]. This condition is exacerbated

by low access to basic sanitation in various rural areas, highlighting the gap between health policies and implementation on the ground.

In Buton Regency, the burden of diarrhea remains relatively high. Health office reports record thousands of diarrhea cases annually, with numerous deaths [18], [19]. The Kadatua Community Health Center (Puskesmas), specifically KaoFe Village, has been recorded as having the highest number of diarrhea cases among other villages in the sub-district [20]-[22]. Ironically, basic sanitation coverage in KaoFe Village remains suboptimal clean water access has not reached all households [23], [24], ownership of sanitary latrines is unequal, and wastewater disposal and waste management facilities remain low. This disparity between the high incidence of diarrhea and the low quality of sanitation indicates a structural problem that requires more comprehensive scientific study.

Several previous studies have demonstrated a significant relationship between environmental sanitation and diarrhea incidence [25]. However, most of these studies tend to analyze sanitation factors in a fragmented manner, for example, focusing only on clean water or latrine ownership, without simultaneously examining the determinants of various basic sanitation components within a single, integrated analysis model [26]. Furthermore, the local context of island regions like Kadatua District, with distinct geographic, social, and infrastructure characteristics from mainland areas, has not been explored in depth. Thus, there remains a research gap regarding a comprehensive and contextual analysis of the determinants of environmental sanitation to explain the risk of diarrhea in rural island areas.

This research presents a novel public health approach that positions environmental sanitation as a multidimensional risk determinant, encompassing clean water access, toilet ownership, waste management, and wastewater disposal systems within a single, integrated analytical framework. By identifying the most dominant sanitation factors contributing to diarrheal events in KaoFe Village, this study not only examines the relationships but also assesses the strength of these risk determinants, relevant for formulating evidence-based interventions.

The urgency of this research is further heightened given the high incidence of diarrhea in KaoFe Village compared to other villages in Kadatua District, as well as the low sanitation coverage that meets health standards. Without interventions based on accurate local data, the risk of diarrheal events will continue to recur, potentially increasing the economic burden on families and the health care system. Therefore, this study is crucial as a basis for developing more targeted, effective, and sustainable prevention strategies to improve public health in Buton Regency.

2. RESEARCH METHOD

This study used a quantitative analytical approach with a cross-sectional design [27]-[29]. The aim was to analyze the determinants of environmental sanitation as a risk factor for diarrhea in the community of KaoFe Village, Kadatua District, Buton Regency. This design was chosen because it can illustrate the relationship between the exposure variable (Environmental sanitation) and the outcome variable (Diarrheal incidence) at the same measurement point, making it relevant for identifying community-based risk factors.

The study was conducted in KaoFe Village, one of the villages within the administrative area of Kadatua District, Buton Regency. Geographically, KaoFe Village covers an area of approximately 41 hectares and is situated at an elevation of approximately 2 meters above sea level. The village is approximately 2 km from the district capital and is located in an archipelago whose accessibility depends on sea transportation, as Kadatua District is a small island within Buton Regency. KaoFe Village has a ferry pier that serves as a primary route for population mobility and logistics distribution.

The boundaries of KaoFe Village include: Marawali Village to the north, Banabungi Selatan Village to the south, Kapoa Village to the west, and Banabungi Village to the east. The geographical characteristics of this coastal area, with its relatively densely populated settlements, have the potential to impact environmental sanitation and domestic waste management systems [30]. Demographically, based on secondary village government data, the population in the last year recorded reached 1,038 people, comprising 260 families. The community's social structure, dominated by coastal households with limited water sources, provides an important context for analyzing the determinants of sanitation.

The population in this study was all 260 heads of households (KK) residing in KaoFe Village. The head of the household was chosen as the unit of analysis because he has the authority to make decisions regarding the use of household sanitation facilities and domestic environmental management. The sample was determined using a simple random sampling technique, ensuring that each head of the household had an equal chance of being selected as a respondent. The sample size was calculated using the proportion formula for a cross-sectional design with a 95% confidence level and a 5% margin of error. Based on this calculation, a representative sample size was obtained that met the study's inclusion and exclusion criteria.

