Original Article

The impact of extreme weather events on primary healthcare facilities in Vietnam: results from a cross-sectional survey of 128 commune health centers affected by Super Typhoon Yagi (2024)

Do Thi Hanh Trang[1], Hoang Van Minh[2], Tran Thi Tuyet Hanh[1]^, Le Thi Thanh Huong[1], Jo-Anne Geere[3], Brahim Herbane[4], Paul Hutchings[5], Mike Van Der Es[3], Duong Duc Thien[6], Do Manh Cuong[7], Nguyen Huy Minh[6], Nguyen Quynh Anh[1], Ho Thi Tu[8], Paul Raymond Hunter[2]

[1]Environmental Health Department, Hanoi University of Public Health, Hanoi, Vietnam; [2]Health Economic Department, Hanoi University of Public Health, Hanoi, Vietnam; [3]The Norwich School of Medicine, University of East Anglia, Norwich, UK; [4]School of Leadership, Management and Marketing, De Montfort University, Leicester, UK; [5]Faculty of Engineering and Physical Sciences, University of Leeds, Leeds, UK; [6]Financial Planing Department, Ministry of Health, Hanoi, Vietnam; [7]Department of Disease Prevention Department, Ministry of Health, Hanoi, Vietnam; [8]Department of Non-Communicable Disease Prevention and Control, Ha Tinh Provincial Center for Disease Control, Ha Tinh Province, Vietnam

Contributions: (I) Conception and design: HV Minh, TTT Hanh, LTT Huong, DTH Trang, JA Geere, B Herbane, P Hutchings, PR Hunter; (II) Administrative support: HV Minh, TTT Hanh, MVD Es, DTH Trang, DD Thien, DM Cuong, NH Minh, HT Tu; (III) Provision of study materials or patients: TTT Hanh, DTH Trang, JA Geere, B Herbane, P Hutchings, PR Hunter; (IV) Collection and assembly of data: HV Minh, TTT Hanh, DTH Trang, DD Thien, DM Cuong, NH Minh, HT Tu; (V) Data analysis and interpretation: DTH Trang, TTT Hanh, HT Tu, NQ Anh; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Associate Prof. Tran Thi Tuyet Hanh, PhD. Environmental Health Department, Hanoi University of Public Health, No. 1A Duc Thang Str., Dong Ngac Ward, Hanoi, Vietnam. Email: tth2@huph.edu.vn.

Background: Health system resilience is crucial for minimizing mortality and morbidity during emergencies and extreme weather events (EWEs). Vietnam is among the countries with the highest disaster risk globally. However, evidence on the immediate impacts of EWEs on grassroots primary healthcare facilities remains limited. This study aimed to investigate the immediate impacts of super Typhoon Yagi (7-9 September 2024) on various aspects of commune health centers (CHCs) across the 10 most severely affected provinces in northern Vietnam.

Methods: A cross-sectional survey using a structured, self-administered questionnaire was conducted in December 2024 with 128 CHCs most severely affected, accounted for 6.9% of the total CHCs in the 10 selected provinces. The survey assessed damage to infrastructure, the healthcare workforce capacity, and service delivery within one-week following Typhoon Yagi.

Results: Typhoon Yagi caused widespread infrastructure damage, with 27.3% to 52.3% of CHCs reporting physical impacts across service areas. Severe damage or destruction was most frequent in utility systems, including clean water tanks (10.8%) and lighting (14.0%). One-quarter (25.8%) of CHCs reported staff shortages due to absenteeism, while 51.4% noted mental health impacts on workers. Service delivery was significantly hampered: 40.6% of CHCs lost electricity and 39.8% experienced complete communication failure. Consequently, about a half of the facilities reported interruptions in important curative services, and 13.4% saw severe or complete disruption of vaccination services. There were strong associations between infrastructure damage and impacts on key clinical and preventive services and reduced staff presence.

Conclusions: While the study focuses on an extreme scenario by sampling the most severely impacted CHCs, the findings highlight acute vulnerabilities in CHC infrastructure and workforce stability, which

^ ORCID: 0000-0002-9191-577X.

resulted in critically limited service delivery under maximum stress. These results reflect localized gaps in disaster preparedness rather than nationwide deficiencies; however, they serve as a critical "stress test" for the primary healthcare system. Strengthening resilience must be prioritized, particularly in high-risk regions, to ensure service continuity amidst Vietnam's ongoing administrative restructuring.

Keywords: Extreme weather events (EWEs); impacts; commune health centers (CHCs); Vietnam; Typhoon Yagi

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Introduction

An extreme weather event (EWE) is defined as a rare, intense, and abnormal meteorological occurrence that deviate from normal patterns (1). EWEs become disasters when their impacts exceed a community's coping ability, causing significant loss of life, injuries, environmental damage, or economic disruption. They occur at the intersection of natural hazards, high exposure, and vulnerable populations, often resulting from sudden, unexpected events or sustained atmospheric pressure (2). In emergencies, disasters, and other crises, the resilience of health systems is critical to minimizing mortality and morbidity (3). The capacity of healthcare services to sustain operations without interruption following severe meteorological shifts is a matter of survival (1). The continued operation of health services relies on a number of key factors namely structurally resilient health facilities; the availability and protection of essential medical equipment; the functionality of community infrastructure and critical services (such as clean water, electricity, waste management, and communication systems etc.); and the capacity of health workers to provide health support in safe and secure locations when they are most needed (4).

