Journal of Health Innovation and Environmental Education
Vol. 3, No. 1, June 2026, pp. 13~20
ISSN: 3062-9632, DOI: 10.37251/jhiee.v3i1.2874

Household Sanitation Access, Maternal Personal Hygiene, and Child Snacking Practices as Predictors of Diarrheal Morbidity in Under-Five Children Living Along the Citarum River Basin

Fuad Hilmi Sudasman [1], Manh Van Pham[2]
[1]Environmental Health Interest in Public Health Study Program, Faculty of Medicine and Health Sciences, Syarif Hidayatullah State Islamic University, Jakarta, Indonesia
[2] Department of Physical Therapy, Hai Duong Medical, Technical University, Hai Duong, Vietnam

Article Info

Article history:

Received Dec 20, 2025
Revised Jan 5, 2026
Accepted Feb 17, 2026
Online First Marc 13, 2026

Keywords:

Child snacking practices
Diarrheal morbidity
Environmental health.
Household sanitation
Maternal personal hygiene
Riverbank communities

ABSTRACT

Purpose of the study: This study aimed to examine household sanitation access, maternal personal hygiene, and child snacking practices as predictors of diarrheal morbidity among under-five children living along the Citarum River Basin, Indonesia.

Methodology: A community-based case–control study was conducted in Kelurahan Andir, Baleendah Subdistrict. A total of 122 participants (61 cases and 61 controls) were selected using simple random sampling. Data were collected through structured questionnaires, non-participant observation, and environmental assessment of sanitation facilities. Variables included clean water access, latrine condition, wastewater disposal, solid waste management, maternal hygiene practices, and child snacking behaviors. Data were analyzed using descriptive and bivariate statistical approaches to assess associations between exposures and diarrheal morbidity.

Main Findings: Although 75.8% of households had access to clean water meeting health standards, substantial deficiencies were observed in latrine adequacy (54.1% not meeting standards), wastewater disposal systems (59.0% inadequate), and solid waste management (67.6% inadequate). These sanitation gaps, combined with suboptimal hygiene practices and unsafe snacking behaviors, indicate multiple environmental and behavioral exposure pathways contributing to diarrheal morbidity in the study area.

Novelty/Originality of this study: ffective prevention strategies should adopt an integrated environmental–behavioral approach that simultaneously strengthens sanitation infrastructure and promotes hygiene behavior change in high-risk settlements.

Corresponding Author:
Fuad Hilmi Sudasman,
Environmental Health Interest in Public Health Study Program, Faculty of Medicine and Health Sciences,
Syarif Hidayatullah State Islamic University,
Jl. Ir. Juanda No. 95, Ciputat, Jakarta, Indonesia.
Email: fuadhilmisudasman18@gmail.com

1. INTRODUCTION

Diarrheal disease remains a leading cause of morbidity and mortality in children under five years of age (*Toddlers*) in developing countries [1], [2]. Globally, billions of diarrheal episodes occur annually, with the largest proportion in Asia and Africa, and toddlers are the most vulnerable group, especially in the first two years of life [3], [4], [5]. Diarrhea not only contributes to child mortality but also has long-term impacts on nutritional

status, growth, and cognitive development [6], [7], [8]. This high disease burden demonstrates that diarrhea is not merely a clinical problem but also reflects suboptimal environmental conditions and public health practices.

Diarrhea transmission generally occurs through the fecal-oral route, which is closely related to air quality, sanitation, and hygiene practices [9], [10]. Limited access to clean water, the use of unimproved latrines, poor domestic waste management, and inadequate handwashing habits have long been identified as key determinants of diarrhea in children [11], [12], [13]. In addition to environmental factors, individual behaviors including the hygiene practices of mothers as primary caregivers and children's dietary habits also play a role in increasing the risk of pathogen exposure [14], [15], [16]. Thus, the incidence of diarrhea in toddlers is the result of a complex interaction between household environmental factors and health behaviors.