This study consists of independent and dependent variables. The independent variable covers components of household environmental sanitation, while the dependent variable is the incidence of diarrhea

within a specific time period among family members. Before presenting the operational definition table, it should be emphasized that each variable is measured based on standardized indicators in environmental health, using a direct observation approach and structured interviews using a closed-ended questionnaire.

Table 1. Operational definitions of research variables

Variables	Indicators	Measurement Method	Scale	Category
Access to clean water	Water source, source protection, physical quality	Observation & Interviews	Nominal	Eligible / Unqualified
Latrines	Type of toilet, septic tank, distance from water source	Observation	Nominal	Healthy / Unhealthy
Waste management	Reservoir, frequency of disposal	Interviews	Nominal	Good / Poor
Wastewater disposal	Sewerage, standing water	Observation	Nominal	Eligible / No
Diarrhea incidence	History of diarrhea in the last 3 months	Interviews	Nominal	Yes / No

The table above shows that all variables are categorized on a nominal scale to facilitate analysis of relationships using appropriate non-parametric statistical tests. Primary data were collected through direct interviews with heads of households using a structured questionnaire and observations of the physical condition of household sanitation. To ensure data validity, the research instrument underwent validity and reliability testing on populations with similar characteristics. Secondary data were obtained from village offices and Health Office reports regarding diarrhea incidence rates.

Data collection was conducted by trained enumerators using the same standard operating procedures to minimize information bias. Data were analyzed in stages, including univariate analysis to describe the frequency distribution of each variable, and bivariate analysis to examine the relationship between environmental sanitation factors and diarrhea incidence using the Chi-square test with a 95% significance level ($\alpha = 0.05$) [31], [32]. To identify the most dominant risk determinants, multivariate analysis using logistic regression was performed. The results of the analysis are expressed as Odds Ratio (OR) values along with 95% confidence intervals.

To clarify the research stages, the following is a research structure chart that illustrates the conceptual and operational flow of the study:

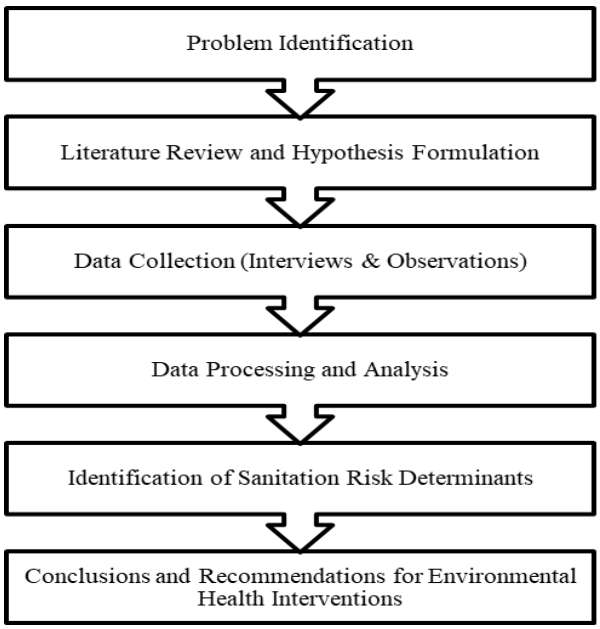

Chart 1. Research Structure

The chart shows that this research was systematically structured, starting from identifying the high incidence of diarrhea to drawing conclusions based on the analysis of risk determinants. This approach ensures methodological transparency and consistency between the research objectives, data collection, and interpretation of results within a public health framework.

3. RESULTS AND DISCUSSION

Descriptive analysis was conducted to present the distribution of environmental sanitation variables and the incidence of diarrhea among households in Desa KaoFe. This analysis provides an overview of the sanitation profile and the proportion of households experiencing diarrhea within the observed period.

