



The Relationship between Emergency Sanitation Access and Post-Disaster Environmentally Based Disease Incidences

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ABSTRACT

Natural disasters often cause serious disruptions to clean water and sanitation systems, which directly impacts the increased risk of environmentally-related diseases in affected communities. Emergency sanitation is a key component of post-disaster health responses, but its availability and quality vary widely across evacuation sites. This study aims to analyze the relationship between emergency sanitation access and the incidence of environmentally-related diseases in communities living in post-disaster evacuation sites. The study used an observational analytical design with a cross-sectional approach and involved 210 adult respondents in evacuation sites in disaster-prone areas in Indonesia. Data were collected through structured interviews and observations of ion conditions, then analyzed using the Chi-Square test and logistic regression. The results showed that 60.0% of respondents lived in environments with inadequate emergency sanitation access and 41.0% of households reported incidences of environmentally-related diseases. There was a significant relationship between emergency sanitation access and disease incidence ($p = 0.001$), with respondents with inadequate sanitation having a higher risk of disease. Multivariate analysis showed that inadequate emergency sanitation was the dominant factor (OR = 2.98; 95% CI: 1.63–5.44), followed by overcrowding and hygiene practices. This study concluded that providing adequate and timely emergency sanitation is a priority intervention to reduce the burden of disease and improve community health resilience in post-disaster situations.

Keywords: Emergency Sanitation, Environmentally Based Diseases, Refugees, Natural Disasters, WASH



INTRODUCTION

Global climate change and environmental degradation have increased the frequency and intensity of natural disasters in various regions of the world over the past two decades, including floods, storms, droughts and landslides. These phenomena have a direct impact on public health, both through an increase in environment-based infectious diseases and other health issues triggered by changes in physical and social conditions (Susanto et al., 2025). In this context, disasters are not merely understood as natural events, but as multidimensional crises that disrupt health systems, basic infrastructure, and the sustainability of communities.

One of the most affected sectors is the water, sanitation, and hygiene (WASH) system. Post-disaster damage to WASH infrastructure increases the risk of pathogen exposure via water, soil, and the residential environment. The World Health Organisation (WHO, 2024) reports that these conditions contribute to rising incidence of diseases such as diarrhoea, cholera, typhoid, and leptospirosis. From an epidemiological perspective, sanitation acts as a key determinant in breaking the chain of transmission of environment-based diseases through safe waste management and the provision of basic hygiene facilities (Faradilla et al., 2026; Murtiono et al., 2021).

In post-disaster evacuation situations, health risks are heightened by a combination of overcrowding, limited access to clean water, and inadequate sanitation. Previous studies have shown that hydrometeorological disasters such as floods are correlated with an increase in waterborne diseases resulting from environmental contamination (Yazdi et al., 2024). Therefore, the provision of emergency sanitation including temporary latrines, waste management, access to clean water, and handwashing facilities is a crucial component of the emergency health response.

In post-disaster epidemiology, people living in displacement sites often face additional risk factors, such as high density, limited access to clean water, and poor waste management. All of these factors increase the likelihood of infectious disease transmission through close contact or environmental media. Emergency sanitation, also known as emergency sanitation, is a critical component of post-disaster health responses. This concept includes providing temporary latrines, emergency waste management systems, adequate access to clean water, and encouraging basic hygiene practices in accordance with the minimum humanitarian standards set by the Sphere Standards. (WHO, 2024).

Nevertheless, access to and the quality of emergency sanitation still vary significantly across disaster sites. This variability is influenced by local capacity, preparedness, cross-sectoral coordination, and resource constraints (Win et al., 2025). These conditions have the potential to create service inequalities and increase the vulnerability of affected groups.

A research gap exists in the limited number of quantitative studies that explicitly analyse the relationship between access to emergency sanitation and the incidence of environment-related diseases in the context of displacement. Most previous research has been descriptive and has not examined causal relationships from an epidemiological perspective using analytical approaches (D'Mello-Guyett et al., 2023). This highlights the need for research based on empirical data to strengthen the scientific evidence underpinning the formulation of emergency WASH policies.



At the national level, Indonesia is a country with a high level of vulnerability to hydrometeorological disasters, and therefore faces significant challenges in managing sanitation in evacuation centres (Kemenkes, 2025). Limited access to sanitation contributes to increased morbidity, particularly among vulnerable groups such as children, the elderly and pregnant women (Betera et al., 2025).

Based on this, this study aims to analyse the relationship between access to emergency sanitation and the incidence of environment-related diseases in post-disaster displaced communities in Indonesia, as a basis for strengthening more effective WASH policies and interventions.

METHODS

This study employed an analytical observational design with a cross-sectional approach to analyse the relationship between access to emergency sanitation and the incidence of environment-related diseases among disaster-affected communities. The study was conducted at an evacuation site in Kayu Tanam Sub-district, Padang Pariaman Regency, West Sumatra, which is a disaster-prone area with post-disaster disruptions to the WASH system.