According to the World Risk Report 2024, which assessed disaster risk for 193 countries of the United Nations, Vietnam was among the top 20 countries with the highest disaster risk globally (5). Over the past two decades, disasters related to climate change have caused severe damage, killing more than 13,000 people and causing property damage of more than 6.4 billion USD in Vietnam (6). More than 70% of the population is at risk from natural disasters originating from natural hazards, particularly low-income populations in both rural and urban settings (6). Although health facilities play a crucial role in ensuring the continuity of health care during and after EWEs, specific data on damages related to health facility service delivery during and after these events in Vietnam are very limited. Understanding the extent of damage to primary healthcare services, especially preventable aspects such as medical equipment failure due to indaquate relocation or utility-related service disruption, and the availability of

Highlight box

Key findings

- The study reported on the results of the first large-scale assessment on the impacts of an extreme weather event (EWE)—Typhoon Yagi occurring in September 2024—on commune health centers (CHCs) in Vietnam. This study assessed an extreme scenario by focusing on the most severely affected CHCs. The assessment revealed that the CHCs were subject to widespread infrastructure damage, severe disruption of essential utility services supporting the operation of the CHCs, staff shortage, and therefore, disruption of both key curative and preventive health services. This study highlights the acute vulnerabilities of CHCs under the stress of an EWE, reflecting shortcomings in disaster preparedness.

What is known and what is new?

- Health system resilience is essential to minimize mortality and morbidity during emergencies and EWEs. Vietnam is among the countries with the highest disaster risk. However, evidence on the immediate impacts of EWEs on grassroots primary healthcare facilities remains limited.
- This study contributed to narrowing the gap in evidence of the impacts of EWEs on primary healthcare facilities in Vietnam. It provided a critical stress test of the CHCs under maximum pressure, identifying specific vulnerabilities in infrastructure and utility resilience, and workforce capacity that hinder service continuity.

What is the implication, and what should change now?

- The findings imply an urgent need for targeted disaster preparedness that prioritize infrastructure integrity, redundant utility system and human resource mobilization. The lessons from an extreme scenario are vital for informing recovery and future resilience planning in Vietnam and other low- and-middle income countries.

health care services to meet critical public health needs following an EWE is essential for evidence-based planning and preparedness. Such evidence is vital to enhance health system resilience and reduce EWEs-related mortality, morbidity, and disruption to essential care during EWEs (7).

Typhoon Yagi, which formed over the eastern Philippines and intensified over the South China Sea, was one of the most powerful storms to strike the region in the last three decades. On September 7, 2024, Typhoon Yagi made landfall in northern Vietnam, causing severe damage to coastal areas in Quang Ninh and Hai Phong provinces with peak wind speeds reaching 213 km/hour (8). The typhoon and subsequent flooding directly affected 26 provinces and cities (accounting for 41% of the total number of provinces and cities in Vietnam), causing 320 fatalities, 25 missing persons and 1,978 people were injured. Widespread infrastructure damage occurred, including more than 283,383 houses, which were damaged or had their rooves blown off; 122,415 houses were flooded; 3,755 schools and 852 medical facilities were affected and damaged (8). The typhoon severely disrupted essential public utilities, hampering transport, electricity, clean water, and telecommunications infrastructure (8). Among the hardest-hit sectors were health services. A total of 852 health facilities [including hospitals, district health centers and commune health centers (CHCs)], of which 718 were CHCs, were directly damaged, which led to disruption of the treatment and healthcare services for the people (9).

Despite anecdotal and local media reports, there has been no comprehensive assessment to date of the immediate impacts of typhoon Yagi on Vietnam's primary health care facilities, especially on CHCs. In Vietnam's current administrative and healthcare structure, which includes the national, provincial and commune levels, CHCs function as the essential grassroots level, providing primary healthcare and preventive services directly within communes and wards. Following a major national administrative restructuring effective from July 2024 and consolidated by July 2025, the number of these units was significantly streamlined through the merging of over 10,000 communes/wards into approximately 3,321 larger administrative entities (10). Each CHC is responsible for critical public health functions, including infectious disease surveillance, national health programs, and basic curative care, typically managed by a multidisciplinary team of general practitioners, nurses, and pharmacists. As the primary point of contact in the national health system, CHCs play a strategic role in emergency response and patient referral, even as their service areas and population coverage have expanded following the 2025 restructuring (11). This paper aimed to report on results from a survey of the impacts of typhoon Yagi on the functionality and infrastructure of CHCs in the 10 most severely affected provinces in Vietnam. Our work is expected to contribute to bridging the gap of evidence of EWE-related impacts on the health sector in Vietnam, thereby inform targeted emergency response, support evidence-based recovery planning, and guide future resilience-building efforts within Vietnam's primary health care system and countries of similar settings in the region. We present this article in accordance with the SURGE reporting checklist (available at https://jphe.amegroups.com/article/view/10.21037/jphe-2026-1-0004/rc).

Methods

Study design and location

This was a cross-sectional survey to collect quantitative data from 128 CHCs in 10 provinces in northern Vietnam, which were most severely affected by Typhoon Yagi in September 2024. These study sites represent a diverse range of topographical and socio-economic contexts, including: (I) high-risk coastal areas: Quang Ninh and Thai Binh, which were the first to face peak wind speeds of up to 213 km/hour during landfall; (II) northern mountainous and midland regions: Yen Bai, Cao Bang, Lao Cai, Lai Chau, Thai Nguyen, and Bac Giang, which suffered from severe flash floods and landslides following the storm; (III) Red River Delta industrial and agricultural hubs: Bac Ninh and Ninh Binh. Collectively, these 10 provinces represent approximately 40% of the total 26 provinces affected by the typhoon.

Sampling and data collection

The sample size was calculated using the formula for estimating a proportion with specified precision (12):
$n = z_{1-\alpha/2}^2 \times p \times (1-p) \times DE/d^2$

Where z was the statistic for a level of confidence (for a significance level of 95%, z value was 1.96); p was the prevalence of CHCs affected by an EWE [a prevalence of 51.6% was selected from a previous study in Vietnam (13)]; d was the precision (d had a value of 15%); DE was the design effect, being equal to 2 (to allow for multi-stage sampling). With these values and an assumed non-response

rate of 40% (as lower response rates were found in online surveys (14), the minimum required sample size calculated was 120.

