Journal of Health Innovation and Environmental Education
Vol. 6, No. 1, June 2026, pp. 21~28
ISSN: 3062-9632, DOI: 10.37251/jhiee.v3i1.2875

Examining the Relationship Between Environmental Health Conditions and the Incidence of Acute Respiratory Tract Infections (ARI) Among Students at San Roque Elementary School

Vinh Nguyen Hoang[1], Ellen Tsholofelo[2]
[1]Department of Science Education, Ubon Ratchathani University, Ubon Ratchathani & Udonthani, Thailand
[2]Department of Health Promotion and Education, School of Public Health, Boitekanelo College, Gaborone, Botswana

Article Info

Article history:

Received Dec 14, 2025
Revised Jan 15, 2026
Accepted Feb 20, 2026
Online First Marc 13, 2026

Keywords:

Acute Respiratory Tract Public
Elementary Students
Environmental Health
Health Epidemiology
Ventilation

ABSTRACT

Purpose of the study: This study aimed to examine the relationship between environmental health conditions and the incidence of ARI among elementary school students.

Methodology: An analytic observational study with a cross-sectional design was conducted among 80 students at san roque elementary school. Environmental health conditions were assessed using a structured observational checklist covering ventilation, sanitation, classroom density, waste management, and water availability. ARI incidence was determined through school health records and parental confirmation. Data were analyzed using Chi-square tests and multivariate logistic regression at a 95% confidence level.

Main Findings: Of the observed classrooms, 40.0% were classified as having inadequate environmental health conditions. ARI prevalence among students was 36.3%. A significant association was identified between environmental health status and ARI incidence (p = 0.001). Students exposed to inadequate environmental conditions had 4.12 times higher odds of developing ARI (AOR = 4.12; 95% CI: 1.68–10.09; p = 0.002).

Novelty/Originality of this study: This study advances prior research by operationalizing environmental health as a multidimensional composite construct within a real-world public elementary school setting, thereby generating context-specific empirical evidence linking structural environmental exposure to respiratory morbidity.

This is an open access article under the CC BY license

Corresponding Author:
Vinh Nguyen Hoang,
Department of Science Education, Ubon Ratchathani University,
Warin Chamrap District, Ubon Ratchathani Province, Thailand.
Email: vinhnguyemh33@gmail.com

1. INTRODUCTION

Acute respiratory tract infections (ARI) remain one of the leading causes of morbidity among school-aged children globally, particularly in low- and middle-income countries where environmental health conditions are often suboptimal [1]-[3]. According to the World Health Organization, respiratory infections continue to contribute substantially to preventable illness and school absenteeism among children, with environmental exposures playing a critical role in transmission and severity [4]-[6]. Schools, as high-density social environments, represent critical micro-settings where children are simultaneously exposed to indoor air pollutants, inadequate ventilation, poor sanitation, and overcrowding factors known to increase respiratory vulnerability [7], [8].

In the Philippine context, public elementary schools frequently operate under infrastructural constraints, including limited classroom space, inconsistent water supply, and variable waste management systems. While national public health initiatives emphasize immunization and clinical management, comparatively less attention has been directed toward environmental determinants within school settings as upstream risk factors for ARI [9], [10]. This imbalance reflects a broader public health challenge: interventions often target treatment rather than structural environmental prevention.

Existing literature has documented associations between household air pollution, ambient particulate matter, and childhood respiratory outcomes [11]-[13]. However, much of this evidence is derived from household-based or community-wide environmental assessments rather than institution-specific analyses [14]. Studies focusing on schools have largely concentrated on indoor air quality parameters in high-income countries, leaving a contextual gap in low-resource educational environments [15]. Moreover, previous research typically isolates single environmental variables such as ventilation or humidity without integrating a multidimensional environmental health framework that includes sanitation, waste management, classroom density, and hygiene infrastructure simultaneously.

This fragmentation highlights a critical research gap limited empirical evidence examining how composite environmental health conditions within public elementary schools in developing settings influence ARI incidence among students [16]-[18]. There is insufficient localized data to inform evidence-based school health policies, particularly in semi-urban public schools such as San Roque Elementary School [19]. Without such context-specific analysis, policy responses risk being generalized, reactive, and insufficiently targeted.