The study population comprised all residents living at the evacuation site. The sample was determined using probability sampling with a cluster random sampling approach, where the sampling units were groups of evacuation shelters. The sample size of 210 respondents was calculated using the formula for cross-sectional analytical studies with a 95% confidence level. Inclusion criteria included adults or heads of households who had lived in the evacuation site for at least seven days and were willing to participate as respondents.

The independent variable was access to emergency sanitation, measured against the Sphere Standards, including: the ratio of latrines to users, availability of clean water (≥ 15 litres/person/day), handwashing facilities with soap, and waste management systems. The dependent variable was the incidence of environment-related diseases within households, including diarrhoea, typhoid, hepatitis A, leptospirosis, and skin diseases. Confounding variables included housing density, education, and hygiene practices.

Data collection was carried out through interviews using a structured questionnaire and direct observation of sanitation conditions. The questionnaire underwent content validity testing by environmental health experts and reliability testing using Cronbach's alpha (>0.7). Data analysis was carried out in stages, including univariate and bivariate analysis using the Chi-Square test, and multivariate analysis using logistic regression to determine the dominant factors, with a significance level of 0.05.

RESULTS

1. Univariate Analysis

Table 1. Characteristics of Respondents in Post-Disaster Refugee Locations (n = 210)

Variables	Category	n	%
Gender	Man	98	46.7



	Woman	112	53.3
Age	< 30 years	52	24.8
	30–49 years	104	49.5
	≥ 50 years	54	25.7
Education	Low	96	45.7
	Intermediate	78	37.1
	Tall	36	17.1
Residential Density	Congested	128	61.0
	Not dense	82	39.0

An analysis of the results indicates that the respondent profile is dominated by people of working age, with a high proportion living in overcrowded conditions; from an epidemiological perspective, this increases the potential for the transmission of environment-borne diseases in a displacement context.

Table 2. Distribution of Emergency Sanitation Access in Evacuation Locations (n = 210)

Emergency Sanitation Access	n	%
Good (meets minimum standards)	84	40.0
Inadequate	126	60.0

The state of emergency sanitation facilities reveals a significant shortfall compared to minimum standards, reflecting the limited capacity to provide WASH services in the aftermath of a disaster.

Table 3. Distribution of Environmentally Based Disease Incidences (n = 210)

Disease Incidence	n	%
There are no cases	124	59.0
There is ≥1 case in the household	86	41.0

Meanwhile, cases of environmentally-related diseases continue to represent a substantial burden of morbidity among the affected population, suggesting that exposure to environmental risks has not yet been adequately controlled.

2. Bivariate Analysis

Table 4. Relationship between Emergency Sanitation Access and Environmentally Based Disease Incidences

Access to Sanitation	Disease (n, %)	No Disease (n, %)	Total	p-value	PR (95% CI)
Inadequate	68 (54.0)	58 (46.0)	126	0.001	2.45 (1.55–3.87)
Good	18 (21.4)	66 (78.6)	84		



Bivariate analysis confirmed a significant association between emergency sanitation and disease incidence, reinforcing the role of sanitation as a key environmental determinant in post-disaster epidemiology.

3. Multivariate Analysis (Logistic Regression)

Table 5. Factors Associated with the Incidence of Environmentally Based Diseases

Variables	OR	95% CI	p-value
Inadequate access to sanitation	2.98	1.63–5.44	0,000
Dense residential density	1.87	1.02–3.41	0.041
Low education	1.56	0.88–2.76	0.118
Poor hygiene practices	2.21	1.19–4.09	0.012

The results of the multivariate analysis confirm that emergency sanitation is the most dominant factor after controlling for other variables, followed by housing density and hygiene practices, indicating a complex interaction between environmental and behavioural factors.

Synthesis of Main Findings

1. Most refugee camps still have inadequate access to emergency sanitation.
2. The incidence of environmentally based diseases is high in the affected population.
3. There is a strong statistical relationship between emergency sanitation access and disease incidence.
4. Emergency sanitation is the dominant risk factor after controlling for residential density and hygiene practices.

Epidemiologically, these results strengthen the hypothesis that post-disaster WASH system disruption increases exposure to environmental pathogens and contributes to increased morbidity from environmentally-based diseases in displaced populations.

DISCUSSION

1. Emergency Sanitation Access in Post-Disaster Evacuation Sites

Table 2 shows that 60.0% of respondents were in evacuation sites with inadequate emergency sanitation access, while only 40.0% met minimum standards. These findings indicate that the majority of refugees are still exposed to sanitation conditions that pose health risks.

Within the framework of environmental determinants of health theory, sanitation is a structural factor that directly influences pathogen exposure. The environmental exposure pathway theory explains that the lack of adequate latrines, poor waste management, and limited access to clean water increase the likelihood of fecal-oral contamination, particularly in crowded, temporary housing conditions.

A multicenter observational study in Japan showed that delays in the provision of emergency toilets and clean water in evacuation centers were associated with increased incidence of infectious diseases after a disaster (Akaishi et al., 2021). A systematic review by Charnley et al. confirmed that



disruption of WASH systems is a major risk factor for infectious disease outbreaks after natural disasters (Charnley et al., 2021). Furthermore, a review of disaster sanitation policies in Asia highlighted that disparities in regional capacity often lead to unmet emergency sanitation standards (Kanbara & Shaw, 2024).