The assessment was conducted in early December 2024, two and a half months following the onset of Typhoon Yagi. At first, the ten most severely affected provinces were identified by the Committee for Natural Disaster Prevention and Control and Search and Rescue under the Vietnam Ministry of Health (MOH) based on their reporting system. In each selected province, the two most severely affected districts were selected. In each selected district, the ten most severely affected communes were selected. The identification of the districts and communes was done by the Committee for Natural Disaster Prevention and Control and Search and Rescue under the Provincial Department of Health based on data of the death toll and economic loss. All CHCs at the 200 selected communes were eligible to participate. CHCs with incompleted questionnaires and/or not sending completed questionnaires by 30th December 2024 were considered as not responding to the study. Altogether 128 out of 200 CHCs completed the survey (proving response to at least 80% of the survey questions), resulting in a response rate of 64%. The 128 participating CHCs represented 6.9% of the total 1,852 commune-level administrative units across the 10 selected provinces at the time of data collection (December 2024) (15).

The research team contacted the head of selected CHCs, explaining the research purposes and procedures, and inviting the CHC to participate in the survey via telephone. In addition, a package of documents including an invitation letter (with signature and contact of the principal investigator), a survey information sheet, an informed-consent form and a self-administered structured questionnaire, was sent to every CHC as Microsoft Word files attached to an email by the assessment team. The head of each CHC was requested to complete the questionnaire and send it back to the research team via email once the questionnaire is completed. During the data collection process, two researchers followed up with the head of the CHCs via email and/or telephone to remind them of the questionnaire completion and to follow up with any missing information in the completed questionnaires. Before the main survey, the questionnaire was piloted with 10 CHCs in Vinh Phuc Province (which were not included in the study sample), and the piloting resulted in minor changes to make the questionnaire clearer and more understandable. The careful pilot process of the survey questionnaire, the follow up of researchers with participants and a clear explanation of the objectives and procedures of the study to the participants helped to address potential sources of bias and minimize missing data. A modest incentive of USD 20 was provided to each participating CHC to compensate for the time and effort involved, in accordance with common research practices in Vietnam.

The questionnaire was developed based on a review of existing literature, including questions about critical components commonly reported as vulnerable to EWEs, namely physical damages to the CHCs, the impact of the typhoon on health staff, and the impact of the typhoon on service delivery one week following the typhoon (16-18). The questionnaire included three components, namely (I) impact on infrastructure, (II) Impact on healthcare staff, and (III) impact on the operation of the health facility. The first component covers questions about the level of damage to infrastructure of key areas of the health facility such as Reception, Pharmacy, Emergency, etc. The second component involves questions about the impact on physical and mental health and work attendance ability of healthcare staff. The third component covers questions about the impact on different aspects contributing to the operationality of the CHC one week following the event such as the number of functional beds, the operationality of clinical and preventive services; and the operationality of the utility systems. The impacts were assessed using a five-point scale, measuring five levels of impact on healthcare settings, as follows: 1. no impact (approximately 100% as normal conditions); 2. mild impact (reduced by approximately 25% of normal capacity); 3. average impact (reduced by approximately 50% of normal capacity); 4. severe impact (reduced by approximately 75% of normal capacity); 5. destroyed (completely inoperative, reduced about 100% capacity). Before the main survey, the questionnaire was piloted with 10 CHCs in Vinh Phuc Province (which were not included in the study sample), and the piloting resulted in minor changes to make the questionnaire clearer and more understandable.

Statistical analysis

Data management and analysis were conducted using STATA 18 software. Descriptive statistics, including frequencies and percentages, were used to summarize key indicators showing the disaster damage and operational status of CHCs during the response phase of Typhoon Yagi. The paper also investigated the association between main outcome variables, including damages to infrastructure,

and the ability to attend work of the health staff and the operation of key services, using Chi-square test with a P value less than 0.05 showing evidence of a statistically significant association. Odd ratios and 95% confidence intervals were also calculated to demonstrate the strength of the associations. In these analyses, a CHC was considered as being subject to impact on infrastructure if it had at least one area being physically affected at any level, from mild impact to completely destroyed by Typhoon Yagi. Only observed (non-missing) data were included in the analyses, and no imputation procedures were performed. A formal analysis of nonresponse error was not conducted due to the lack of information on non-respondents, which is a common limitation in survey-based studies.

Ethical consideration

The study was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. The study protocol was approved by the Ethics Committee of Hanoi University of Public Health, Vietnam (Decision No. 413/2024/YTCC-HD3 dated 31st October 2024). Data were anonymized to ensure confidentiality. Written informed consent was obtained from all heads of the CHCs.

Results

Sample characteristics

The survey was completed by the heads of 128 CHCs, making the response rate of 64%. The 128 participating CHCs served an average population of 7,508.6±4,864.6 residents, with a wide range from 1,146 to 28,722 people. The healthcare workforce at these facilities was relatively small, with a mean of 6.06±1.40 staff members per center (range, 3 to 11). Under normal operating conditions, the average inpatient bed occupancy rate was (range: 0% to 100%), reflecting the baseline capacity of these grassroots facilities prior to the impact of the typhoon.

Impacts of Typhoon Yagi on the CHCs

Table 1 presents descriptions of infrastructure damage in different areas of the CHCs. All assessed components of the CHCs were affected at varying levels. The areas having damaged or destroyed infrastructure varied from medical service provision areas, such as patient reception, emergency area, examination and treatment area and pharmacy counter to utilities such as water storage and lighting system. The proportion of CHCs reporting physical damage or destruction ranged from 27.3% to 52.3% depending on the area. The areas most commonly reported with severe damage or destruction involved clean water tanks, water storage areas, sanitary areas, building roofs, building ceilings, signs, electrical lines, and lighting systems at important areas (with the proportion of reporting CHCs ranging from 10.1% to 14%).

Table 2 provides information on the impact of Typhoon Yagi on healthcare personnel. About one-quarter of the CHCs saw a reduction in the availability of working staff due to the storm. Specifically, 15.6% of the CHCs experienced mild impact, 5.5% moderate impact, while a small proportion reported severe (3.1%) and very severe (1.6%) impacts. Approximately one-quarter of the CHCs reported impacts on the physical health of their healthcare personnel due to Typhoon Yagi, mostly at a mild level. A small percentage reported severe (3.9%) and very severe (1.6%) levels.