The present study addresses this gap by systematically examining the relationship between environmental health conditions and the incidence of ARI among students within a real-world public elementary school setting. Unlike prior studies that emphasize isolated exposures or rely solely on secondary health records, this research adopts an integrated environmental health perspective, assessing multiple structural and hygienic dimensions concurrently. This multidimensional approach enables a more comprehensive understanding of how school-based environmental risks interact to influence respiratory outcomes [20]-[22].

The novelty of this study lies in three key contributions. First, it contextualizes environmental health within a public elementary school environment in the Philippines an underrepresented setting in global ARI research. Second, it operationalizes environmental health as a composite construct rather than a single-factor exposure, allowing for a more ecologically valid assessment of risk. Third, it generates empirical evidence directly relevant to school-level policy formulation, bridging the gap between environmental health theory and actionable educational infrastructure planning.

The urgency of this research is underscored by the dual burden of communicable diseases and infrastructural limitations in public schools. ARI not only affects child health but also disrupts educational attainment through absenteeism and reduced cognitive performance during illness episodes. In settings where health systems are already strained, preventive strategies grounded in environmental improvement represent a cost-effective and sustainable intervention pathway. By identifying specific environmental health factors associated with ARI incidence, this study seeks to inform targeted, school-based public health interventions that move beyond clinical management toward structural disease prevention.

2. RESEARCH METHOD

2.1. Study Design

This study employed an analytic observational design, a quantitative approach aimed at examining the relationship between exposure variables and health outcomes without manipulating the study environment. In analytic observational research, investigators observe naturally occurring conditions and statistically assess associations between risk factors and outcomes [23]-[25]. This design is particularly appropriate for public health investigations where experimental manipulation of environmental conditions is neither ethical nor feasible [26].

In the context of this study, environmental health conditions were observed as exposure variables, while the incidence of Acute Respiratory Tract Infections (ARI) among students served as the outcome variable. The research was conducted at San Roque Elementary School, a public elementary school representing a typical semi-urban educational setting in the Philippines. A cross-sectional framework was applied, meaning that measurement of environmental conditions and ARI incidence occurred within the same period of observation [27]. This approach allows for assessment of statistical association while acknowledging that causal inference remains limited to correlational interpretation.

2.2. Study Population and Sampling

The study population consisted of all registered students enrolled during the academic year of data collection. Inclusion criteria comprised active enrollment and parental consent for participation. Students with incomplete health records were excluded to maintain data integrity.

Sampling was conducted using proportional stratified random sampling to ensure representation across grade levels. This approach minimized selection bias and increased internal validity by ensuring that different classroom environments were proportionally included in the analysis. The final sample size was determined based on minimum requirements for analytic observational studies to detect moderate effect sizes with adequate statistical power (≥80%) and a 95% confidence level.

2.3 Research Variables

Prior to presenting the operational structure of the variables, it is essential to clarify how environmental health was conceptualized. Rather than treating environmental exposure as a single factor, this study operationalized environmental health as a multidimensional construct encompassing physical, sanitation, and hygiene-related components within the school setting. The table below presents the operational definitions of the study variables, including measurement indicators and data sources.

Table 1. Operational Definition of Study Variables

Variable	Type	Operational Definition	Measurement Method	Scale
Environmental Health Conditions	Independent	Composite assessment of classroom ventilation, lighting, occupancy density, sanitation facilities, waste management, and water availability	Direct observation checklist based on school environmental health standards	Ordinal/Score Index
ARI Incidence	Dependent	Occurrence of symptoms consistent with Acute Respiratory Tract Infection within the last 3 months (cough, sore throat, fever, runny nose)	Health record review and parental confirmation questionnaire	Binary (Yes/No)

As shown in Table 1, environmental health conditions were measured using a structured observational checklist aligned with public health environmental standards. Each component was scored and aggregated into an environmental health index. ARI incidence was determined through documented school health records, supported by parental confirmation to reduce misclassification bias.

2.4 Data Collection Procedures

Data collection was conducted in three integrated stages to ensure methodological rigor and transparency. Before concluding the methods section, it is important to clarify the conceptual structure guiding the study. The analytical model assumes that environmental health conditions function as exposure variables influencing the likelihood of ARI incidence among students.