Table 1. Distribution of environmental sanitation conditions among households in Desa KaoFe

Variable	Category	n	%
Access to clean water	Meets health standards	102	65.4
	Does not meet standards	54	34.6
Household latrine	Healthy latrine	88	56.4
	Unhealthy / no latrine	68	43.6
Solid waste management	Adequate	79	50.6
	Inadequate	77	49.4
Wastewater disposal	Meets standards	38	24.4
	Does not meet standards	118	75.6
Diarrhea incidence (last 3 months)	Yes	49	31.4
	No	107	68.6

Table 1 shows that although 65.4% of households had access to clean water that met health standards, only 24.4% had adequate wastewater disposal systems. Nearly half of the households (43.6%) did not have a healthy latrine, and 49.4% demonstrated inadequate solid waste management practices. The prevalence of diarrhea within the last three months was 31.4%, indicating that nearly one-third of households reported at least one case of diarrhea. These findings suggest that sanitation deficiencies remain substantial in the study area, particularly in wastewater management.

Bivariate Analysis: Association Between Environmental Sanitation and Diarrhea Incidence

Bivariate analysis was performed using the Chi-square test to determine the association between each sanitation variable and diarrhea incidence. The results are presented below.

Diarrhea Incidence Based on Household Interview

Table 2. Distribution of Diarrhea Incidence Based on Interview

Diarrhea in the Last 3 Months	n	%
Yes	49	31.4
No	107	68.6

Table 2 shows that 31.4% of households reported at least one diarrhea case within the last three months, based on structured interviews with heads of households. Respondents confirmed that most cases occurred among children under five years old.

Table 3. Association Between Access to Clean Water and Diarrhea Incidence

Access to Clean Water	Diarrhea (n, %)	No Diarrhea (n, %)	p-value
Meets standards	19 (18.6%)	83 (81.4%)	0.001
Does not meet standards	30 (55.6%)	24 (44.4%)	

Table 3 indicates a statistically significant association between access to clean water and diarrhea incidence ($p = 0.001$). Households without access to adequate clean water were significantly more likely to report diarrhea cases compared to those with proper access.

Table 4. Association Between Household Latrine and Diarrhea Incidence

Household Latrine	Diarrhea (n, %)	No Diarrhea (n, %)	p-value
Healthy latrine	16 (18.2%)	72 (81.8%)	0.002
Unhealthy / none	33 (48.5%)	35 (51.5%)	

As shown in table 4, the presence of a healthy latrine was significantly associated with lower diarrhea incidence ($p = 0.002$). Households lacking proper sanitation facilities experienced nearly three times higher proportions of diarrhea cases.

Table 5. Association Between Solid Waste Management and Diarrhea Incidence

Solid Waste Management	Diarrhea (n, %)	No Diarrhea (n, %)	p-value
Adequate	14 (17.7%)	65 (82.3%)	0.000

Inadequate	35 (45.5%)	42 (54.5%)

Table 5 demonstrates a strong and statistically significant relationship between solid waste management practices and diarrhea incidence ($p < 0.001$). Households with inadequate waste management had markedly higher diarrhea occurrence.

Table 6. Association Between Wastewater Disposal and Diarrhea Incidence

Wastewater Disposal	Diarrhea (n, %)	No Diarrhea (n, %)	p-value
Meets standards	5 (13.2%)	33 (86.8%)	0.000
Does not meet standards	44 (37.3%)	74 (62.7%)	

Table 6 reveals a statistically significant association between wastewater disposal systems and diarrhea incidence ($p < 0.001$). Households without proper wastewater channels were substantially more likely to report diarrhea cases compared to those with adequate systems.

The bivariate analysis demonstrates that all environmental sanitation variablesaccess to clean water, household latrine availability, solid waste management, and wastewater disposal were significantly associated with diarrhea incidence. Among these factors, inadequate wastewater disposal and poor solid waste management showed the strongest proportional differences in diarrhea occurrence. These findings confirm that environmental sanitation plays a critical role in determining the risk of diarrhea in Desa KaoFe. The consistent statistical significance across all variables underscores the multifactorial nature of diarrhea transmission and highlights the need for integrated sanitation interventions at the household level.