Although various studies have examined the relationship between sanitation and hygiene and diarrhea, most tend to analyze these factors separately. Approaches that integrate household sanitation access, mothers' personal hygiene practices, and children's snacking habits into a single analytical framework are still relatively limited, particularly in communities living in ecologically high-risk areas [17]. Furthermore, the socio-ecological context of riverbank areas, characterized by high population density, potential air pollution, and community dependence on surface water sources, has not been comprehensively explored in relation to diarrhea morbidity in children [18]. This gap highlights the need for more integrated and contextual studies.

Regions along the Citarum River Basin are known to have high levels of environmental pollution and significant domestic pressures [19], [20], [21]. In some riverbank areas, restrictions on the ownership of sanitary latrines, the practice of disposing of waste directly into the river, and the use of potentially contaminated groundwater are still found [21], [22]. This condition is exacerbated by children's high mobility and activity in the home environment, including the consumption of food that does not necessarily meet food hygiene standards. Epidemiologically, this situation creates multiple exposures to infectious agents that cause diarrhea. However, empirical evidence specifically examining how the combination of household sanitation access, maternal hygiene, and snacking habits predicts diarrhea morbidity in children under five in the Citarum River Basin is still limited.

At the local level, the Baleendah area, particularly Andir Village, is reported to have a relatively high diarrhea caseload compared to other areas in Bandung Regency. This fact indicates a public health vulnerability that requires evidence-based explanation [24], [25], [26]. However, the available data are generally descriptive and do not yet reflect the relative contribution of each risk factor at the household level. The absence of an analysis that positions these variables as predictors in a single integrated model represents both a scientific gap and an opportunity to generate more applicable findings for planning environmental health interventions.

Based on this background, this study offers novelty in three main aspects. First, it integrates environmental dimensions (household sanitation access) and behavioral dimensions (maternal personal hygiene and children's snacking habits) into a single predictive model for diarrhea morbidity in children under five. Second, this study focuses on riverbank communities, which ecologically have a higher risk of pathogen exposure than non-riparian areas. Third, this study positions diarrheal morbidity as a health outcome analyzed within the context of household determinants, so that the results can provide an evidence-based basis for family- and community-based interventions.

Therefore, this study aims to analyze the role of household sanitation access, maternal personal hygiene practices, and children's snacking habits as predictors of diarrheal morbidity in toddlers living along the Citarum River Basin. A more comprehensive understanding of these determinants is crucial for designing more targeted prevention strategies, particularly for child populations in environmentally high-risk areas.