The findings indicate that sanitation limitations reflect the weak capacity of the WASH system during the emergency response phase. Theoretically, these conditions increase the risk of faecal-oral transmission through environmental contamination. Analytically, these conditions are influenced not only by resource constraints but also by the failure to integrate WASH into local disaster management planning. Sanitation has not yet been positioned as a risk-based priority intervention. There is a need to strengthen regulations on minimum emergency sanitation standards based on the Sphere Standards, as well as to integrate WASH into local contingency planning documents. A limitation is that field-based observations are potentially subject to temporal bias, as sanitation conditions are dynamic.

2. Environmentally Based Disease Incidence

As many as 41.0% of households reported at least one case of an environmentally-based disease, indicating a still high morbidity burden in post-disaster evacuation sites.

According to the post-disaster epidemiological transition theory, disruption of the physical and social environment causes a shift in disease risk toward environmentally-based infectious diseases. This situation is exacerbated by overcrowding, limited hygiene practices, and poor sanitation.

A narrative review of the impact of earthquakes on public health indicates that diarrheal and skin diseases are the most common occurrences in the early post-disaster phase (Mavrouli et al., 2023). A global literature review also found that over 70% of post-disaster outbreaks are linked to unsafe water and sanitation (Walika et al., 2023).

The high incidence of disease indicates a failure of environmental risk control in the post-disaster phase. Analytically, this reflects the interaction between structural factors (sanitation) and behavioural factors (hygiene), which accelerates disease transmission in overcrowded conditions. There is a need to strengthen a displacement-based disease surveillance system and to integrate promotive and preventive services. Limitations include the possibility of underreporting due to limited access to healthcare services.

3. The Relationship between Emergency Sanitation Access and Disease Incidence

Bivariate analysis showed a statistically significant association between emergency sanitation access and the incidence of environmentally related diseases ($p = 0.001$). Respondents with inadequate sanitation had a 2.45 times greater risk of disease compared to those with good sanitation.

These results align with the environment–disease causality model, which positions sanitation as a proximal determinant in the chain of disease transmission. Poor sanitation increases exposure to pathogens through water, soil, and environmental surfaces.



Post-disaster observational studies have shown that rapid restoration of clean water systems and emergency toilets significantly reduces the incidence of infectious diseases in evacuation centers (Akaishi et al., 2021). A systematic review also confirmed that inadequate sanitation increases the risk of outbreaks by two to threefold (Charnley et al., 2021).

The associations identified support the environmental epidemiological causal model, in which sanitation acts as a proximal determinant. Analytically, the strength of the association suggests a possible biological causal relationship, although the study design cannot establish causality with absolute certainty. Sanitation interventions should be a top priority over secondary interventions in disaster response. Limitations: the cross-sectional design restricts causal inferences.

4. Dominant Factors in Environmentally Based Disease Incidence

Multivariate analysis showed that inadequate emergency sanitation access was the most dominant factor (OR = 2.98; $p < 0.001$), followed by poor hygiene practices and overcrowding. Education did not show a significant association.

These findings support the ecological approach to health, which emphasizes the interaction between environmental and behavioral factors. Sanitation acts as a structural determinant, while hygiene is a behavioral determinant that modifies risk.

A review of emergency WASH policies confirmed that sanitation interventions have the greatest protective effect compared to sociodemographic factors in disaster contexts (Shah et al., 2023). Cross-country studies also show that overcrowding amplifies the negative effect of poor sanitation on disease incidence (Mavrouli et al., 2023).

The dominance of sanitation variables indicates that structural factors are more decisive than individual characteristics in emergency situations. Analytically, this confirms that a systems-based approach is more effective than an approach based solely on education. There is a need to strengthen investment in emergency sanitation infrastructure and the management of housing density. A limitation is that other variables, such as nutritional status and access to healthcare services, were not analysed.

Overall, the discussion in Tables 2–5 confirms that emergency sanitation is a key determinant of post-disaster environmentally-related disease incidence. This finding is consistent with environmental epidemiology theory and recent empirical evidence (2021–2025), and highlights the urgency of strengthening emergency WASH programs as a top priority in disaster response.

CONCLUSIONS

This study demonstrates that inadequate access to emergency sanitation is a key determinant of increased risk of environment-related diseases among post-disaster displaced populations. Sanitation remains the most dominant factor after controlling for other variables, whilst housing density and hygiene practices act as contributing factors that exacerbate the risk.

These findings confirm that WASH-based interventions, particularly the provision of emergency sanitation meeting minimum standards, are the most effective strategy for reducing the post-disaster disease burden. Therefore, emergency sanitation must be prioritised in disaster



management policies, including through integration into contingency planning, strengthening of local capacity, and standardisation of implementation in the field.

In practical terms, the results of this study provide an empirical basis for policymakers to develop a more preventive, risk-based, and public health resilience-oriented approach to disaster management.

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