This study demonstrates that environmental sanitation remains a critical determinant of diarrhea incidence in Desa KaoFe. The descriptive findings revealed that although access to clean water reached 65.4%, other essential sanitation components were substantially inadequate, particularly wastewater disposal (75.6% not meeting standards) and unhealthy or absent latrines (43.6%). The prevalence of diarrhea within the last three months was 31.4%, indicating that nearly one-third of households experienced diarrheal episodes. These findings suggest that partial sanitation coverage does not necessarily translate into effective disease prevention when other sanitation components remain deficient.

The bivariate analysis further confirmed that all examined sanitation variables access to clean water, household latrine availability, solid waste management, and wastewater disposal were significantly associated with diarrhea incidence. Households lacking adequate clean water access reported markedly higher diarrhea occurrence (55.6%) compared to those with safe water (18.6%). Similarly, the absence of healthy latrines and improper waste management were strongly linked to increased diarrhea cases. Notably, inadequate wastewater disposal demonstrated one of the strongest proportional differences, highlighting the role of stagnant wastewater and environmental contamination in facilitating fecal oral transmission [33], [34]. These results reinforce the epidemiological pathway that links environmental contamination to gastrointestinal infections through water, food, and vector-mediated exposure.

When compared with previous studies, the findings are consistent with the broader body of evidence demonstrating the association between sanitation and diarrheal diseases. Numerous studies in low-resource and rural settings have identified water quality, latrine ownership, and waste disposal as significant predictors of diarrhea [35], [36]. However, many earlier investigations have examined these factors separately or focused primarily on a single dominant variable, such as water access alone [37], [38]. The gap in prior research lies in the limited integration of multiple sanitation dimensions within a unified analytical framework, particularly in small island or coastal rural contexts [39], [40]. This study addresses that gap by simultaneously examining four core sanitation components and demonstrating their collective and individual contributions to diarrhea risk within a geographically isolated island community.

The novelty of this research lies in its multidimensional assessment of sanitation determinants within a specific island-based rural setting. Unlike studies conducted in mainland or urban environments, this research contextualizes sanitation risk within a coastal, low-altitude village with limited wastewater infrastructure and high environmental vulnerability. The findings reveal that even when clean water access appears relatively moderate, weaknesses in wastewater and solid waste systems can undermine overall sanitation effectiveness. This integrative approach provides a more comprehensive understanding of how sanitation systems operate as interconnected determinants rather than isolated risk factors.

From a public health perspective, the implications of these findings are substantial. First, interventions aimed solely at improving access to clean water may be insufficient without parallel improvements in wastewater management and latrine quality. Second, the strong association between wastewater disposal and diarrhea underscores the urgent need for community-based drainage systems and improved household greywater channels. Third, health promotion strategies should incorporate behavioral education alongside infrastructure development, given that sanitation effectiveness depends on both facility availability and proper utilization. Policymakers and local health authorities should therefore prioritize integrated environmental health programs

that address water, sanitation, and hygiene (WASH) comprehensively rather than through fragmented interventions.

4. CONCLUSION

This study aimed to determine the role of environmental sanitation factors as determinants of diarrhea incidence in Desa KaoFe. The findings indicate that 31.4% of households reported diarrhea cases within the last three months. Descriptive results showed that 34.6% of households did not have access to clean water meeting health standards, 43.6% lacked healthy latrines, 49.4% practiced inadequate solid waste management, and 75.6% had wastewater disposal systems that did not meet sanitary requirements. Bivariate analysis demonstrated statistically significant associations between all sanitation variables and diarrhea incidence ($p < 0.05$), confirming that inadequate sanitation conditions substantially increase the risk of diarrheal disease. These findings highlight that environmental sanitation in Desa KaoFe remains insufficient and represents a significant public health concern. Integrated sanitation improvement programs focusing on wastewater management, safe latrine construction, and sustainable waste disposal systems should be prioritized to reduce diarrhea risk.