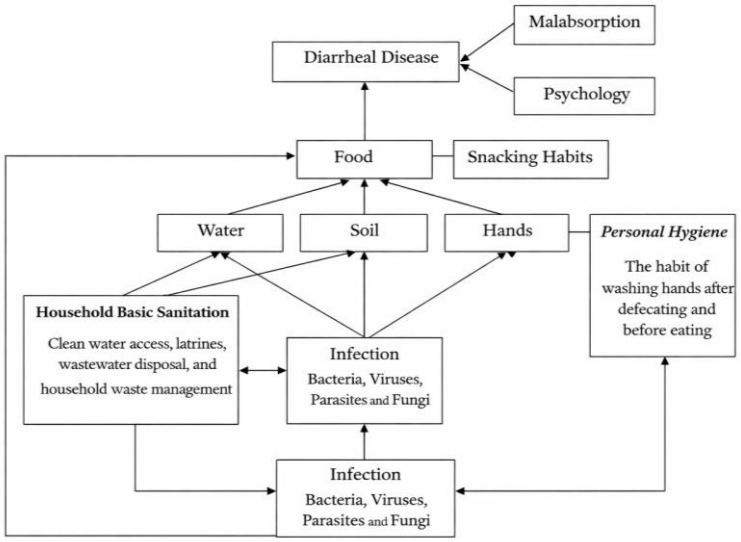

Figure 1. Theoretical framework of the study

This study is grounded in an integrated environmental–behavioral health framework which posits that diarrheal morbidity in under-five children is the result of complex interactions between environmental exposure pathways and caregiver-mediated behavioral practices. In riverbank settlements, limited access to adequate household sanitation including safe water supply, improved latrines, wastewater disposal systems, and solid waste management facilitates environmental contamination of water, soil, and household surfaces. These contaminated media act as reservoirs for pathogenic microorganisms (bacteria, viruses, parasites, and fungi), increasing the likelihood of infection transmission through the fecal–oral route. Food serves as a critical transmission vehicle, particularly when exposed to contaminated water, soil, or hands during preparation, storage, or consumption. Within this framework, diarrheal disease represents the clinical manifestation of cumulative exposure to these environmental and microbial risks.

Beyond structural sanitation constraints, the framework emphasizes the pivotal role of maternal personal hygiene and child snacking practices as proximal behavioral determinants that may either mitigate or amplify exposure risk. Proper handwashing practices after defecation and before food handling interrupt pathogen transmission, whereas inadequate hygiene increases contamination probability at the household level. Similarly, frequent consumption of street or unpackaged snacks in environments with suboptimal hygiene standards may introduce additional microbial exposure. By conceptualizing household sanitation access as a distal environmental determinant and maternal hygiene and snacking habits as intermediate behavioral pathways, this study positions diarrheal morbidity as the measurable health outcome of an interconnected exposure system. This integrative perspective provides a theoretically coherent basis for examining the predictive role of environmental and behavioral factors within high-risk river basin communities.

2. RESEARCH METHOD

2.1. Study Design and Setting

This study employed a quantitative approach using a case control design. The case control framework was selected to identify potential risk factors associated with diarrheal morbidity by comparing children under five years of age with a history of diarrhea (cases) and those without such history (controls), and retrospectively examining their exposure status [27], [28], [29]. This design is appropriate for investigating associations between environmental and behavioral exposures and relatively frequent community-based health outcomes [30], [31].

The study was conducted in Kelurahan Andir, Baleendah Subdistrict, Bandung Regency, Indonesia, particularly in settlements located along the Citarum River Basin. This area was selected due to its high reported burden of diarrheal cases and its environmental vulnerability as a riverbank community.

2.2. Sample Size Determination

Sample size calculation was based on the comparison of two proportions (P1 and P2) derived from previous studies examining sanitation-related risk factors for diarrhea. Among the reviewed variables, the largest minimum sample requirement was identified for the wastewater disposal variable (n = 111), which was therefore adopted to ensure adequate statistical power.

To account for a potential 10% non-response or dropout rate, the final required sample size was increased to 122 participants. A 1:1 ratio between cases and controls was applied, resulting in 61 cases and 61 controls.

Table 1. Sample Size Estimation Based on Previous Studies

No	Variable	P1	P2	Minimum Sample
1	Clean water facility	0.49	0.184	29
2	Latrine ownership	0.487	0.239	46
3	Wastewater disposal facility	0.309	0.167	111
4	Solid waste management	0.766	0.25	11
5	Household environmental sanitation	0.549	0.357	83

The largest calculated sample size (111) was used as the basis for determining the final sample size.

2.3. Study Population and Sampling Procedure

The source population consisted of children under five years of age residing in Kelurahan Andir. Case data were obtained from the Baleendah Primary Health Center *(UPT Puskesmas Baleendah*), including records of under-five outpatient visits diagnosed with diarrhea between January and May. Cases were defined as under-five children recorded in the health center registry as having experienced diarrhea during the study period and residing in the riverbank area. Controls were under-five children from the same geographical area with no recorded history of diarrhea during the same period [32], [33].