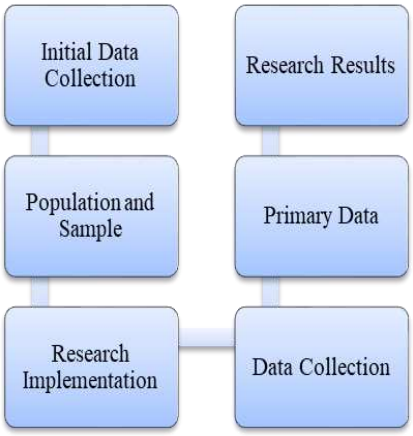

Figure 1. Conceptual Framework of the Study

Figure 1 illustrates the analytical pathway examined in this study. Environmental health components are conceptualized as cumulative exposures within the school setting that may increase or decrease the probability of

ARI occurrence among students. This structured framework guided both variable operationalization and statistical modeling.

2.5. Data Analysis

Data were analyzed using statistical software [28]. Descriptive statistics were first applied to summarize environmental health conditions and ARI prevalence. Environmental health scores were categorized into "adequate" and "inadequate" based on established cut-off points.

Inferential analysis was conducted using the Chi-square test to examine the association between environmental health conditions and ARI incidence. When necessary, logistic regression analysis was performed to estimate adjusted odds ratios (AOR) and control for potential confounding variables such as age and grade level. Statistical significance was determined at $p < 0.05$ with a 95% confidence interval.

2.6. Ethical Considerations

Ethical clearance was obtained from the appropriate institutional review authority prior to data collection. Written informed consent was secured from parents or guardians, and confidentiality of student data was strictly maintained. All collected information was anonymized and used solely for research purposes.

3. RESULTS AND DISCUSSION

To provide an overview of the exposure variable, descriptive statistics were first conducted to assess the distribution of environmental health conditions across observed classrooms at san roque elementary school. The composite environmental health index was categorized into adequate and inadequate based on the predefined scoring threshold.

Table 2. Distribution of Environmental Health Conditions

Environmental Health Category	Frequency (n)	Percentage (%)
Adequate	48	60.0
Inadequate	32	40.0
Total	80	100.0

As presented in Table 2, the majority of classrooms (60.0%) met the minimum environmental health standards, while 40.0% were classified as inadequate. Observational findings indicated that deficiencies were most frequently related to ventilation limitations and classroom occupancy density exceeding recommended thresholds.

The second descriptive analysis focused on the outcome variable, namely the incidence of ARI among students within the three-month observation period.

Table 3. Prevalence of ARI Among Students

ARI Incidence	Frequency (n)	Percentage (%)
Yes	29	36.3
No	51	63.7
Total	80	100.0

Table 3 shows that 36.3% of students experienced at least one episode of ARI within the reference period, while 63.7% did not report symptoms consistent with ARI. This prevalence indicates that more than one-third of the student population was affected during the study window, underscoring the relevance of environmental determinants in this setting.

To test the primary hypothesis of this study, a Chi-square analysis was performed to examine the relationship between environmental health conditions and ARI incidence.

Table 4. Association Between Environmental Health Conditions and ARI Incidence

Environmental Health	ARI (Yes) n (%)	ARI (No) n (%)	Total	p-value
Adequate	10 (20.8%)	38 (79.2%)	48	
Inadequate	19 (59.4%)	13 (40.6%)	32	0.001*
Total	29	51	80	

As shown in Table 4, ARI incidence was markedly higher among students exposed to inadequate environmental health conditions (59.4%) compared to those in adequate environments (20.8%). The Chi-square test indicated a statistically significant association between environmental health status and ARI incidence ($p =$

0.001). These findings suggest that students in classrooms with substandard environmental conditions were significantly more likely to experience ARI episodes.

To further assess the strength of association and control for potential confounding variables (age and grade level), logistic regression analysis was conducted.

Table 5. Logistic Regression Analysis of Environmental Health Conditions and ARI Incidence

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
Inadequate Environmental Health	4.12	1.68–10.09	0.002*
Age	1.08	0.82–1.41	0.563
Grade Level	0.94	0.71–1.24	0.668

The logistic regression model demonstrates that students exposed to inadequate environmental health conditions had 4.12 times higher odds of developing ARI compared to those in adequate environments (AOR = 4.12; 95% CI: 1.68–10.09; p = 0.002), after adjusting for age and grade level. Neither age nor grade level showed a statistically significant association with ARI incidence.