Typhoon Yagi had a greater impact on the mental health of healthcare personnel than on their physical health. The proportion of CHCs with staff affected mentally by Typhoon Yagi was 51.4%. Most CHCs with staff affected mentally reported mild to moderate levels of impact. The proportion of CHCs that reported the impact of the ability to work of the health care personnel one week following the typhoon was 32.8%, mostly with mild to moderate levels (21.1% and 7.8%, respectively).

Table 3 presents the results regarding the impact of the Typhoon Yagi on the operation of the CHCs in different aspects including bed capacity, delivery of curative and preventive services, access to utilities that support the operation of the CHCs, impact on medical equipment, drugs and supplies, impact on sanitation condition, waste collection and treatment and impact on the ability to receive and transport patients. About one-fourth of the CHCs reported impacts on the availability of functional patient beds. Notably, the typhoon affected the delivery of curative services, including patient reception, laboratory sampling and testings, emergency care, examination, and treatment of half of the CHCs. The proportion of CHCs reporting severe or very severe impact was 15.6% for patient reception activities, 10.3% for emergency care, 13.3% for medical examination services, and 14.8% for treatment services.

Providing preventive services is an important function of CHCs in Vietnam. This component of services saw the same pattern of damage as curative services, with

Table 1 Impacts of Typhoon Yagi on the infrastructure of the commune health centers

No.	Infrastructure	No impact (~100% as normal conditions)	Mild impacts (~25% reduced capacity)	Average impacts (~50% reduced capacity)	Severe impacts (~75% reduced capacity)	Destroyed (completely inoperative/~100% reduced capacity)
1	Patient reception area (n=126)	74 (58.7)	28 (22.2)	14 (11.1)	8 (6.3)	2 (1.6)
2	Emergency area (n=125)	85 (68)	19 (15.2)	11 (8.8)	8 (6.4)	2 (1.6)
3	Examination and treatment area (n=126)	82 (65.1)	22 (17.5)	13 (10.3)	7 (5.6)	2 (1.6)
4	Pharmacy counter (n=124)	90 (72.6)	16 (12.9)	11 (8.9)	6 (4.8)	1 (0.8)
5	Computers: medical records storage (n=126)	88 (69.8)	19 (15.1)	11 (8.7)	5 (4.0)	3 (2.4)
6	Medicine and supplies storage area (n=124)	95 (76.6)	16 (12.9)	8 (6.5)	4 (3.2)	1 (0.8)
7	Clean water tank (n=120)	78 (65)	25 (20.8)	4 (3.3)	10 (8.3)	3 (2.5)
8	Waste storage area (n=123)	82 (66.7)	21 (17.1)	5 (4.1)	11 (8.9)	4 (3.3)
9	Sanitary area (n=125)	81 (64.8)	20 (16)	8 (6.4)	13 (10.4)	3 (2.4)
10	Shelves, cabinets, and equipment (n=125)	93 (74.4)	19 (15.2)	6 (4.8)	5 (4.0)	2 (1.6)
11	Building roofs (n=127)	78 (61.4)	20 (15.7)	16 (12.6)	6 (4.7)	7 (5.5)
12	Building ceilings (n=125)	81 (64.8)	24 (19.2)	8 (6.4)	10 (8)	2 (1.6)
13	Building walls (n=127)	82 (64.6)	25 (19.7)	11 (8.7)	8 (6.3)	1 (0.8)
14	Glass windows (n=126)	79 (62.7)	23 (18.3)	17 (13.5)	6 (4.8)	1 (0.8)
15	Doors (n=126)	91 (72.2)	15 (11.9)	10 (7.9)	8 (6.3)	2 (1.6)
16	Floors (n=122)	89 (73)	12 (9.8)	11 (9)	9 (7.4)	1 (0.8)
17	Air conditioners and fans (n=123)	95 (77.2)	12 (9.8)	6 (4.9)	7 (5.7)	3 (2.4)
18	Ventilation system (n=85)	72 (84.7)	7 (8.2)	1 (1.2)	2 (2.4)	3 (3.5)
19	Signs (n=122)	61 (50)	31 (25.4)	12 (9.8)	9 (7.4)	9 (7.4)
20	Important area lighting system (n=121)	70 (57.9)	27 (22.3)	7 (5.8)	12 (9.9)	5 (4.1)
21	Electrical lines (n=124)	77 (62.1)	19 (15.3)	10 (8.1)	10 (8.1)	8 (6.5)

Data are presented as n (%).

Table 2 Impact on health staff of health facilities (n=128)

Characteristic	No effect	Mild effect (~25% reduction)	Moderate impact (~50% reduction)	Severe impact (~75% reduction)	Very severe impact (100% did not go to work)
Impact on the number of healthcare worker working in health facilities	95 (74.2)	20 (15.6)	7 (5.5)	4 (3.1)	2 (1.6)
Impact on the physical health of healthcare workers	83 (64.8)	31 (24.2)	7 (5.5)	5 (3.9)	2 (1.6)
Impact on the mental health of healthcare workers	75 (58.6)	36 (28.1)	10 (7.8)	5 (3.9)	2 (1.6)
Impact on the ability of healthcare workers to attend work	86 (67.2)	27 (21.1)	10 (7.8)	3 (2.3)	2 (1.6)

Data are presented as n (%).