Addresses listed in the health center registry were verified and cross-checked with neighborhood administrative records (RW level) to ensure accuracy. Eligible cases were selected through simple random sampling from RW 001, 002, 003, 006, 007, and 013. Controls were selected from the same RW using the same random sampling method and matched by area of residence.

Participants who did not meet inclusion criteria or met exclusion criteria during field verification were replaced using the same randomization procedure.

2.4. Data Collection

Data collection was conducted using structured questionnaires, non-participant observation, and direct measurement. The questionnaire captured information on:

- Household sanitation access (clean water facilities, latrine ownership, wastewater disposal, and solid waste management),
- Maternal personal hygiene practices (particularly handwashing after defecation and before food handling),
- Child snacking practices, and
- History of diarrheal episodes.

Observational checklists were used to assess the physical condition of sanitation facilities. A measuring tool was used when necessary to verify environmental characteristics.

2.5. Instrument Validity and Reliability

The questionnaire initially consisted of 46 items. Construct validity was assessed using Pearson's product–moment correlation. Items were considered valid if the calculated correlation coefficient (r-count) exceeded the critical value (r-table = 0.361). Eight items that did not meet this criterion (B4, B5, B6, B7, B8, C7, D8, and D9) were removed, as their content was adequately represented by other valid items.

Internal consistency reliability was evaluated using Cronbach's alpha. The instrument demonstrated strong reliability, with a Cronbach's alpha value of 0.881, exceeding the acceptable threshold. Therefore, the questionnaire was deemed reliable for measuring the study variables.

2.6. Data Analysis

Data were analyzed using statistical software. Descriptive (univariate) analysis was performed to summarize the distribution of dependent and independent variables. Categorical variables were presented as frequencies and percentages. Bivariate analysis was conducted to assess the association between household sanitation access, maternal personal hygiene, child snacking practices, and diarrheal morbidity. Odds ratios (OR) with 95% confidence intervals (CI) were calculated to estimate the strength of association. Statistical significance was determined at a predefined alpha level.

3. RESULTS AND DISCUSSION

Descriptive analysis was conducted to assess the distribution of household sanitation components among families residing along the Citarum River Basin in Kelurahan Andir. The sanitation indicators examined included access to clean water facilities, latrine ownership, wastewater disposal systems, and household solid waste management. A total of 244 households were included in this descriptive assessment.

Clean water facilities were categorized into two groups: meeting health standards and not meeting health standards.

Table 2. Distribution of Clean Water Facilities in the Citarum Riverbank Area (n = 244)

Clean Water Facilities	Frequency (n)	Percentage (%)
Meeting standards	185	75.8
Not meeting standards	59	24.2
Total	244	100.0

As shown in table 2, the majority of households (75.8%) had clean water facilities that met established health standards. However, nearly one-quarter (24.2%) of households relied on water sources that did not meet safety criteria. Although the overall coverage appears relatively high, the presence of unsafe water sources among one in four households indicates a substantial potential pathway for microbial contamination, particularly in a riverbank setting vulnerable to environmental pollution. This finding highlights that clean water access remains an important, though not the sole, sanitation concern in the study area.

Latrine ownership and condition were similarly categorized into meeting and not meeting health standards.

Table 2. Distribution of Latrine Facilities in the Citarum Riverbank Area (n = 244)

Latrine Condition	Frequency (n)	Percentage (%)
Meeting standards	112	45.9
Not meeting standards	132	54.1
Total	244	100.0

Table 2 demonstrates that more than half of households (54.1%) had latrines that did not meet minimum sanitation standards. Only 45.9% of households possessed adequate latrine facilities. This distribution suggests that improper fecal disposal remains a critical issue in the study area and may significantly contribute to environmental contamination. Compared with clean water access, latrine adequacy appears to represent a more pronounced sanitation gap within this community.

The condition of household wastewater disposal systems was assessed to determine whether greywater and domestic effluent were managed safely.