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USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors confirm that no artificial intelligence (AI)-assisted technologieswere utilized in thepreparation, analysis, or writing of this manuscript. Allstages of the research process, including data collection, data interpretation, and the development of the manuscript, were conducted solely by the authors without any support from AI-based tools

REFERENCES

[1] A. Liberati *et al.*, "The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration," *PLoS Med.*, vol. 6, no. 7, pp. 1–28, 2009, doi: 10.1371/journal.pmed.1000100.

[2] J. G. Djokoto, P. Pomeyie, and C. A. Wongnaa, "Foreign direct investment in food manufacturing and stages of human development," *Cogent Econ. Financ.*, vol. 11, no. 2, pp. 37-45, 2023, doi: 10.1080/23322039.2023.2267738.

[3] O. H. Gumara, A. S. Wahyuri, D. Damrah, and N. Ihsan, "Effectiveness of e-modules for physical education, sports and health subjects in improving learning outcomes of junior high school students," *Edumaspul J. Pendidik.*, vol. 7, no. 1, pp. 1320–1327, 2023, doi: 10.33487/edumaspul.v7i1.6037.

[4] N. Alam, H. R. Chowdhury, A. Ahmed, M. Rahman, and P. Kim Streatfield, "Distribution of cause of death in rural Bangladesh during 2003-2010: Evidence from two rural areas within matlab health and demographic surveillance site," *Glob. Health Action*, vol. 7, no. 1, 2014, doi: 10.3402/gha.v7.25510.

[5] D. C. Karaferis, D. A. Niakas, D. Balaska, and A. Flokou, "Valuing outpatients' perspective on primary health care services in greece: A cross-sectional survey on satisfaction and personal-centered care," *Healthcare*, vol. 12, no. 14, pp. 1–20, 2024, doi: 10.3390/healthcare12141427.

[6] J. Singh, B. Matthees, and A. L. Odetunde, "Leaning online education during COVID-19 pandemic – attitudes and perceptions of non-traditional adult learners," *Qual. Assur. Educ.*, vol. 29, no. 4, pp. 408–421, 2021, doi: 10.1108/QAE-12-2020-0147.

[7] E. K. Odjer and E. K. G. Mensah, "Maternal mortality and legal accountability: examining government responsibility for preventable deaths," *J. Law Crim. Justice*, vol. 13, no. 5, pp. 49–73, 2025, doi: 10.15640/jlcj.v13p4.

[8] M. M. Mugambi, "Inculcating values among learners in schools: An analysis of global practices and approaches," *J. Educ. Train.*, vol. 9, no. 2, p. 178, 2022, doi: 10.5296/jet.v9i2.20055.

[9] M. Kiran, Y. Xie, N. Anjum, G. Ball, B. Pierscionek, and D. Russell, "Machine learning and artificial intelligence in type 2 diabetes prediction: a comprehensive 33-year bibliometric and literature analysis," *Front. Digit. Heal.*, vol. 7, no. 2, pp. 1–27, 2025, doi: 10.3389/fdgth.2025.1557467

[10] A. Musa *et al.*, "Antimicrobial activities of the extracts and secondary metabolites from clausena genus – a review," *Open Chem.*, vol. 20, no. 1, pp. 627–650, 2022, doi: 10.1515/chem-2022-0176.

[11] D. A. Majeed, "Data analysis and machine learning applications in environmental management," *J. Ilm. Ilmu Terap. Univ. Jambi*, vol. 8, no. 2, pp. 398–408, 2024, doi: 10.22437/jiituj.v8i2.32769.

[12] D. Nandari, A. A. M. Semariyani, and N. M. A. S. Singapurwa, "Chemical and microbiology analysis of salted anchovies (Stolephorus sp.) in east denpasar traditional market," *SEAS (Sustainable Environ. Agric. Sci.*, vol. 4, no. 2, pp. 120–129, Nov. 2020, doi: 10.22225/seas.4.2.2621.120-129.

[13] Sutomo *et al.*, "Short communication: Plant diversity utilization and land cover composition in the Subak Jatiluwih, Bali, Indonesia," *Biodiversitas*, 2021, doi: 10.13057/biodiv/d220345.