Table 3 Impact of typhoon Yagi on the operation of the commune health centers

No.	Impacts on the operation of the CHCs	No impacts (~100% as normal condition)	Mild impacts (~25% reduced capacity)	Moderate impacts (~50% reduced capacity)	Severe impacts (~75% reduced capacity)	Very severe impact (~100% reduced capacity)
1	Number of inpatient beds operational during typhoon Yagi (n=128)	95 (74.2)	15 (11.7)	9 (7.0)	5 (3.9)	4 (3.1)
2	Number of inpatient beds operational one week following typhoon Yagi (n=128)	97 (75.8)	13 (10.2)	7 (5.5)	7 (5.5)	4 (3.1)
3	Impacts on key curative services					
	Impacts on patient reception activities (n=128)	58 (45.3)	32 (25.0)	18 (14.1)	15 (11.7)	5 (3.9)
	Impacts on laboratory sampling and testing activities (n=74)	59 (79.7)	9 (12.2)	4 (5.4)	2 (2.7)	0
	Impacts on emergency care at the CHCs (n=117)	64 (54.7)	31 (26.5)	10 (8.5)	11 (9.4)	1 (0.9)
	Impacts on medical examination services (n=128)	53 (41.4)	35 (27.3)	23 (18.0)	13 (10.2)	4 (3.1)
	Impacts on patient treatment services (n=128)	57 (44.5)	40 (31.3)	12 (9.4)	15 (11.7)	4 (3.1)
4	Impacts on key preventive services					
	Vaccination services (n=97)	47 (48.5)	29 (29.9)	8 (8.2)	5 (5.2)	8 (8.2)
	Health communication and education services (n=97)	39 (40.2)	21 (21.6)	20 (20.6)	8 (8.2)	9 (9.3)
5	Impacts on essential utilities					
	Access to clean water for health facilities one week following the typhoon (n=128)	64 (50.0)	23 (18.0)	25 (19.5)	13 (10.2)	3 (2.3)
	Access to electricity at health facilities one week following the typhoon (n=128)	53 (41.4)	12 (9.4)	9 (7.0)	2 (1.6)	52 (40.6)
	Impact on communication (telephone, internet) (n=128)	47 (36.7)	14 (10.9)	7 (5.5)	9 (7.0)	51 (39.8)
6	Impact on medical equipment, drugs, and supplies (n=128)	89 (69.5)	30 (23.4)	6 (4.7)	2 (1.6)	1 (0.8)
7	Impacts on sanitation conditions, waste collection, and treatment (n=128)	81 (63.3)	28 (21.9)	6 (4.7)	6 (4.7)	7 (5.5)
8	Impacts on the ability to receive and transport patients					
	Impacts on the ability to receive patients requiring first aid (n=128)	72 (56.3)	28 (21.9)	17 (13.3)	9 (7.0)	2 (1.6)
	Ability to transport patients to higher-level health facilities (n=128)	66 (51.6)	23 (18%)	19 (14.8)	14 (10.9)	6 (4.7)

Data are presented as n (%). CHCs, commune health centers.

51.5% reporting disruption of vaccination services and 59.8% reporting disruption of health communication and education activities. Another finding of concern was that 13.4% of the CHCs reported severe impact or complete disruption of vaccination services within the first week following the typhoon.

Disruptions extended to essential utilities, with more than half of the CHCs experiencing compromised access to water, electricity and communication services. As many as 40.6% of the CHCs did not have access to electricity and 39.8% of the CHCs experienced complete disruption of communication systems. Severe to very severe impacts on access to clean water within one week following the disaster were reported by 12.5% of the health facilities. In addition, more than 30% of the CHCs experienced reduced capacity of medical equipment, drugs and supplies, sanitation conditions, waste collection, and treatment. Reduced patient transportation and referral capacity were reported by about half of the CHCs.

The associations between impacts on infrastructure and the operation of key services are presented in *Table 4*.

It can be seen from *Table 4* that there were strong associations between impacts on infrastructure and impacts on key clinical and preventive services of the CHCs, including patient reception, emergency care, patient examination, patient treatment, vaccination, health communication and education, admission of patients requiring first aid and transportation of patients to higher-level health facilities. This indicated that the CHCs experiencing impacts on their infrastructure were more likely to be subject to disruption of important services.

The associations between the impacts on health workers' ability to attend work and the operation of key services within the first week since the onset of the typhoon are presented in *Table 5*.

Table 5 shows that there were strong associations between the impact on health workers' ability to attend work and impact on key clinical and preventive services of the CHCs, indicating that the CHCs having impacts on health staff were more likely to be subject to disruption of important services.

Discussion

This study reported on the results of the first large-scale assessment of the immediate impacts of an EWE on CHCs in Vietnam using Typhoon Yagi as a case study. While the global literature frequently documents EWE-induced disruptions, this assessment addresses a critical evidence gap in Vietnam, a country ranked among the top 20 for global disaster risk (5). Current national disaster reporting mechanisms in Vietnam often rely on superficial indicators, such as the total count of damaged facilities and total economic loss, without granular data on specific functional impairments or structural components (19). By documenting the acute multifaceted vulnerabilities and revealing critical weaknesses in infrastructure, equipment and supplies, service delivery and human resources of these primary healthcare facilities, this study provides a necessary 'stress test' of the grassroots health system. Such detailed baseline evidence on the level of impact is a prerequisite for identifying preparedness gaps and informs the development of more sophisticated indicators for future response and recovery monitoring.

The findings demonstrated the impacts of a strong typhoon on the infrastructure of a wide range of areas in a CHC, ranging from critical service areas such as patient reception, emergency areas, examination and treatment areas, and pharmacy counter to utility systems such as water storage and lighting systems. Between 27.9% and 50% of facilities reported physical damage, while 10.8% to 14.6% experienced severe damage or total destruction to vital infrastructure components such as clean water tanks, roofs, ceilings, and electrical systems. Particularly, as many as 40.6% of the CHCs did not have access to electricity and 39.8% of the CHCs experienced complete disruption of communication systems one week post the event. These findings reflected the fragility and vulnerability of CHCs, especially utility services and reception areas, which should be targeted to build resilience. It has been recognized that infrastructure resilience is critical to climate-adaptive health systems, especially in low-resource settings (20-22).

