

Post-flood morbidity and associated factors among flood-affected residents: a cross-sectional study in Dak Lak, Vietnam

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ABSTRACT

Floods are among the most frequent natural disasters in Vietnam and may substantially affect community health. This study aimed to investigate post-flood diseases and associated risk factors among residents in Dak Lak Province. A community-based cross-sectional study was conducted among 183 adults in Hoa Le and Krong Kmar communes, Dak Lak Province. Participants were recruited using convenience sampling. Data were collected through face-to-face interviews using a structured questionnaire. Multivariable logistic regression was performed to identify factors associated with post-flood morbidity. Overall, 44.3% of participants reported at least one illness during the flood or within three days thereafter. Respiratory diseases were the most common (12.0%), followed by infectious (9.3%), dermatological (8.2%), gastrointestinal (6.6%), and ocular diseases (3.8%). Female sex (OR = 2.52; 95% CI: 1.31-4.83), emergency evacuation (OR = 5.42; 95% CI: 1.41-20.90), and disruption of essential services (OR = 2.06; 95% CI: 1.01-4.18) were significantly associated with post-flood illness. Flooding was associated with substantial morbidity, particularly respiratory and infectious diseases. Strengthening access to safe water, healthcare services, and disease surveillance may help reduce post-flood health risks in affected communities.

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1. INTRODUCTION

Flooding is the most frequent natural disaster worldwide and poses substantial threats to human health, environmental stability, and socioeconomic systems. Over the past four decades, the global population exposed to flood hazards has increased markedly, with approximately 1.81 billion people living in high-risk flood-prone areas [1], [2]. Driven by anthropogenic climate change, flood events are projected to increase in frequency, intensity, and duration as a result of extreme precipitation and rising sea levels [3], [4].

Beyond immediate mortality and injury, floods may cause substantial indirect health impacts through contamination of water and food supplies, increased exposure to environmental pathogens, displacement, and disruption of healthcare and essential services [5], [6]. Previous studies have reported increased risks of respiratory, infectious, gastrointestinal, and dermatological diseases following flood events [7]-[9]. Vietnam is highly vulnerable to hydrometeorological disasters, with recurrent floods causing major health and socioeconomic impacts each year [10], [11]. Previous studies have also highlighted substantial community vulnerability and limited resilience capacity in flood-prone areas of Vietnam [12], [13]. However, most existing studies have focused on specific diseases or hospital-based outcomes, while community-level evidence on overall morbidity patterns remains limited, particularly in the Central Highlands region [7], [14].

Dak Lak Province is frequently affected by seasonal flooding, which disrupts sanitation systems, transportation, and access to healthcare services, especially in rural communities [10]. However, evidence on post-flood morbidity and associated risk factors in this setting remains scarce. Therefore, this study aimed to describe post-flood morbidity patterns and identify associated risk factors among flood-affected residents in Dak Lak Province, Vietnam. The findings may support disaster preparedness planning and post-flood public health interventions in similar flood-prone settings.

2. METHOD

2.1. Study design and setting

A community-based cross-sectional study was conducted from December 2025 to January 2026 in Hoa Le and Krong Kmar communes, Dak Lak Province, Vietnam, following a major flood event during the 2025 rainy season. The flood caused widespread inundation, transportation disruption, and interruption of essential services, including clean water supply and healthcare access. These communes were purposively selected because they are frequently affected by seasonal flooding and include predominantly rural populations with limited disaster resilience capacity. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. Due to post-disaster conditions, convenience sampling was applied.

2.2. Participants and sampling

Eligible participants were individuals aged ≥ 18 years who resided in the affected areas and experienced the flood event during the study period. A convenience sampling approach was used, whereby all eligible and consenting individuals were invited to participate. Individuals with severe cognitive impairment or those unable to complete the interview were excluded. The final analytical sample comprised 183 participants.

2.3. Data collection

Data were collected through face-to-face interviews using a structured questionnaire administered by trained physicians and researchers from Buon Ma Thuot Medical University. The questionnaire was developed based on previous studies, reviewed by public health researchers, and pilot-tested in a nearby community before formal data collection (Cronbach's alpha values of 0.841). Information collected included socio-demographic characteristics, flood-related exposures, and self-reported health conditions during the flood or within three days thereafter. Each interview lasted approximately 20-30 minutes. To minimize interviewer bias, all interviewers received standardized training and followed the same interview protocol.