These findings confirm that environmental health conditions within the school setting function as an independent risk factor for ARI among students. The strength of association observed in the adjusted model reinforces the central hypothesis of this study and highlights the structural nature of respiratory health risk in school environments.

This study demonstrates a statistically significant and robust association between environmental health conditions and the incidence of Acute Respiratory Tract Infections (ARI) among students at San Roque Elementary School. Students exposed to inadequate environmental conditions exhibited more than fourfold increased odds of experiencing ARI compared to those in adequately maintained classrooms [29]. This finding confirms that environmental determinants within school settings are not peripheral contributors but constitute a central structural risk factor for respiratory morbidity among school-aged children. The magnitude of association observed in the adjusted model underscores that environmental exposure operates independently of age and grade level, reinforcing its etiological relevance.

From an epidemiological standpoint, these results align with the broader framework advanced by the World Health Organization, which emphasizes environmental quality particularly ventilation, sanitation, and crowding as critical determinants of communicable respiratory diseases [30], [31]. However, while prior global reports predominantly synthesize macro-level or household-based environmental data, empirical studies focusing specifically on school-level environmental health in low and middle-income settings remain limited [32], [33]. Most existing literature examines indoor air pollution within domestic environments or urban ambient particulate matter exposure, often overlooking institutional micro-environments such as public elementary schools. This imbalance creates a contextual blind spot in public health evidence, particularly in Southeast Asian educational settings.

The present findings contribute to closing this gap by situating environmental health assessment directly within a real-world public school environment and linking composite environmental indicators to verified ARI outcomes. Previous studies have frequently examined isolated factors such as ventilation adequacy or humidity without integrating sanitation infrastructure, waste management systems, water access, and classroom density into a multidimensional exposure construct [34]-[36]. By operationalizing environmental health as a composite index, this study advances a more ecologically valid and system-oriented analytical approach. This multidimensionality constitutes a key novelty of the research, as it captures the cumulative exposure burden experienced by students rather than fragmenting environmental risk into disconnected variables [37], [38].

Another important contribution lies in the contextual specificity of the evidence. Much of the literature on school environmental quality originates from high-income countries where infrastructural standards and regulatory enforcement differ substantially from those in resource-constrained public schools [39], [40]. The current findings provide localized empirical data from a semi-urban Philippine public school, thereby enriching the global evidence base with data from underrepresented contexts. This contextualization enhances external validity for comparable educational systems facing similar infrastructural constraints and strengthens the relevance of environmental health research in Southeast Asia.

The implications of these findings are both theoretical and practical. Theoretically, the results reinforce ecological models of health that conceptualize disease risk as a product of structural environmental exposure rather than solely individual susceptibility. The significant association observed in this study supports the argument that ARI prevention strategies must extend beyond clinical treatment and immunization programs toward upstream environmental modification. Practically, the fourfold increased risk associated with inadequate environmental conditions suggests that relatively modest infrastructural improvements such as optimizing ventilation, reducing classroom crowding, strengthening sanitation maintenance, and ensuring consistent access

to clean water could substantially reduce ARI incidence and related absenteeism. In resource-limited educational systems, structural environmental interventions may represent a cost-effective and sustainable disease prevention strategy compared to recurrent clinical management.

Despite these contributions, several limitations must be acknowledged. First, the cross-sectional analytic observational design precludes causal inference. Although a strong association was identified, temporal sequencing between exposure and outcome cannot be definitively established. Second, ARI incidence was based on recorded symptoms and parental confirmation rather than laboratory confirmation, introducing potential misclassification bias. Third, the environmental health index, while multidimensional, relied partly on observational scoring, which may introduce measurement variability despite quality control efforts. Finally, the study was conducted within a single institutional setting, limiting generalizability beyond comparable public elementary schools.

These limitations, however, also delineate directions for future research. Longitudinal cohort designs could strengthen causal interpretation, while multi-school comparative studies would enhance external validity. Incorporating objective indoor air quality measurements such as particulate matter concentration or CO_2 levels could further refine exposure assessment. Nonetheless, within its methodological boundaries, this study provides compelling evidence that environmental health conditions within school settings constitute a significant and independent determinant of ARI among students.

