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Public Health Management Readiness in Controlling the Risk of Infectious Diseases Post-Disaster

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ABSTRACT

Indonesia is highly vulnerable to natural disasters, which often disrupt health systems and increase the risk of infectious disease outbreaks in the post-disaster period. Empirical quantitative evidence on the relationship between public health management preparedness and infectious disease control at the primary healthcare level remains limited. This study analyzed the association between management preparedness and post-disaster infectious disease control effectiveness in Padang Panjang, West Sumatra. A cross-sectional analytic study was conducted involving 60 health personnel engaged in post-disaster management using total sampling. Data were collected through validated structured questionnaires and supported by surveillance reports. Statistical analyses included descriptive tests, Chi-square, Spearman correlation, and multivariate logistic regression ($\alpha < 0.05$). Results showed that overall preparedness was categorized as good, particularly in epidemiological surveillance, although logistical readiness was relatively weak. Infectious disease control performance was generally good in case detection, prevention coverage, and response, while disease incidence trends remained moderate. A significant positive association was found between preparedness and disease control effectiveness ($p < 0.05$; $r = 0.462$). Multivariate analysis identified surveillance systems as the strongest predictor (Adjusted OR = 4.39), followed by logistics, human resources, and intersectoral coordination. Strengthening surveillance capacity, logistics, resource distribution, and cross-sector collaboration is essential to improve sustainable post-disaster infectious disease control.

Keywords: *Public Health Management Preparedness, Infectious Disease Risks, Post-Disaster*

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INTRODUCTION

Climate change and the increasing number of extreme weather events such as floods, storms, heat waves, and tropical cyclones have led to an increasing trend in the occurrence of natural disasters globally and regionally in recent decades. Continued climate change significantly endangers human health by influencing disaster patterns and increasing the vulnerability of health systems worldwide and in specific regions. Natural disasters not only cause physical damage and economic losses but also significantly impact public health, particularly by disrupting basic health services, sanitation systems, and access to clean water. These impacts exacerbate the health conditions of already vulnerable individuals and communities, particularly vulnerable groups such as children, the elderly, and people with long-term medical conditions (World Health Organization, 2023).

Indonesia is one of the countries with the highest disaster risk in the world due to its geological and hydrometeorological conditions. Data from the National Disaster Management Agency shows that in the last five years there have been thousands of disasters, predominantly floods, landslides and earthquakes, which have had a direct impact on the public health system (Darmanto et al., 2022). In West Sumatra Province, an area prone to earthquakes and floods, disruptions to primary health care services and infectious disease surveillance systems often occur in the post-disaster phase. Reports from the Indonesian Ministry of Health also confirm increased vigilance against environment-based diseases and vaccine-preventable diseases (PD3I) in evacuation sites, particularly diarrhoea, respiratory tract infections, and vector-borne diseases.

In post-disaster contexts, changes in the physical environment and sanitation are often significant factors contributing to increased transmission of infectious diseases. Damage to water and sanitation infrastructure creates opportunities for water-borne pathogens such as bacteria and viruses to infect humans, while stagnant water and new habitats for vectors such as mosquitoes accelerate the spread of vector-borne diseases (Mercogliano et al., 2025).

Furthermore, disasters have complex epidemiological impacts, including increased levels of displacement and post-disaster population mobility. Large population mobilization, crowded conditions, and lack of sanitation facilities increase the risk of droplet-based or direct-contact transmission of diseases such as diarrhea and acute respiratory infections (ARI). Following disasters, several types of infectious diseases are known to increase, including waterborne, vector-borne, and respiratory diseases. For example, a report from the Indonesian Ministry of Health highlighted the need for vigilance regarding vaccine-preventable diseases (VPD3I) in evacuation sites, emphasizing that suboptimal surveillance and interventions increase the risk of infectious disease outbreaks (KLB) (Ministry of Health, 2025).