Table 3. Distribution of Wastewater Disposal Systems (n = 244)

Wastewater Disposal System	Frequency (n)	Percentage (%)
Meeting standards	100	41.0
Not meeting standards	144	59.0
Total	244	100.0

As presented in Table 3, 59.0% of households had wastewater disposal systems that did not meet health standards. Only 41.0% managed domestic wastewater appropriately. This indicates that the majority of households may discharge wastewater directly into open drains or the river environment, increasing the risk of pathogen proliferation and exposure. The relatively high proportion of inadequate wastewater management reinforces the structural sanitation vulnerability of this riverbank settlement.

Household solid waste management practices were evaluated based on the availability and proper use of waste storage and disposal systems.

Table 4. Distribution of Household Solid Waste Management (n = 244)

Solid Waste Management	Frequency (n)	Percentage (%)
Meeting standards	79	32.4
Not meeting standards	165	67.6
Total	244	100.0

Table 4 shows that 67.6% of households did not meet recommended standards for solid waste management, while only 32.4% demonstrated adequate practices. This represents the lowest compliance among all sanitation components assessed. Inadequate waste management can contribute to environmental contamination, attract disease vectors, and indirectly increase the risk of food and water contamination.

Overall, while access to clean water was relatively high, other sanitation components particularly latrine adequacy, wastewater disposal, and solid waste management showed substantial deficiencies. The highest

proportion of non-compliance was observed in solid waste management (67.6%), followed by wastewater disposal (59.0%) and latrine facilities (54.1%).

These findings indicate that although water access appears comparatively adequate, broader environmental sanitation infrastructure remains insufficient in the Citarum riverbank community. The coexistence of inadequate fecal disposal systems, unsafe wastewater management, and poor solid waste practices may create multiple environmental transmission pathways for diarrheal pathogens. This descriptive profile provides the contextual foundation for subsequent analytical examination of the association between sanitation access and diarrheal morbidity among under-five children.

This study shows that although the majority of households in the Citarum Riverbanks have access to clean water facilities that meet standards (75.8%), other sanitation components particularly latrines (54.1% do not meet standards), wastewater drainage (59.0% do not meet standards), and household waste management (67.6% do not meet standards) remain in a worrying condition. This pattern illustrates the disparity in household sanitation access, with clean water availability being relatively better compared to domestic waste management systems. In the context of diarrheal epidemiology, this condition has the potential to create a persistent fecal-oral exposure pathway through environmental contamination, even though the primary water source appears administratively adequate.

This finding aligns with previous studies showing that inadequate sanitation, particularly latrine ownership and wastewater management, is significantly associated with an increased risk of diarrhea in children under five. Studies in various regions of Indonesia and other developing countries consistently report that open defecation practices, open drainage systems, and direct disposal of domestic waste into the environment increase the likelihood of water and soil contamination by pathogenic bacteria. However, most previous studies tend to examine sanitation components separately or place environmental factors solely as the primary determinant, without integrating the behavioral dimensions of caregivers and children's eating habits into a coherent analytical framework.

This is where the research gap this study aims to address lies. First, previous research has predominantly used a descriptive approach or a single analysis of a single sanitation variable, thus failing to provide a comprehensive picture of the simultaneous interaction between household sanitation access and behavioral factors [34]. Second, the context of riverbank communities which are ecologically more vulnerable to water pollution has not been widely studied using an integrated predictive approach [12]. Third, children's snacking habits, as an additional exposure pathway, are still relatively rarely included in household-based diarrhea risk models [4]. Therefore, this study fills this scientific gap by developing an integrative perspective that links structural determinants (sanitation access) and behavioral determinants (maternal personal hygiene and children's snacking habits) within a single interacting exposure system [35].

The novelty of this research lies in its conceptual approach, which combines environmental and behavioral factors in the context of high-risk riparian communities. This study not only describes sanitation conditions but also positions these components as predictors within the household-based disease transmission system. By positioning sanitation as a distal determinant and maternal hygiene practices and children's snacking habits as proximal determinants, this study provides a more comprehensive framework for understanding diarrheal morbidity in toddlers [36], [37]. This approach broadens the discourse from simply "facility availability" to "how facilities and behavior interact to create health risks."