[14] S. B. Prayitno, Sarwan, and Sarjito, "The diversity of gut bacteria associated with milkfish (Chanos chanos forsksal) from northern coast of central java, Indonesia," *Procedia Environ. Sci.*, vol. 23, no. 3, pp. 375–384, 2015, doi: 10.1016/j.proenv.2015.01.054.
[15] H. Yin, S. Huang, and W. Wang, "Work environment characteristics and teacher well-being: The mediation of emotion regulation strategies," *Int. J. Environ. Res. Public Health*, vol. 13, no. 9, 2016, doi: 10.3390/ijerph13090907.
[16] E. J. Kim and Y. S. Roh, "Competence-based training needs assessment for basic life support instructors," *Nurs. Health Sci.*, vol. 21, no. 2, pp. 198–205, 2019, doi: 10.1111/nhs.12581.
[17] C. Palermo *et al.*, "Setting priorities for health education research: A mixed methods study," *Med. Teach.*, vol. 41, no. 9, pp. 1029–1038, 2019, doi: 10.1080/0142159X.2019.1612520.
[18] M. Kennedy-Martin *et al.*, "Which multi-attribute utility instruments are recommended for use in cost-utility analysis? A review of national health technology assessment (HTA) guidelines," *Eur. J. Heal. Econ.*, vol. 21, no. 8, pp. 1245–1257, 2020, doi: 10.1007/s10198-020-01195-8.
[19] F. Saltan and Ö. Arslan, "The use of augmented reality in formal education: A scoping review," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 13, no. 2, pp. 503–520, 2017, doi: 10.12973/eurasia.2017.00628a.
[20] M. M. D. Wahyuni *et al.*, "Epidemiological surveillance on diarrheal diseases at pasir panjang primary health care center 2025," *J. Widya Med.*, vol. 11, no. 2, pp. 100–110, 2025, doi: 10.33508/jwm.v11i2.7508.
[21] O. J. Sumampouw, J. E. Nelwan, F. V. Kuhon, O. R. Pinontoan, E. C. Musa, and J. Tahulending, "The determinants of the incidence of diarrhea in underfive children in Urban coastal areas: A Cross-sectional study," *Int. J. Nat. Heal. Sci.*, vol. 4, no. 1, pp. 37–50, 2026, doi: 10.59890/ijnhs.v4i1.147.
[22] Dewi Suparti, E. C. Situmorang, R. Hasugian, R. Situmorang, and F. Diniarti, "Diarrhea prevention and treatment counseling in Suka Maju Village, penarik district, Mukomuko regency," *J. Inov. Kerja Nyata*, vol. 1, no. 1, pp. 51–56, 2025, doi: 10.70963/jikn.v1i1.833.
[23] Y.-E. Cha, Y.-Z. Fu, and W. Yao, "Knowledge, practice of personal hygiene, school sanitation, and risk factors of contracting diarrhea among Rural students from fivew western provinces in China," *Int. J. Environ. Res. Public Health*, vol. 18, no. 18, p. 9505, 2021, doi: 10.3390/ijerph18189505.
[24] D. Cendekia, D. Ayu Afifah, and W. Hanifah, "Linearity graph in the prediction of granular active carbon (GAC) adsorption ability," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 1012, no. 1, 2021, doi: 10.1088/1755-1315/1012/1/012079.
[25] M. W. A. Kesiman and K. Agustini, "The implementation of hypertext-based learning media for a local cultural based learning," *J. Inf. Technol. Educ. Innov. Pract.*, vol. 11, no. 4, pp. 377–385, 2012, doi: 10.28945/1741.
[26] J. Novotný and B. G. Mamo, "Household-level sanitation in Ethiopia and its influencing factors: a systematic review," *BMC Public Health*, vol. 22, no. 1, p. 1448, 2022, doi: 10.1186/s12889-022-13822-5.