Limited access to clean water, hygienic facilities, and basic health services is often a major barrier to post-disaster disease prevention. These barriers increase the risk of morbidity and burden the health system in disaster areas, necessitating promotive, preventive, and curative public health strategies (Mercogliano et al., 2025).

In disasters, public health management is crucial for controlling these risks. This management concept encompasses the systematic planning, organization, implementation, and

control of health programs that are responsive to post-disaster changes and threats. This includes integrating epidemiological surveillance, early warning systems, and cross-sector coordination to respond quickly to health threats (Nuzzo et al., 2019).

The preparedness of health organizations is crucial for building a resilient public health system. Human resources, health logistics, information systems, and standard operating procedures are all components that enable a rapid and efficient response to post-disaster disease threats (Raharjo et al., 2025).

Empirical research in the field shows a gap between preparedness policies and operational implementation. Examples include the lack of coordination of surveillance data and disparities in capacity between regions in implementing post-disaster health preparedness. This can hamper infectious disease control and potentially lead to outbreaks or outbreaks in affected areas. Many current studies also demonstrate this gap: many studies concentrate on the emergency response phase rather than the comprehensive managerial preparedness phase. A holistic understanding of public health risks is systematically hampered by the lack of quantitative indicators measuring the relationship between the level of health system preparedness and post-disaster disease incidence (Aini et al., 2026).

In the context of public health policy, strengthening resilient health systems in response to disasters is a crucial priority, particularly in Indonesia, which is prone to natural disasters. This system focuses not only on rapid crisis response but also on maintaining basic services and preventing post-disaster outbreaks of infectious diseases through a holistic approach (Ghebreyesus et al., 2022).

This research has significant implications for supporting the development of evidence-based health preparedness policies, improving the quality of post-disaster infectious disease control programs, and providing practical recommendations for policymakers and public health practitioners. Theoretically, this research also contributes to the literature on public health preparedness and disaster risk management. (Raharjo et al., 2025).

Thus, the research focuses on assessing the level of public health management preparedness, identifying factors influencing the effectiveness of post-disaster disease risk control, and analyzing the relationship between health system capacity and post-disaster infectious disease incidence. The findings of this study are expected to generate applicable strategic recommendations for strengthening public health preparedness in the future.

METHODS

This study used a quantitative approach with an analytical observational design and cross-sectional design to analyse the relationship between public health management readiness and infectious disease risk control in the post-disaster phase. The study was conducted in Padang Panjang City, West Sumatra Province, Indonesia, which is a region prone to hydrometeorological and geological disasters and has an active primary health care system in the post-disaster recovery phase. Data collection was carried out during the year of the study after the emergency response phase ended and entered the early to mid-recovery period.

The study population consisted of all health workers involved in post-disaster public health management in primary health facilities in Padang Panjang City, including heads of community health centres, persons in charge of epidemiological surveillance, health promotion officers, and environmental health officers. Based on data from the local Health Office, the accessible population numbered 60 people, all of whom were sampled using total sampling (n = 60) to increase analytical power and avoid selection bias.

The independent variable was the level of preparedness for post-disaster public health management, which included four main components: human resource preparedness, logistics and health facility preparedness, information systems and epidemiological surveillance, and standard operating procedures and cross-sector coordination. The dependent variable is the control of infectious disease risk after a disaster, measured through indicators of case detection speed, prevention activity coverage, case response, and trends in priority infectious diseases. Measurements used a five-point Likert scale, which was then categorised as low, medium, and high based on the score distribution.

The research instrument was a structured questionnaire developed based on the public health emergency preparedness and resilient health systems framework. Content validity was tested by three experts in public health and disaster management. Construct validity was tested using Pearson product-moment correlations between item scores and total scores, with a criterion of r calculated > r table (α = 0.05). All items were declared valid. The reliability test using Cronbach's Alpha coefficient showed a value >0.80 for all variables, indicating excellent internal consistency.