4. CONCLUSION

This study aimed to examine the relationship between environmental health conditions and the incidence of Acute Respiratory Tract Infections (ARI) among students at San Roque Elementary School. The findings demonstrate that 40.0% of classrooms were categorized as having inadequate environmental health conditions, while 36.3% of students experienced at least one ARI episode within the three-month observation period. Statistical analysis revealed a significant association between environmental health status and ARI incidence ($p = 0.001$). Multivariate analysis further confirmed that students exposed to inadequate environmental conditions had 4.12 times higher odds of developing ARI (AOR = 4.12; 95% CI: 1.68–10.09; $p = 0.002$), independent of age and grade level. These results affirm that environmental health conditions within school settings constitute an independent and structurally significant determinant of respiratory morbidity among elementary students. Strengthening school-based environmental standards particularly ventilation, sanitation, and classroom density management should be prioritized as a preventive public health strategy. Future research should employ longitudinal and multi-site designs to strengthen causal inference and expand generalizability across diverse educational contexts..

ACKNOWLEDGEMENTS

The authors express sincere gratitude to the school administration, teachers, parents, and students of san roque elementary school for their cooperation and participation in this study. Appreciation is also extended to all research assistants who contributed to data collection and validation.

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] X. Wang, Y. Li, X. Mei, E. Bushe, H. Campbell, and H. Nair, "Global hospital admissions and in-hospital mortality associated with all-cause and virus-specific acute lower respiratory infections in children and adolescents aged 5–19 years between 1995 and 2019: A systematic review and modelling study," *BMJ Glob. Heal.*, vol. 6, no. 7, pp. 14–25, Jul. 2021, doi: 10.1136/bmjgh-2021-006014.

[2] M. T. Saadi and P. Junadi, "Understanding outpatients' intention to revisit a hospital: A study using theory of planned behavior and satisfaction in an Indonesian hospital," *Int. J. Pharm. Healthc. Mark.*, vol. 19, no. 4, Sep. 2025, doi: 10.1108/IJPHM-01-2025-0003.

[3] S. L. McGuinness *et al.*, "Effect of hygiene interventions on acute respiratory infections in childcare, school and domestic settings in low- and middle-income countries: a systematic review," *Trop. Med. Int. Heal.*, vol. 23, no. 8, pp. 816–833, Aug. 2018, doi: 10.1111/tmi.13080.

[4] A. Razzaque, L. Nahar, M. Akter Khanam, and P. Kim Streatfield, "Socio-demographic differentials of adult health indicators in matlab, Bangladesh: Self-rated health, health state, quality of life and disability level," *Glob. Health Action*, vol. 3, no. 1, p. 4618, 2010, doi: 10.3402/gha.v3i0.4618.

[5] B. O'Rourke, W. Oortwijn, and T. Schuller, "The new definition of health technology assessment: A milestone in