2.4. Disease classification

Disease information was primarily based on self-reported symptoms and previous medical diagnoses because healthcare access was limited during the post-disaster period. Reported conditions were classified according to broad clinical categories adapted from the International Classification of Diseases, 10th Revision (ICD-10), including respiratory, infectious, dermatological, gastrointestinal, and ocular diseases.

- Respiratory: common cold, influenza, pharyngitis, sinusitis, and rhinitis
- Infectious: dengue fever, malaria, Japanese encephalitis, pertussis, and diphtheria
- Dermatological: fungal infections (e.g., tinea pedis/manuum), scabies, ringworm, tinea versicolor, and dermatitis
- Gastrointestinal: acute diarrhea, intestinal infections and hepatitis A
- Ocular: conjunctivitis, keratitis and blepharitis.

2.5. Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 20.0. Categorical variables were summarized as frequencies and percentages. Bivariate analyses were conducted using Chi-square or Fisher's exact tests, as appropriate. Variables with $p < 0.05$ in bivariate analysis were included in a multivariable logistic regression model to identify factors independently associated with post-flood morbidity. Results are presented as odds ratios (ORs) with 95% confidence intervals (CIs). A two-sided p -value < 0.05 was considered statistically significant.

2.6. Ethics

This study was carried out in accordance with established ethical principles for health research. Written informed consent was obtained from all participants prior to their enrollment in the study. Participants' confidentiality and anonymity were rigorously maintained, and all collected data were used exclusively for scientific research purposes.

3. RESULTS AND DISCUSSION

3.1. Results

A total of 183 eligible participants were enrolled in the study. Participants were categorized based on socio-demographic characteristics, including age group, sex, educational attainment, and current income level. Educational attainment was classified into three categories: primary (below lower secondary school), vocational/technical secondary, and tertiary (college or higher).

The results in Table 1 showed the socio-demographic characteristics of the 183 study participants. The 60-69 age group accounted for the largest proportion (33.9%), followed by those aged ≥ 70 years (32.2%), while participants aged 18-50 years represented the smallest proportion (13.7%). Females comprised 62.3% of the sample, compared to 37.7% males. Regarding educational attainment, most participants had a vocational/technical secondary level (51.9%), followed by primary education (39.9%), whereas those with tertiary education accounted for the smallest proportion (8.2%). In terms of income, the majority of participants reported a monthly income of below 200 USD (77.0%), while 18.0% earned 200-500 USD and only 5.0% reported an income above 500 USD.

Table 1. Socio-demographic characteristics of participant

	Characteristic	Frequency (n)	Percentage (%)
Age group	18–50 years	25	13.7
	50–59 years	37	20.2
	60–69 years	62	33.9
	Above 70 years	59	32.2
Gender	Male	69	37.7
	Female	114	62.3
Education level	Primary (below lower secondary)	73	39.9
	Vocational/Technical secondary	95	51.9
	Tertiary (college and above)	15	8.2
Average monthly income	Below 200 USD	141	77.0
	200–500 USD	33	18.0
	Above 500 USD	9	5.0

The results of the health status of participants during the flood and within three days thereafter (Table 2) illustrated that 55.7% of participants reported no illness, whereas 44.3% experienced at least one health problem during this period. Among the reported conditions, respiratory diseases were the most common (12.0%), followed by infectious diseases (9.3%), dermatological diseases (8.2%), and gastrointestinal diseases (6.6%). Eye diseases were the least common (3.8%), while other conditions accounted for 4.4%.

Table 2. Patterns of post-flood morbidity

Disease group	Frequency (n)	Percentage (%)
Normal	102	55.7
Respiratory	22	12.0
Infectious	17	9.3
Dermatological	12	6.6
Gastrointestinal	15	8.2
Ocular	7	3.8
Other	8	4.4

Table 3 indicates the associations between flood-related factors and post-flood disease patterns. A higher proportion of respiratory and infectious disease cases was observed among participants from households affected by housing damage, flooding, or property loss. Specifically, among those with respiratory diseases, 72.7% lived in households with housing damage, and 77.3% reported property loss. Similarly, 70.6% of infectious disease cases occurred in households with housing damage and 76.5% in those with property loss. However, only property loss showed a borderline association with post-flood disease

patterns ($p = 0.05$). Other factors, including housing damage, household flooding, emergency evacuation, and disruption of daily utilities, were not statistically significantly associated with disease patterns ($p > 0.05$).