Data analysis was performed in stages using statistical software. Univariate analysis was used to describe the distribution of respondent characteristics and research variables in the form of means, standard deviations, frequencies, and percentages. Bivariate analysis used the Chi-square test to test categorical relationships and the Spearman correlation test to assess the relationship between ordinal scores. Furthermore, multivariate analysis was performed using multiple logistic regression to identify the most dominant readiness components affecting infectious disease risk control by controlling for confounding variables (length of service and disaster training). The significance level was set at $p < 0.05$ with a 95% confidence interval.

RESULTS

1. Univariate Analysis

Univariate analysis was conducted to describe the distribution of respondent characteristics, the level of preparedness of post-disaster public health management, and the state of infectious disease risk control. The results were presented using descriptive statistics in the form of means, standard deviations, and categorical distributions to provide an empirical picture of the state of health system preparedness in disaster-affected areas.

Table 1. Characteristics of Research Respondents

Characteristics	Category	n	%
Position	Head of the Community Health Center	12	20.0

	Person in charge of surveillance	15	25.0
	Health promotion officer	18	30.0
	Environmental health officer	15	25.0
Years of service	1–5 years	14	23.3
	6–10 years	21	35.0
	>10 years	25	41.7
Disaster training	Once	38	63.3
	Never	22	36.7

The distribution of respondents indicates a representativeness of relevant public health management functions in post-disaster response. Most respondents had more than 10 years of experience, and the majority had received disaster training, indicating sufficient experience in managing post-disaster health programs.

Table 2. Level of Post-Disaster Public Health Management Readiness (Scale 1–5)

Readiness Components	Category
Human resource readiness	Good
Readiness of logistics and health facilities	Enough
Epidemiological information & surveillance systems	Good
SOP and cross-sector coordination	Good
Average total readiness	**Good**

Overall, public health management preparedness is in the good category. The highest-scoring component is the epidemiological information and surveillance system, indicating relatively effective disease detection and reporting. Conversely, logistical preparedness remains in the fair category, indicating limitations in post-disaster health facilities and resource distribution.

Table 3. Post-Disaster Infectious Disease Risk Control Conditions

Control Indicators	Category
Case detection speed	Good
Coverage of prevention activities (immunization, hygiene promotion)	Good
Case handling response	Good
Trends in the incidence of priority infectious diseases	Enough

Post-disaster infectious disease risk control is generally considered good, particularly in terms of case detection and response. However, the incidence trend indicator remains in the fair category, indicating that despite the effective response system, post-disaster environmental pressures continue to contribute to the emergence of infectious disease cases.

Table 4. Distribution of Readiness Level Categories

Category	n	%
Tall	17	28.3

Currently	31	51.7
Low	12	20.0

Most health facilities are at a moderate level of preparedness, indicating that the system has a basic managerial structure in place but is not yet fully optimized. Low preparedness rates are still found in some areas, reflecting capacity disparities among post-disaster health facilities.

Descriptive results indicate that public health management preparedness is at a good level, with variations in logistics and resource distribution. Infectious disease risk control is also relatively good, particularly in surveillance and rapid response functions. However, there are still indications of an increase in cases of several priority diseases, suggesting that system preparedness is not yet fully capable of optimally suppressing environmental and social risk factors post-disaster. These findings highlight the importance of strengthening logistics, equalizing health facility capacity, and integrating cross-sectoral coordination to improve the effectiveness of infectious disease control.

2. Bivariate Analysis

A bivariate analysis was conducted to examine the relationship between the level of post-disaster public health management preparedness and the effectiveness of infectious disease risk control. Due to the cross-sectional design of the study, both variables were measured simultaneously to examine the association between the variables under real-world conditions.