international collaboration," *Int. J. Technol. Assess. Health Care*, vol. 36, no. 3, pp. 187–190, 2020, doi: 10.1017/S0266462320000215.
[6] E. Sacks, M. Schleiff, M. Were, A. M. Chowdhury, and H. B. Perry, "Communities, universal health coverage and primary health care," *Bull. World Health Organ.*, vol. 98, no. 11, pp. 773–780, Nov. 2020, doi: 10.2471/BLT.20.252445.
[7] L. Kano, E. W. K. Tsang, and H. W. chung Yeung, "Global value chains: A review of the multi-disciplinary literature," *J. Int. Bus. Stud.*, vol. 51, no. 4, pp. 577–622, 2020, doi: 10.1057/s41267-020-00304-2.
[8] V. Czok, M. Krug, S. Müller, J. Huwer, and H. Weitzel, "Learning effects of augmented reality and game-based learning for science teaching in higher education in the context of education for sustainable development," *Sustain.*, vol. 15, no. 21, 2023, doi: 10.3390/su152115313.
[9] Y. K.M and S. P. Gudur, "Strategic approaches to managing respiratory tract infection risk factors: a comprehensive review," *Asian J. Hosp. Pharm.*, vol. 4, no. 1, pp. 1–8, Mar. 2024, doi: 10.38022/ajhp.v4i1.80.
[10] E. Moran, J. Kubale, G. Noppert, R. Malosh, and J. Zelner, "Inequality in acute respiratory infection outcomes in the United States: A review of the literature and its implications for public health policy and practice," Apr. 26, 2020. doi: 10.1101/2020.04.22.20069781.
[11] H. Jary, "Household air pollution and acute lower respiratory infections in adults: A systematic review," *PLoS One*, vol. 11, no. 12, pp. 656–664, Dec. 2016, doi: 10.1371/journal.pone.0167656.
[12] A. R. Sherris, "Associations between ambient fine particulate matter and child respiratory infection: The role of particulate matter source composition in Dhaka, Bangladesh," *Environ. Pollut.*, vol. 290, no. 12, pp. 1–11, Dec. 2021, doi: 10.1016/j.envpol.2021.118073.
[13] W. Zhang, R. Ma, Y. Wang, N. Jiang, Y. Zhang, and T. Li, "The relationship between particulate matter and lung function of children: A systematic review and meta-analysis," *Environ. Pollut.*, vol. 309, no. 127, p. 119, Sep. 2022, doi: 10.1016/j.envpol.2022.119735.
[14] K. Saxena, "Association between maternal prenatal exposure to household air pollution and child respiratory health: a systematic review and meta-analysis," *Yale J. Biol. Med.*, vol. 97, no. 1, pp. 29–40, Mar. 2024, doi: 10.59249/TAVR4964.
[15] A. J. Kroopnick and E. C. Miller, "Approach to altered mental status in pregnancy and postpartum," *Semin. Neurol.*, vol. 44, no. 06, pp. 695–706, Dec. 2024, doi: 10.1055/s-0044-1788977.
[16] I. V. Roche, M. Ubalde-Lopez, C. Daher, M. Nieuwenhuijsen, and M. Gascon, "The health-related and learning performance effects of air pollution and other urban-related environmental factors on school-age children and adolescents a scoping review of systematic reviews," *Curr. Environ. Heal. Reports*, vol. 11, no. 2, pp. 300–316, Feb. 2024, doi: 10.1007/s40572-024-00431-0.
[17] I. Demchenko, B. Maksymchuk, V. Bilan, I. Maksymchuk, and I. Kalynovska, "Training future physical education teachers for professional activities under the conditions of inclusive education," *Brain. Broad Res. Artif. Intell. Neurosci.*, vol. 12, no. 3, pp. 191–213, 2021, doi: 10.18662/brain/12.3/227.
[18] A. M. N. Azmi *et al.*, "The impact of leg width on muscle activation and performance during push-up exercise," *Int. J. Hum. Mov. Sport. Sci.*, vol. 11, no. 6, pp. 1238–1243, 2023, doi: 10.13189/saj.2023.110607.
[19] J. L. Roque, "Revisiting the level of school-based management in public elementary schools of Santiago City, Isabela, Philippines," *J. Educ. Teach. Trainers*, vol. 14, no. 1, pp. 1–12, Jan. 2023, doi: 10.47750/jett.2023.14.01.012.
[20] H. KOĞAR, "Which scale short form development method is better? A comparison of ACO, TS, and SCOFA," *Int. J. Assess. Tools Educ.*, vol. 9, no. 3, pp. 583–592, 2022, doi: 10.21449/ijate.946231.
[21] N. Kesorn, P. Junpeng, M. Marwiang, K. Pongboriboon, K. N. Tang, and M. Wilson, "Development of an assessment tool for mathematical reading, analytical thinking and mathematical writing," *Int. J. Eval. Res. Educ.*, vol. 9, no. 4, p. 955, Dec. 2020, doi: 10.11591/ijere.v9i4.20505.
[22] E. Kiel, A. Braun, M. Muckenthaler, U. Heimlich, and S. Weiss, "Self-efficacy of teachers in inclusive classes. How do teachers with different self-efficacy beliefs differ in implementing inclusion?," *Eur. J. Spec. Needs Educ.*, vol. 35, no. 3, pp. 333–349, 2020, doi: 10.1080/08856257.2019.1683685.
[23] D. Madigan, P. B. Ryan, and M. Schuemie, "Does design matter? systematic evaluation of the impact of analytical choices on effect estimates in observational studies," *Ther. Adv. Drug Saf.*, vol. 4, no. 2, pp. 53–62, Apr. 2013, doi: 10.1177/2042098613477445.
[24] W. Sauerbrei, M. Abrahamowicz, D. G. Altman, S. le Cessie, and J. Carpenter, "Strengthening analytical thinking for observational studies: The stratos initiative," *Stat. Med.*, vol. 33, no. 30, pp. 5413–5432, Dec. 2014, doi: 10.1002/sim.6265.
[25] M. Stoto, M. Oakes, E. Stuart, E. L. Priest, and L. Savitz, "Analytical methods for a learning health system: Design of observational studies," *eGEMs (Generating Evid. Methods to Improv. patient outcomes)*, vol. 5, no. 1, p. 29, Dec. 2017, doi: 10.5334/egems.251.
[26] N. A. Quarderer *et al.*, "Fostering the development of earth data science skills in a diverse community of online learners: A case study of the earth data science corps," *J. Stat. Data Sci. Educ.*, vol. 0, no. 0, pp. 1–22, 2024, doi: 10.1080/26939169.2024.2362886.
[27] M. T. Ho, P. Mantello, and Q. H. Vuong, "Emotional AI in education and toys: Investigating moral risk awareness in the acceptance of AI technologies from a cross-sectional survey of the Japanese population," *Heliyon*, vol. 10, no. 16, p. e36251, 2024, doi: 10.1016/j.heliyon.2024.e36251.
[28] L. Ashour, "A review of user-friendly freely-available statistical analysis software for medical researchers and biostatisticians," *Res. Stat.*, vol. 2, no. 1, pp. 1–13, 2024, doi: 10.1080/27684520.2024.2322630.
[29] S. Bhambhani, K. R. Kondhare, and A. P. Giri, "Diversity in chemical structures and biological properties of plant alkaloids," *Molecules*, vol. 26, no. 11, p. 3374, Jun. 2021, doi: 10.3390/molecules26113374.
[30] B. Passaretti, C. Missiuna, A. J. Levinson, L. S. Turkstra, T. Gallagher, and W. Campbell, "Development and