[27] A. M. Rubeba, "Lecturers' teaching competencies towards improving teaching and learning process in universities in Tanzania: Students' perspectives," *Heliyon*, vol. 11, no. 1, p. e41683, 2025, doi: 10.1016/j.heliyon.2025.e41683.
[28] J. Y. Ho *et al.*, "Towards an integrated approach to improve the understanding of the relationships between water-borne infections and health outcomes: Using Malaysia as a detailed case study," *Front. Water*, vol. 4, no. 3, pp. 1–8, 2022, doi: 10.3389/frwa.2022.779860.
[29] M. Abduh, T. Alawiya, G. Apriansyah, R. A. Sirodj, and M. W. Afgani, "Survey design: Cross sectional dalam penelitian kualitatif," *J. Pendidik. Sains dan Komput.*, vol. 3, no. 1, pp. 31–39, 2023, doi: 10.22437/jiituj.v5i1.12886.
[30] S. Sousa, E. Correia, J. Leite, and C. Viseu, "Environmental knowledge, attitudes and behavior of higher education students: a case study in Portugal," *Int. Res. Geogr. Environ. Educ.*, vol. 0, no. 0, pp. 1–18, 2020, doi: 10.1080/10382046.2020.1838122.
[31] S. T. Nihan, "Karl Pearsons chi-square tests," *Educ. Res. Rev.*, vol. 15, no. 9, pp. 575–580, 2020, doi: 10.5897/err2019.3817.
[32] A. K. Mbah and A. Paothong, "Shapiro–francia test compared to other normality test using expected p-value," *J. Stat. Comput. Simul.*, vol. 85, no. 15, pp. 3002–3016, 2015, doi: 10.1080/00949655.2014.947986.
[33] A. M. Aljeboree, "Direct dyes derived from 4 , 4 -diaminobenzanilide synthesis , characterization and toxicity evaluation of a disazo symmetric direct dye," *Bioresour. Technol.*, vol. 2, no. 3, pp. 1–12, 2014, doi: 10.1007/s12257-009-0199-4
[34] L. A. Mukadar, T. Joko, and O. Setiani, "Liquid waste pollution load analysis home industry batik and the impact on the quality of river water in the sub-district of Pekalongan Selatan, Pekalongan city," *Int. J. Heal. Educ. Soc.*, vol. 4, no. 11, pp. 47–60, 2021,
[35] T. U. Zaman, H. D. Goswami, and Y. Hassan, "The impact of growth and development of slums on the health status and health awareness of slum dwellers," *Int. J. Med. Res. Heal. Sci.*, vol. 7, no. 3, pp. 55–65, 2018.
[36] M. C. da C. Carvalho, S. A. Ribeiro, L. S. de Sousa, A. Â. M. Lima, and B. L. L. Maciel, "Undernutrition and intestinal infections in children: A narrative review," *Nutrients*, vol. 17, no. 9, p. 1479, Apr. 2025, doi: 10.3390/nu17091479.
[37] E. U. Alum, E. I. Obeagu, and O. P.-C. Ugwu, "Enhancing quality water, good sanitation, and proper hygiene is the panacea to diarrhea control and the attainment of some related sustainable development goals: A review," *Medicine (Baltimore).*, vol. 103, no. 38, p. e39578, 2024, doi: 10.1097/MD.0000000000039578.
[38] A. Setya Roswendi and Y. Zakiyah, "Relationship between environmental sanitation and the incidence of scabies: A literature review," *KnE Med.*, vol. 2022, pp. 207–215, 2022, doi: 10.18502/kme.v2i2.11083.
[39] W. Wasehudin, I. Anshori, M. T. Rahman, I. Syafe'i, and G. C. Kesuma, "A creativity education model for coastal communities amid the covid-19 pandemic," *J. Environ. Manag. Tour.*, vol. 12, no. 3, pp. 729–741, 2021.
[40] P. Adatara, A. Afaya, E. A. Baku, S. M. Salia, and A. Asempah, "Perspective of traditional birth attendants on their experiences and roles in maternal health care in rural areas of northern Ghana," *Int. J. Reprod. Med.*, vol. 2018, no. 10, pp. 1–10, Oct. 2018, doi: 10.1155/2018/2165627.