Table 5. Relationship between Management Readiness Level and Infectious Disease Risk Control

Readiness Level	Good Control	Adequate Control	Lack of Control	Total	p-value
Tall	14 (82.4%)	3 (17.6%)	0 (0%)	17	0.003
Currently	18 (58.1%)	11 (35.5%)	2 (6.4%)	31	
Low	3 (25.0%)	6 (50.0%)	3 (25.0%)	12	
Total	**35**	**20**	**5**	**60**	

There was a significant relationship between the level of public health management preparedness and post-disaster infectious disease risk control ($p < 0.05$). The proportion of good control was more dominant in the high-preparedness group, while the low-preparedness group showed a greater proportion of inadequate control. This finding indicates that increasing the preparedness capacity of the health system is associated with the effectiveness of infectious disease control.

Table 6. Correlation of Readiness Scores with Infectious Disease Risk Control Scores

Variables	r (Spearman)	p-value	Direction of Relationship
Public health management readiness score	0.462	0.001	Moderate positive

There is a moderate positive correlation between the level of public health management preparedness and infectious disease risk control ($r = 0.462$; $p < 0.01$). This means that the higher the preparedness score, which encompasses human resources, logistics, surveillance, and

coordination, the better the achievement of post-disaster infectious disease control indicators. This aligns with the preparedness framework, which emphasizes the role of organizational capacity and epidemiological information systems in rapid response and prevention of extraordinary events.

Table 7. Analysis of the Relationship between Readiness Components and Risk Control

Readiness Components	r	p-value	Interpretation
HR Readiness	0.39	0.004	Significant relationship
Logistics readiness	0.41	0.002	Significant relationship
Surveillance system	0.52	0.000	The strongest relationship
SOP & coordination	0.36	0.006	Significant relationship

All components of preparedness are significantly related to infectious disease risk control. The epidemiological surveillance system demonstrated the strongest correlation, confirming that early detection and case reporting are key factors in preventing post-disaster disease outbreaks. Logistical and human resource readiness also contribute to the effectiveness of promotive and preventive interventions in the field.

Bivariate analysis showed a significant relationship between public health management preparedness and infectious disease risk control in the post-disaster phase. Higher preparedness was associated with increased case detection speed, coverage of prevention activities, and response. The epidemiological surveillance component emerged as the most dominant determinant at the bivariate level of association, underscoring the importance of a responsive health information system in reducing the risk of infectious disease occurrence in post-disaster situations.

3. Multivariate Analysis

Table 8. Multiple Logistic Regression Analysis of Factors Affecting Post-Disaster Infectious Disease Risk Control (n = 60)

Independent Variable	B	SE	p-value	Adjusted OR	95% CI
Human Resource Readiness	0.87	0.39	0.028	2.39	1.10 – 5.21
Logistical Readiness	1.02	0.41	0.014	2.77	1.23 – 6.24
Surveillance System	1.48	0.45	0.001	4.39	1.82 – 10.58
SOP & Coordination	0.79	0.36	0.031	2.20	1.07 – 4.53
Length of Service (>10 years)	0.42	0.33	0.204	1.52	0.79 – 2.95
Disaster Training	0.65	0.35	0.061	1.92	0.97 – 3.79

Model Fit:

- *Nagelkerke $R^2 = 0.46$*
- *Hosmer–Lemeshow Test $p = 0.71$*

Logistic regression analysis shows that epidemiological surveillance systems are the most dominant factor in improving the effectiveness of post-disaster infectious disease risk control

(Adjusted OR = 4.39; p = 0.001). Facilities with strong surveillance are more than four times more likely to achieve good disease control than facilities with poor surveillance.

Logistical preparedness (Adjusted OR = 2.77; p = 0.014), human resource preparedness (Adjusted OR = 2.39; p = 0.028), and SOPs and cross-sector coordination (Adjusted OR = 2.20; p = 0.031) also had a significant effect. This indicates that the structural and operational capacity of the health system plays a real role in strengthening post-disaster case detection, prevention, and response.

Conversely, length of service and disaster training did not show a significant effect after controlling for systemic variables, indicating that the strength of the organisational system is more decisive than the individual characteristics of health workers.