In terms of implications, these findings suggest that diarrhea prevention interventions in riverbank areas cannot simply focus on improving access to clean water. Improvement efforts must be systemic, including increasing the ownership and quality of healthy latrines, developing safe wastewater disposal systems, and strengthening household waste management systems. Furthermore, behavior-change-based interventions such as handwashing education and monitoring children's snack consumption need to be integrated into environmental health programs. An integrated, cross-sectoral approach (health, environment, and spatial planning) is crucial in the context of the Citarum Watershed, which faces high ecological pressure. The results of this study can form the basis for evidence-based policy in planning community-based sanitation programs.

However, this study has several limitations. The retrospective case-control design cannot fully confirm causal relationships, only associations. Measurement of behavioral variables such as personal hygiene and snacking habits relies on respondent self-reports, potentially subject to recall bias. Furthermore, this study was conducted in a specific area along the Citarum Riverbanks, so generalizations to other areas with different socio-ecological characteristics require caution. Further research with a longitudinal design or a multilevel approach that considers community and macro-environmental factors would enhance understanding of the determinants of diarrhea in children under five in high-risk areas.

Overall, this study confirms that diarrhea morbidity among children under five in riverbank areas is the result of a complex interaction between limited sanitation infrastructure and household behavioral practices. By strengthening an integrative approach between structural and behavioral dimensions, this research contributes to the development of a more comprehensive and contextual diarrhea prevention model in vulnerable communities.

4. CONCLUSION

This study demonstrates that diarrheal morbidity among under-five children living along the Citarum River Basin is closely linked to structural deficiencies in household sanitation and reinforcing behavioral risk pathways. Although access to clean water was relatively high, substantial gaps were identified in latrine adequacy, wastewater disposal systems, and solid waste management. These sanitation deficits, when combined with suboptimal maternal personal hygiene practices and unsafe child snacking behaviors, create a multi-layered exposure environment that facilitates fecal–oral transmission of enteric pathogens.

The findings underscore that diarrheal disease in riverbank communities cannot be adequately addressed through single-component interventions. Instead, it reflects the cumulative effect of environmental contamination and household-level behavioral practices. By integrating sanitation infrastructure and caregiver-mediated behaviors within a unified analytical framework, this study advances a more comprehensive understanding of diarrheal risk in ecologically vulnerable settlements. The results highlight that improving water access alone is insufficient if fecal disposal, wastewater management, and food hygiene remain inadequately controlled.

Importantly, this research contributes to the evidence base by contextualizing diarrheal risk within high-density riparian communities, where environmental exposure pathways are intensified by proximity to polluted water bodies. The integrated environmental–behavioral perspective adopted in this study provides a replicable framework for examining child health vulnerabilities in other river basin settings across low- and middle-income countries. Based on these findings, the researchers recommend that further behavioral change efforts targeting maternal hand hygiene and safe food handling practices be strengthened through public health programs. Child-focused food safety education and monitoring of informal food environments should be integrated into local public health initiatives.

ACKNOWLEDGEMENTS

The authors would like to express their sincere gratitude to the baleendah primary health center and the local authorities of Kelurahan Andir for their support and access to data. Appreciation is also extended to all participating families for their cooperation and valuable contributions to this study.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors confirm that no artificial intelligence (AI)-assisted technologies were utilized in the preparation, analysis, or writing of this manuscript. All stages 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] 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.

[2] E. Yanti, D. Hermon, E. Barlian, I. Dewata, and I. Umar, “Directions for sanitation-based environmental structuring using AHP for the prevention of diarrhea in Pagar Alam City - Indonesia,” *Int. J. Manag. Humanit.*, vol. 4, no. 9, pp. 25–29, 2020, doi: 10.35940/ijmh.i0848.054920.