evaluation of an online professional development course to support delivery of tiered school-based rehabilitation services," *Disabil. Rehabil.*, vol. 10, no. 1, pp. 1–13, 2024, doi: 10.1080/09638288.2024.2417769.

[31] V. Mohan, "Slowing the diabetes epidemic in the world health organization south-east asia region: The role of diet and physical activity," *WHO South-East Asia J. Public Heal.*, vol. 5, no. 1, pp. 5–15, 2016, doi: 10.4103/2224-3151.206554.

[32] E. Ruoss, "Opportunities to leverage world heritage sites for local development in the alps," *Eco.mont*, vol. 8, no. 1, pp. 53–61, 2016, doi: 10.1553/eco.mont-8-1s53.

[33] M. A. S. Khasawneh, "Beyond digital platforms: Gamified skill development in real-world scenarios and environmental variables," *Int. J. Data Netw. Sci.*, vol. 8, pp. 213–220, 2024, doi: 10.5267/j.ijdns.2023.10.002.

[34] 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

[35] 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, Sep. 2024, doi: 10.1097/MD.0000000000039578.

[36] C. Ai Tran, D. H. Van, T. Thuy Phuong Nguyen, T. Thi Thanh Nguyen, and T. Minh Nguyen, "Research in higher education quality assurance worldwide (2003–2023): A bibliometric analysis from the Scopus database," *Cogent Educ.*, vol. 12, no. 1, p., 2025, doi: 10.1080/2331186X.2025.2479405.

[37] Q. Gao, S. Zhang, Z. Cai, K. Liu, N. Hui, and M. Tong, "Understanding student teachers' collaborative problem solving competency: Insights from process data and multidimensional item response theory," *Think. Ski. Creat.*, vol. 45, p. 101097, 2022.

[38] 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.

[39] N. A. Hidayati, H. J. Waluyo, R. Winarni, and Suyitno, "Exploring the implementation of local wisdom-based character education among indonesian higher education students," *Int. J. Instr.*, vol. 13, no. 2, pp. 179–198, 2020, doi: 10.29333/iji.2020.13213a.

[40] Y. Narny, A. Muhajir, and R. Cribb, "Disaster history as a reflection of human–environment relations: An ecological approach to disaster studies in Indonesia," *E3S Web Conf.*, vol. 677, no. 7, pp. 110–123, Dec. 2025, doi: 10.1051/e3sconf/202567711003.