Our analysis (*Table 4*) identified strong associations between damage to infrastructure and the disruption of key services of the CHCs in the aftermath of the disaster. Currently, Vietnam has national standards and regulations that clearly stipulate design criteria for a CHC, including detailed regulations on size, structure, area, and material requirements for various infrastructure components to ensure the integrity, safety, and smooth operation of the health facility (23). For CHCs, national standards also clearly show criteria that take into account the mitigation of the impact of EWEs, though only taking into account design standards for CHCs in flooded and non-flooded areas (23). Compliance with design regulations during construction, while ensuring that the infrastructure is ready

Table 4 Associations between impact on infrastructure and impact on key services

Impact on key services	Impact on infrastructure		OR (95% CI)	P value
	Yes, n (%)	No, n (%)		
Patient reception			19.8 (6.9–56.6)	<0.001
Yes	65 (73.9)	5 (12.5)		
No	23 (26.1)	35 (87.5)		
Emergency care at the commune health center			16.2 (4.6–56.6)	<0.001
Yes	50 (56.8)	3 (7.5)		
No	38 (43.2)	37 (92.5)		
Patient examination			20.6 (7.5–56.2)	<0.001
Yes	69 (78.4)	6 (15.0)		
No	19 (21.6)	34 (85.0)		
Patient treatment			12.6 (4.9–32.2)	<0.001
Yes	64 (72.7)	7 (17.5)		
No	24 (27.3)	33 (82.5)		
Vaccination services			4.6 (1.6–12.8)	0.006
Yes	44 (60.3)	6 (25)		
No	29 (39.7	18 (75)		
Health communication and education services			14.2 (4.3–46.9)	<0.001
Yes	54 (74.0)	4 (16.7)		
No	19 (26.0)	20 (83.3)		
Admitting patients requiring first aid			9.6 (3.5–26.9)	<0.001
Yes	51 (58.0)	5 (12.5)		
No	37 (42.0)	35 (87.5)		
Transportation of patients to higher-level health facilities			6.4 (2.6–15.4)	<0.001
Yes	54 (61.4)	8 (20.0)		
No	34 (38.6)	32 (80.0)		

CI, confidence interval; OR, odds ratio.

for potential hazards in the area, specific to the local context, right from the design and construction stage, is crucial. More importantly, regular comprehensive inventory of the infrastructure and measures to reinforce and prepare before EWEs occur, such as cross-roofing, reinforcing doors, having backup utility systems essential to the provision of health care such as electricity, water, communications, waste treatment, evacuating equipment, supplies, and transfer of treatment areas to alternative, safe rooms or locations, also need to be addressed in the emergency preparedness plan of health facilities.

The study found that Typhoon Yagi affected health staff's attendance in approximately one-quarter of the CHCs. There were CHCs, though with a small proportion (less than 5%) reporting severe or very severe impacts on the proportion of health workers working in the health facility, physical health, mental health, and the ability of health workers to work during and immediately following the disaster. Existing literature shows that an aspect of healthcare disruption during EWEs that is often overlooked is the impact on health workers (24,25). During disasters, healthcare workers often experience significantly

Table 5 Associations between health staff's ability to attend work and impact on key services

Impact on key services	Impact on health workers' ability to attend work		OR (95% CI)	P value
	Yes, n (%)	No, n (%)		
Patient reception			4.86 (2.1–11.4)	<0.001
Yes	33 (78.6)	37 (43.0)		
No	9 (21.4)	49 (57.0)		
Emergency care at the commune health center			3.55 (1.6–7.7)	0.002
Yes	26 (61.9)	27 (31.4)		
No	16 (38.1)	59 (68.6)		
Patient examination			4.67 (1.9–11.2)	0.001
Yes	34 (81.0)	41 (47.7)		
No	8 (19.0)	45 (52.3)		
Patient treatment			8.74 (3.3–23.0)	<0.001
Yes	36 (85.7)	35 (40.7)		
No	6 (14.3)	51 (59.3)		
Vaccination services			9.86 (3.4–29.1)	<0.001
Yes	27 (84.4)	23 (35.4)		
No	5 (15.6)	42 (64.6)		
Health communication and education services			19.82 (4.4–90.0)	<0.001
Yes	30 (93.8)	28 (43.1)		
No	2 (6.3)	37 (56.9)		
Admitting patients requiring first aid			6.88 (3.0–15.8)	<0.001
Yes	31 (73.8)	25 (29.1)		
No	11 (26.2)	61 (70.9)		
Transportation of patients to higher-level health facilities			10.93 (4.3–27.7)	<0.001
Yes	35 (83.3)	27 (31.4)		
No	7 (16.7)	59 (68.6)		

CI, confidence interval; OR, odds ratio.

increased workload under great pressure, which can lead to both physical and mental exhaustion. Such conditions can impair their ability to provide quality care, which can have a negative impact on patient outcomes. Furthermore, healthcare workers may also be personally affected by disaster events, which can lead to disruptions in both their personal and professional lives, which can in turn affect their ability to work, hence contributing to the disruption of health care (24,26).

Furthermore, our findings show strong associations between impacts on healthcare personnel's ability to work within one week since the onset of the disaster (*Table 5*) and disruption of key clinical and preventive services of the CHCs. There remains substantial room for improvement and issues that need to be addressed particularly around staff safety and wellbeing in current disaster prevention and control policies in Vietnam for the health sector such as the Action Plan of Natural Disaster Prevention and Control and Search and Rescue of the Health Sector for the period of 2021–2025 or the National Action Plan for the Health Sector Response to Climate Change in the period 2019–2030, with a vision to 2030 (27). Evidence from this

assessment implies that to ensure health facilities' resilience to disasters, preparedness efforts should extend their focus beyond infrastructure, involving strategies for effective mobilization of human resources within and among health facilities in emergency situations to prevent shortages, and addressing support strategies including psychosocial support to increase the resilience of healthcare personnel, thereby enhancing their ability to participate in providing health services in the context of EWEs (28).

The study reiterates the importance of critical infrastructure to support the operation of a health facility. Due to Typhoon Yagi, 40.6% of the CHCs did not have access to electricity, and 39.8% of the CHCs experienced complete disruption of communication systems. Severe to very severe impacts on access to clean water within one week following the disaster were reported by 12.5% of the health facilities. There has been a significant number of case studies showing evidence of the impacts of utility failure, ranging from inoperability of medical services to coordination with outside and evacuation of health facility buildings (29,30). The assessment also found that more than 30% of the CHCs experienced reduced functionality of medical equipment, drugs and supplies, and sanitation conditions, waste collection, and treatment. These findings again emphasize the importance of protecting non-structural components of the CHCs to ensure their resilience to EWEs.