[3] M. Kelly, “The nutrition transition in developing Asia: dietary change, drivers and health impacts,” in *Surviving. SpringerBriefs in Global Understanding* . *Springe*, 2016, pp. 83–90. doi: 10.1007/978-3-319-42468-2_9.

[4] K. Sun, “Bridging the sustainability gap in rural health equity: policy evaluation and transnational lessons from Guizhou’s targeted medical assistance program,” *Front. Public Heal.*, vol. 13, no. 2, p. 108, Jun. 2025, doi: 10.3389/fpubh.2025.1621223.

[5] A. E. Strode, P. P. Singh, C. M. Slack, and D. R. Wassenaar, “Research ethics committees in a tight spot: Approving consent strategies for child research that are prima facie illegal but are ethical in terms of national guidelines,” *South African Med. J.*, vol. 108, no. 10, pp. 828–832, 2018, doi: 10.7196/SAMJ.2018.v108i10.13203.

[6] B. J. J. McCormick and D. R. Lang, “Diarrheal disease and enteric infections in LMIC communities: How big is the problem?,” *Trop. Dis. Travel Med. Vaccines*, vol. 2, no. 1, p. 11, 2016, doi: 10.1186/s40794-016-0028-7.

[7] 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.

[8] J. K. Das, Z. A. Padhani, and Z. A. Bhutta, “*Persistent Diarrhea in Children in Developing Countries BT - Textbook Of Pediatric Gastroenterology, Hepatology and Nutrition: A Comprehensive Guide to Practice*,”, Cham: Springer International Publishing, pp. 231–240, 2022, doi: 10.1007/978-3-030-80068-0_17.

[9] 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.

[10] S. S. Madsen, “What is the motivation of Norwegian and New Zealand teacher educators for using digital technology