Figure 1 showed factors associated with post-flood disease risk. Female, emergency evacuation, and disruption of essential services were significantly associated with increased disease risk. Specifically, females had higher odds of disease compared to males ($OR = 2.52$, $p = 0.01$). Participants who underwent emergency evacuation had substantially higher odds of disease ($OR = 5.42$, $p = 0.01$), while disruption of essential services was also associated with increased odds ($OR = 2.06$, $p = 0.04$). Other factors, including housing damage, household flooding, and property loss, were not significantly associated with disease risk ($p > 0.05$).

Table 3. Associations between flood-related factors

Disease group	Housing damage	Water entry into home	Property loss	Emergency evacuation	Service disruption
Respiratory (n, %)	16 (72.7)	16 (72.7)	17 (77.3)	3 (13.6)	20 (90.1)
Infectious (n, %)	12 (70.6)	12 (70.6)	13 (76.5)	4 (23.5)	15 (88.2)
Gastrointestinal (n, %)	6 (50.0)	5 (41.7)	4 (33.3)	0	5 (41.7)
Dermatological (n, %)	7 (46.7)	7 (46.7)	8 (53.3)	0	7 (46.7)
Ocular (n, %)	4 (57.1)	4 (57.1)	3 (42.9)	1 (14.3)	5 (71.4)
p-value	0.49	0.34	0.05	0.28	0.07

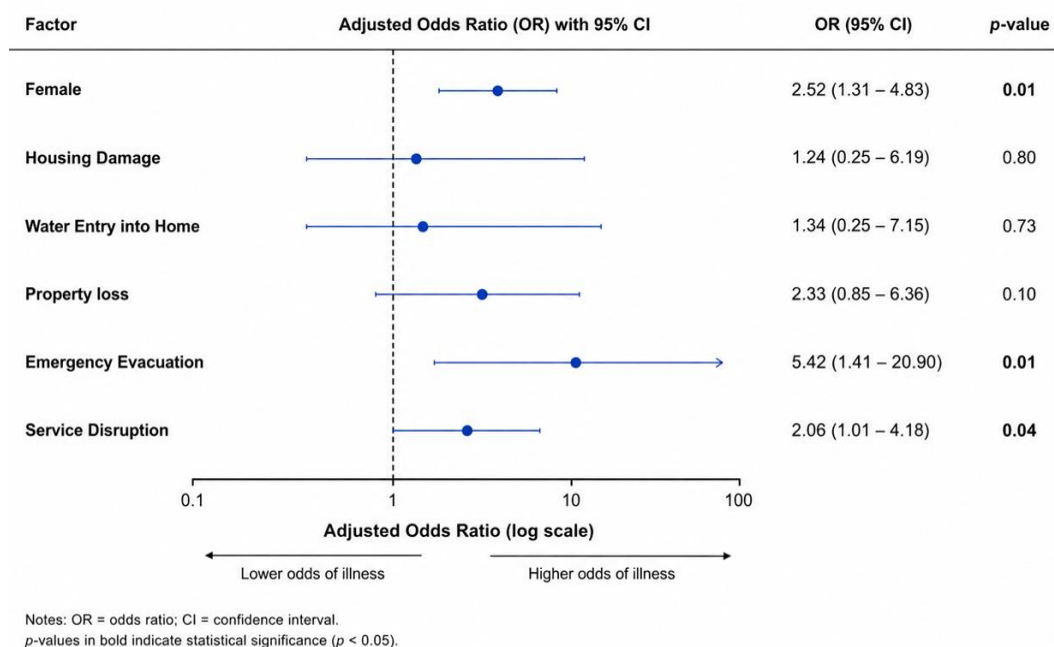


Figure 1. Multivariate logistic regression of risk factors for post-flood illness

3.2. Discussion

This study provides community-based evidence on post-flood morbidity in a flood-prone region of Vietnam, highlighting the substantial health burden experienced during the immediate post-disaster period. The findings suggest that flooding may increase the risk of multiple health conditions, particularly respiratory, infectious, dermatological, and gastrointestinal diseases. This increased risk may occur through environmental contamination, overcrowding, and disruption of essential services.