The study provided evidence of EWEs' impacts on the healthcare delivery capacity. Key curative services, including patient reception, laboratory sampling and testing, emergency care, examination, and treatment, were affected in about 50% of the CHCs with varying levels of severity. These observations align with previous research indicating that large-scale environmental disasters create substantial barriers to both the provision and the public's reach of clinical care (24). This outcome may result from damage to infrastructure, disruption of utility services, including power outages, water shortages, road damage, and communication interruptions, shortage of health care staff (24,31), aggravated by the increased health needs of the affected community (32).

Of particular concern was that about half of the CHCs were subject to disruption of vaccination services, with 13.4% of CHCs reporting severe or complete interruption. It has been observed that public health emergencies can be triggered by an EWE, humanitarian emergency, or disease outbreak. Furthermore, pandemic events may occur if ongoing immunization services are affected (33), posing additional challenges to curative services, which are already constrained by the disaster damage and overloaded with the health needs of the community affected by the disaster. Unfortunately, the focus of disaster response efforts is often to address immediate needs such as search and rescue, emergency medical care, and providing food, water, and shelter. However, the long-term health needs of disaster-affected populations, including the need for vaccination, must not be overlooked (34). Immunization programs serve as a vital safeguard for vulnerable populations, notably the elderly, pediatric groups, and immunocompromised patients, against post-disaster infectious surges (34). It also strengthens community resilience and supports recovery by reducing illness burden and preventing further disease spread. The finding highlights the importance of planning for appropriate and effective vaccine delivery to at-risk populations in emergencies, alongside ensuring the capacity for continuing provision of curative services.

Limitations

The study had some limitations that are worth considering when interpreting its findings and conclusions. First, data were self-reported via emailed questionnaires, which may have resulted in a lower response rate of 64% which may account for the resulting bias from non-response and potential reporting bias compared to face-to-face interviews, particularly the potential for hidden information or data discrepancies. However, this was also the most feasible data collection method within the scope of resources allowed for including many health facilities. Second, the study relied on subjective assessments of the impacts of Typhoon Yagi on CHCs from CHCs' heads rather than independent damage assessments, which may limit the accuracy of the reported impacts. However, CHC heads were responsible for understanding operational requirements and having an overview of disaster impacts, and so have relevant insight to respond to the survey questions. Further studies on the impacts of EWEs on health facilities may use assessment methods based on standardized measurement tools for more accurate assessment, such as observations and damage quantification criteria among health facilities. Third, the assessment covered only the 10 most affected provinces, and thus the findings may not be generalizable to all regions or disaster types, however, a focus on the most affected provinces provided evidence of the worst scenarios to inform preparation in provinces, which may face more severe or widespread impacts in the future. Typhoon Yagi

was a historically destructive disaster, so the assessment results were not representative of all EWEs in Vietnam. Climate change is likely to lead to more frequent and severe EWEs in Vietnam and other countries in the future (35), and so evidence of the impacts of Typhoon Yagi are relevant for preparedness and planning. Further studies in other contexts are needed to gain more evidence on the impact of EWEs on health facilities. Lastly, as an initial quantitative study, qualitative assessments may be needed to explore underlying causes of vulnerability and inform targeted preparedness programs and policies.

Conclusions

This assessment contributes to narrowing the evidence gap regarding EWEs' impacts on primary healthcare facilities in Vietnam. It is important to note that since this study purposefully sampled the most severely affected districts and communes based on mortality and economic loss, the findings represent an extreme scenario and may not be generalizable to the overall state of disaster preparedness across Vietnam. However, these multifaceted vulnerabilities, ranging from fragile infrastructure and utility systems to workforce instability, resulted in critically limited-service delivery, provide a critical baseline for the 'worst-case' performance of the healthcare system. The findings imply an urgent need for targeted, rather than universal, enhancement of disaster response plans. Future strategies should adopt a comprehensive approach addressing structural safety, redundant utility systems, and support for staff to ensure that even the most at-risk CHCs can maintain essential functions during catastrophic events.

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Footnote

Reporting Checklist: The authors have completed the SURGE reporting checklist. Available at https://jphe.amegroups.com/article/view/10.21037/jphe-2026-1-0004/rc

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. The study protocol was approved by the Ethics Committee of Hanoi University of Public Health (Decision No. 413/2024/YTCC-HD3 dated 31st October 2024). Data were anonymized to ensure confidentiality. Written informed consent was obtained from all heads of the commune health centers.