when teaching?," *Nord. J. Comp. Int. Educ.*, vol. 4, no. 2, pp. 42–63, Jul. 2020, doi: 10.7577/njcie.3826.
[11] 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, Sep. 2021, doi: 10.3390/ijerph18189505.
[12] H. Perkins, "Beyond techno-solutionism: Towards critical perspectives in environmental education and digital technology. A critical-hermeneutic review," *Int. J. Child-Computer Interact.*, vol. 42, no. November, p. 100705, 2024, doi: 10.1016/j.ijcci.2024.100705.
[13] N. Tor and G. Gordon, "Digital interactive quantitative curiosity assessment tool: Questions worlds," *Int. J. Inf. Educ. Technol.*, vol. 10, no. 8, pp. 614–621, 2020, doi: 10.18178/ijiet.2020.10.8.1433.
[14] J. D. Rutledge *et al.*, "Recommendations for integrating traditional birth attendants to improve maternal health outcomes in low- and middle-income countries," *Int. J. Matern. Child Heal. AIDS*, vol. 13, p. e019, Sep. 2024, doi: 10.25259/IJMA_16_2024.
[15] N. Z. Siddik and R. Sutanto, "Postpartum education in the working area of the tebing community health center," *Zo. Kedokt. Progr. Stud. Pendidik. Dr. Univ. Batam*, vol. 10, no. 3, pp. 24–28, 2021, doi: 10.37776/zked.v10i3.520.
[16] B. Y. Rizkiwati, S. U. M. Widjaja, A. Haryono, H. Wahyono, and M. Z. Majdi, "Financial literacy education models for 7–12 years old based on the local wisdom of sasak tribe Lombok Indonesia," *Pegem Egit. ve Ogr. Derg.*, vol. 12, no. 2, pp. 58–70, 2022, doi: 10.47750/pegegog.12.02.05.
[17] F. Mawarda, "Analysis of language disorders in people with stuttering (psycholinguistic study)," *Lingua*, vol. 17, no. 1, pp. 44–52, 2021.
[18] 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, Mar. 2022, doi: 10.3389/frwa.2022.779860.
[19] E. Simamora, A. Mansyur, and E. Wydiastuti, "Bootstrap percentile for estimating confidence interval of heteroscedasticity linear regression model parameters," in *AIP Conference Proceedings*, 2022, pp. 1–7. doi: 10.1063/5.0113065.
[20] J. Cavelle, "A political ecology of the citarum river basin: exploring 'integrated water resources management' in West Java, Indonesia," *Berkeley Undergrad. J.*, vol. 26, no. 1, pp. 42–50, 2013, doi: 10.5070/B3261016209.
[21] A. Signoroni, M. Savardi, A. Baronio, and S. Benini, "Deep learning meets hyperspectral image analysis: A multidisciplinary review," *J. Imaging*, vol. 5, no. 5, p. 52, May 2019, doi: 10.3390/jimaging5050052.
[22] S. Sumarwati, "Traditional ecological knowledge on the slope of Mount Lawu, Indonesia: all about non-rice food security," *J. Ethn. Foods*, vol. 9, no. 1, 2022, doi: 10.1186/s42779-022-00120-z.
[23] A. M. Aljeboree *et al.*, "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
[24] 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, Sep. 2025, doi: 10.15640/jlcj.v13p4.
[25] M. Petticrew and H. Roberts, *Systematic Reviews in the Social Sciences: A Practical Guide*. 2008. doi: 10.1002/9780470754887.
[26] 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, Jul. 2024, doi: 10.3390/healthcare12141427.
[27] C. A. Ameh, M. Mdegela, S. White, and N. van den Broek, "The effectiveness of training in emergency obstetric care: a systematic literature review," *Health Policy Plan.*, vol. 34, no. 4, pp. 257–270, May 2019, doi: 10.1093/heapol/czz028.
[28] O. D. Apuke, "Quantitative research methods : A synopsis approach," *Kuwait Chapter Arab. J. Bus. Manag. Rev.*, vol. 6, no. 11, pp. 40–47, 2017, doi: 10.12816/0040336.
[29] J. W. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (4th ed.)*, Thousand O. CA: SAGE, 2014.
[30] P. Y. Lin and C. D. Schunn, "The dimensions and impact of informal science learning experiences on middle schoolers' attitudes and abilities in science," *Int. J. Sci. Educ.*, vol. 38, no. 17, pp. 2551–2572, 2016, doi: 10.1080/09500693.2016.1251631.
[31] S. Yin *et al.*, "Ethnobotany, phytochemistry, pharmacology, and toxicology of the genus datura (*Solanaceae*)," *Nat. Prod. Res.*, vol. 6, no. 2, pp. 1–16, Mar. 2025, doi: 10.1080/14786419.2025.2457598.
[32] K. M. Baker, K. W. Stickney, and D. D. Sachs, "STEM cooperating teachers' professional growth: The positive impacts of a year-long clinical residency collaboration," *Educ. Sci.*, vol. 14, no. 8, 2024, doi: 10.3390/educsci14080899.
[33] 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.
[34] 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.
[35] N. Choi, S. Kang, H. J. Cho, and J. Sheo, "Promoting young children's interest in learning english in efl context: The role of mothers," *Educ. Sci.*, vol. 9, no. 1, 2019, doi: 10.3390/educsci9010046.
[36] Y. A. Sherif, M. A. Hassan, M. Thuy Vu, T. K. Rosengart, and R. W. Davis, "Twelve tips on enhancing global health education in graduate medical training programs," *Med. Teach.*, vol. 43, no. 2, pp. 142–147, 2021, doi: 10.1080/0142159X.2020.1762033.
[37] K. C. Margot and T. Kettler, "Teachers' perception of STEM integration and education: A systematic literature review," *Int. J. STEM Educ.*, vol. 6, no. 1, 2019, doi: 10.1186/s40594-018-0151-2.