Our findings are consistent with previous studies on the public health impacts of flooding. A systematic review by Alderman *et al.* [7] reported that flood events are associated with increased risks of infectious and gastrointestinal diseases due to poor sanitation and disruption of clean water supplies. Similarly, a study conducted in Mozambique documented substantial increases in respiratory infections, diarrheal diseases, and other communicable diseases following major flood events [15]. These findings collectively indicate that post-disaster environmental changes play an important role in disease transmission in affected communities.

Respiratory diseases represented the largest proportion of post-flood conditions in the present study. This pattern may reflect prolonged exposure to damp environments, mold proliferation, and overcrowded temporary shelters following flooding [16]-[19]. Such environmental conditions may increase susceptibility to respiratory infections and exacerbate pre-existing respiratory diseases. Unlike hospital-based studies that mainly capture severe cases, our community-based findings suggest that a considerable burden of mild-to-moderate respiratory illness may remain underrecognized after flood events [14], [20].

Dermatological and gastrointestinal diseases were also frequently reported. Exposure to contaminated water, mud, and poor sanitation conditions during post-flood clean-up activities may contribute substantially to skin and gastrointestinal infections [21]-[26]. Similar increases in skin, eye, and gastrointestinal diseases have been reported in Taiwan following flood events [27], [28]. These findings emphasize the importance of environmental sanitation and safe water access during post-disaster recovery periods.

The multivariable analysis identified female sex, disruption of essential services, and emergency evacuation as significant factors associated with post-flood morbidity. The increased risk observed among females may be related to greater involvement in household activities, caregiving, and post-flood cleaning, which may increase exposure to contaminated environments. In addition, disruption of clean water supply, electricity, and healthcare access may further aggravate health risks during the post-disaster period. The strong association between emergency evacuation and disease risk may also reflect the health consequences of overcrowded temporary shelters and limited hygiene facilities during displacement [29]-[31]. These findings highlight the importance of integrating health protection measures into evacuation and disaster response planning.

From a public health perspective, the findings underscore the need to strengthen community-based disaster preparedness and post-flood health response systems. Early restoration of clean water supply systems, temporary sanitation facilities, and continuity of primary healthcare services should be prioritized following flood events. In addition, targeted support for vulnerable groups, particularly women and displaced residents, may help reduce health inequalities in disaster-affected communities. Strengthening community-level disease surveillance systems may also facilitate early detection and control of post-flood disease outbreaks.

This study has several limitations. First, the cross-sectional design precludes causal inference between identified factors and disease outcomes. Second, the use of convenience sampling may introduce selection bias and limit the generalizability of the findings. Third, disease outcomes were primarily based on self-reported symptoms without systematic clinical or laboratory confirmation, which may have resulted in misclassification of some conditions. Despite these limitations, the study provides valuable empirical evidence on post-flood disease patterns in a disaster-prone region of Vietnam.

4. CONCLUSION

This study provides community-based evidence on post-flood morbidity in Dak Lak Province, Vietnam, highlighting the substantial health impacts of flooding. Environmental contamination, disruption of essential services, and displacement during flood events may increase the risk of respiratory, infectious, dermatological, and gastrointestinal diseases in affected communities. Female sex, emergency evacuation, and disruption of essential services were identified as factors associated with increased post-flood morbidity.

These findings emphasize the importance of strengthening access to clean water, sanitation systems, primary healthcare services, and community-based disease surveillance during post-disaster response. The study also contributes additional evidence from the Central Highlands of Vietnam, where community-level data remain limited. Future longitudinal studies with clinical confirmation are needed to better assess the long-term health impacts of flooding.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization

M : **M**ethodology

So : **S**oftware

Va : **V**alidation

Fo : **F**ormal analysis

I : **I**nvestigation

R : **R**esources

D : **D**ata Curation

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Vi : **V**isualization

Su : **S**upervision

P : **P**roject administration

Fu : **F**unding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest regarding the publication of this article.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

All procedures involving human participants were conducted in accordance with the Declaration of Helsinki (1975, revised in 2013) and were approved by the Ethics Committee of Buon Ma Thuot Medical University.

DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author, upon reasonable request. The data, which contain information that could compromise the privacy of research participants, are not publicly available due to certain restrictions.

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