References

1. World Meteorological Organization. Extreme weather [Internet]. [cited 2026 Mar 23]. Available online: https://wmo.int/topics/extreme-weather#:~:text=Main%20themes,390%2C000%20ha
2. Ebi KL, Vanos J, Baldwin JW, et al. Extreme Weather and Climate Change: Population Health and Health System Implications. Annu Rev Public Health 2021;42:293-315.
3. Kruk ME, Myers M, Varpilah ST, et al. What is a resilient health system? Lessons from Ebola. Lancet 2015;385:1910-2.
4. World Health Organization, Pan American Health Organization. Hospital safety index: guide for evaluators, 2nd ed [Internet]. Geneva: World Health Organization; 2015.
5. Bündnis Entwicklung Hilft, Institute for International Law of Peace and Armed Conflict. The WorldRiskReport 2024 - Focus: Multiple Crises. Berlin: Bündnis Entwicklung Hilft.; 2024.
6. Global Facility for Disaster Reduction and Recovery (GFDRR). Mainstreaming disaster resilience in Vietnam: Engaging with communities to build resilience - Viet Nam [Internet]. World Bank; 2018. Available online: https://reliefweb.int/report/viet-nam/mainstreaming-disaster-resilience-vietnam-engaging-communities-build-resilience
7. Gil Cuesta J, van Loenhout JAF, de Lara-Banquesio ML, et al. The Impact of Typhoon Haiyan on Health Staff: A Qualitative Study in Two Hospitals in Eastern Visayas, The Philippines. Front Public Health 2018;6:208.
8. United Nations Development Programme (UNDP). Viet Nam Multi-Sector Assessment (VMSA) Report for Typhoon Yagi Recovery. Hanoi: UNDP; 2024.
9. Open Development Vietnam. Vietnam ranks sixth in Global Climate Risk Index [Internet]. 2019 [cited 2024 Apr 11]. Available online: https://vietnam.opendevelopmentmekong.net/news/vietnam-ranks-sixth-in-global-climate-risk-index/
10. The Government in Vietnam. Resolution No. 126/NQ-CP dated May 09, 2025 on dossiers on Scheme for arrangement of commune-level administrative divisions in 2025.
11. Vietnam Ministry of Health. Circular No. 43/2025/TT-BYT: Guidance on the functions, tasks, powers, and organizational structure of commune-level health stations. Vietnam Ministry of Health; 2025.
12. Chadha VK. Sample Size Determination in Health Studies. NTI Bulletin 2006;42:55-62.
13. Ha N, Vu H, Le T. Rapid health, assessment in emergencies: Vietnam experience. Southeast Asian Journal of Tropical Medicine and Public Health 2009;40:23-30.
14. Wu MJ, Zhao K, Fils-Aime F. Response rates of online surveys in published research: A meta-analysis. Computers in Human Behavior Reports 2022;7:100206.
15. The Standing Committee of the National Assembly. Resolution No. 1239/NQ-UBTVQH15 of the Standing Committee of the National Assembly: On the rearrangement of commune-level administrative units of Yen Bai Province for the 2023–2025 period.
16. Vietnam Ministry of Health. Decision No. 4695/QD-BYT dated November 21, 2013 of the Minister of Health on promulgating the Toolkit for Assessing Hospital Safety in Emergency and Disaster Situations.
17. Brainard J, Sedekia Y, Jones NR, et al. Extreme weather effects on health services and communities in low and lower-middle income countries: a thematic systematic review. Trans R Soc Trop Med Hyg 2026;trag007.
18. Abebe YA, Pregnolato M, Jonkman SN. Flood impacts on healthcare facilities and disaster preparedness–A systematic review. International Journal of Disaster Risk Reduction 2025;119:105340.
19. Vietnam Ministry of Planning and Investment, Vietnam Ministry of Agriculture and Rural Development. Joint Circular No. 43/2015/TTLT-BNNPTNT-BKHĐT about Guidelines for statistical reporting and damage assessment caused by natural disasters.
20. Mosadeghrad AM, Isfahani P, Eslambolchi L, et al. Strategies to strengthen a climate-resilient health system: a scoping review. Global Health 2023;19:62.
21. World Health Organization. Operational framework for building climate resilient and low carbon health systems. Geneva: WHO; 2023.
22. Sänger N, Heinzel C, Sandholz S. Advancing Resilience of Critical Health Infrastructures to Cascading Impacts of Water Supply Outages—Insights from a Systematic Literature Review. Infrastructures 2021;6:177.
23. Vietnam Ministry of Science and Technology. National Technical Standard TCVN 7022:2002 on Commune Health Stations–Design Requirements. Vietnam Ministry of Science and Technology; 2002.
24. Salam A, Wireko AA, Jiffry R, et al. The impact of natural disasters on healthcare and surgical services in low- and middle-income countries. Ann Med Surg (Lond) 2023;85:3774-7.
25. Pradhan NA, Najmi R, Fatmi Z. District health systems capacity to maintain healthcare service delivery in Pakistan

during floods: A qualitative study. International Journal of Disaster Risk Reduction 2022;78:103092.
26. Achour N, Elhaj H, Ali A. Hospital resilience to extreme events: A staff capability of attendance perspective. International Journal of Disaster Risk Reduction. 2022;72:102851.
27. Vietnam Ministry of Health. Decision No. 7562/QĐ-BYT in December 21, 2018 on National Action Plan for the Health Sector Response to Climate Change in the Period 2019–2030, with a Vision to 2050. Hanoi: Vietnam Ministry of Health; 2018.
28. Melnychuk E, Sallade TD, Kraus CK. Hospitals as disaster victims: Lessons not learned? J Am Coll Emerg Physicians Open 2022;3:e12632.
29. Achour N, Miyajima M, Pascale F, et al. Hospital resilience to natural hazards: classification and performance of utilities. Disaster Prevention and Management 2014;23:40-52.
30. Rodríguez-Madera SL, Varas-Díaz N, Padilla M, et al. The impact of Hurricane Maria on Puerto Rico's health system: post-disaster perceptions and experiences of health care providers and administrators. Glob Health Res Policy 2021;6:44.
31. Wang W, Li H, Huang M. A literature review on the impact of disasters on healthcare systems, the role of nursing in disaster management, and strategies for cancer care delivery in disaster-affected populations. Front Oncol 2023;13:1178092.
32. Feizolahzadeh S, Vaezi A, Mirzaei M, et al. Barriers and facilitators to provide continuity of care to dischargeable patients in disasters: A qualitative study. Injury 2019;50:869-76.
33. Walldorf JA, Date KA, Sreenivasan N, et al. Lessons Learned from Emergency Response Vaccination Efforts for Cholera, Typhoid, Yellow Fever, and Ebola. Emerg Infect Dis 2017;23:S210-6.
34. Alomari O. Why vaccinations should be a top priority in earthquake relief efforts. Lancet 2023;401:1263-4.
35. The World Bank Group, Asian Development Bank. Climate Risk Country Profile: Vietnam [Internet]. The World Bank Group and the Asian Development Bank; 2020. Available online: https://climateknowledgeportal.worldbank.org/sites/default/files/2021-06/15448-WB_Vietnam%20Country%20Profile-WEB.pdf

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