The Nagelkerke R^2 value of 0.46 indicates that the model explains 46% of the variation in disease control, with good goodness-of-fit (Hosmer–Lemeshow p = 0.71). Overall, strengthening surveillance and logistics is a strategic priority in improving the effectiveness of infectious disease control after a disaster.

DISCUSSION

1. Level of Post-Disaster Public Health Management Readiness

The research results indicate that the overall level of public health management preparedness is good, particularly in the information system and epidemiological surveillance components. However, logistical and health facility readiness remains moderate, indicating limitations in the availability and distribution of post-disaster health resources.

These findings align with the theory of public health emergency preparedness, which emphasizes that health system readiness is a multidimensional construct encompassing human resources, logistics, information systems, and institutional coordination (Khan et al., 2019). According to the modern preparedness framework, robust surveillance systems are often the fastest-growing component because they are integrated with routine reporting systems, while logistics require more complex structural investments and cross-sectoral support (Lee et al., 2023).

A scoping review by Lee et al. (2023) showed that many countries have relatively good post-disaster surveillance preparedness, but still face serious challenges in health logistics and the continuity of medical supplies. Furthermore, studies of post-earthquake and flood disasters in various countries also confirmed that logistical limitations are a major limiting factor in the effectiveness of public health responses (Mavrouli et al., 2023).

Researchers assume that a "good" rating for management readiness does not fully reflect the resilience of a sustainable health system. High surveillance readiness can potentially create the illusion of preparedness, while logistical weaknesses can actually create a vulnerability for intervention failure in the field. Therefore, managerial readiness that is not matched by logistical capacity risks compromising the effectiveness of post-disaster disease control.

2. Post-Disaster Infectious Disease Risk Control Conditions

The study results indicate that post-disaster infectious disease risk control is in the good category in terms of speed of case detection, coverage of prevention activities, and response. However, the trend of infectious disease incidence remains in the fair category, indicating that the reduction in disease incidence has not been optimal despite the control system being in place.

From a post-disaster infectious disease ecology perspective, successful detection and rapid response do not automatically reduce disease incidence due to the complex and multi-layered dynamics of the post-disaster environment (Quintanilla, 2022). Factors such as damaged sanitation, limited clean water, and overcrowding in temporary housing can maintain transmission risk despite technically sound health interventions (Charnley et al., 2021).

A systematic study by Charnley et al. (2021) showed that many post-disaster areas continued to experience cases of infectious diseases in the early to mid-recovery phase, despite active surveillance and response systems. Furthermore, a comprehensive review by Mavrouli et al. (2023) confirmed that post-disaster disease trends were more often influenced by environmental and social conditions than by technical weaknesses in health response systems (Mavrouli et al., 2023).

Researchers assume that a "good" control outcome reflects administrative and clinical response capacity rather than structural risk control success. In other words, the health system is capable of "managing cases" but has not yet fully broken the chain of risk determinants stemming from the environmental and social conditions following a disaster. This assumption indicates a potential optimism bias in assessing disease control performance when focusing solely on process indicators.

3. Distribution of Readiness Level Categories

The distribution of readiness levels shows that most health facilities are in the medium category, with a proportion of facilities in the low readiness category still being quite significant.

According to the theory of uneven preparedness in health systems, post-disaster health systems tend to develop unevenly due to differences in resources, managerial capacity, and local policy support (Awaliah et al., 2025). This inequality has the potential to reduce aggregate system resilience because the failure of one service unit can impact the performance of the entire system (Charnley et al., 2021).

Cross-regional research shows that health facilities with moderate to low preparedness are more vulnerable to service disruptions and increased risk of infectious diseases post-disaster compared to facilities with high preparedness (Mavrouli et al., 2023).

Researchers assume that the dominance of the moderate readiness category reflects normative preparedness, that is, readiness sufficient to carry out routine functions but insufficient to withstand prolonged epidemiological pressure. The presence of facilities with low readiness is assumed to be a point of systemic vulnerability, potentially becoming the initial location for an increase in infectious disease cases.

4. The Relationship Between Readiness Level and Infectious Disease Risk Control

The results of the analysis showed a significant relationship between the level of public health management readiness and the effectiveness of post-disaster infectious disease risk control ($p < 0.05$).

The organizational readiness–performance linkage theory explains that organizational readiness determines a health system's ability to effectively implement policies and procedures in a crisis. Higher readiness enables a more rapid, coordinated, and adaptive response to disease threats (Charnley et al., 2021).

Post-disaster studies show that areas with high levels of preparedness tend to have better disease control than areas with low preparedness, even though they face relatively the same level of environmental risk (Mavrouli et al., 2023).

Researchers assume that the relationships found are associative and contextual, not absolute causal. This means that high levels of preparedness do not necessarily guarantee successful disease control if they are not supported by improvements in non-health determinants. This assumption emphasizes that improving managerial preparedness without a cross-sectoral approach has the potential to have limited impact.

5. Correlation of Readiness Scores with Infectious Disease Risk Control Scores

A positive correlation with moderate strength ($r = 0.462$) indicates that an increase in the readiness score is followed by an increase in the infectious disease risk control score, but the relationship is not strong.

Within the framework of complex adaptive systems, public health outcomes are the result of the interaction of various dynamic system components.(Maillet et al., 2025). Therefore, management readiness only plays a role as one determinant among environmental, social, behavioral, and public policy factors (Charnley et al., 2021).

Recent research shows that the correlation between health system preparedness and post-disaster disease control is generally at a moderate level, indicating a significant contribution of external factors outside the health sector (Mavrouli et al., 2023).

Researchers assume that the moderate strength of the correlation reflects the limitations of the sectoral approach, where health systems operate within a framework that does not fully control risk determinants. Thus, this correlation may also be influenced by unmeasured latent variables, such as population mobility, community compliance, and post-disaster settlement stability.

6. The Relationship between Readiness Components and Infectious Disease Risk Control

All components of preparedness have a significant relationship with infectious disease risk control, with the epidemiological surveillance system showing the strongest relationship.

The early detection and response dominance theory places surveillance as a key component in infectious disease control, as it allows for early identification and rapid intervention before cases escalate (Irma et al., 2024).

Post-disaster research shows that robust surveillance systems are consistently associated with more effective outbreak control, even under conditions of logistical and resource constraints (Mavrouli et al., 2023).

Researchers believe that the dominant role of surveillance has the potential to create an over-reliance on reporting systems, while long-term structural interventions such as sanitation improvements and logistics enhancements have not received adequate attention. This situation risks making disease control reactive rather than preventative and transformative.

CONCLUSIONS

This study concludes that the readiness of public health management in Padang Panjang City after the disaster is generally in the good category, especially in terms of information systems and epidemiological surveillance, which have proven to be the most dominant components in improving the effectiveness of infectious disease risk control. However, logistical and health facility preparedness is still relatively weak, indicating that detection and response capacities are in place but are not yet fully supported by the availability and equitable distribution of physical resources. The control of infectious disease risk is classified as good in terms of case detection speed, prevention coverage, and response management, but the trend of disease incidence, which remains in the moderate category, indicates that post-disaster environmental and social determinants continue to contribute to the emergence of cases. There is a significant moderate correlation between the level of management preparedness and the effectiveness of disease control, confirming that managerial preparedness is an important determinant, although not the only factor influencing control outcomes.

Based on these findings, strengthening the health logistics system needs to be a priority through buffer stock planning, a risk-based emergency distribution system, and equitable support for facilities with moderate and low levels of preparedness. Optimisation of the epidemiological surveillance system must be carried out through the integration of real-time reporting and increased data analysis capacity at the primary care level. In addition, cross-sector collaboration, particularly with the sanitation, housing, and disaster management sectors, needs to be strengthened to comprehensively control environmental and social determinants post-disaster. The development of preparedness policies based on quantitative indicators of managerial readiness is also recommended so that regional health system evaluations are more measurable, adaptive, and sustainable.

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