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COMMUNITY-DRIVEN HEALTH STRATEGIES FOR PREVENTING DISEASE OUTBREAKS AFTER THE 2004 ACEH TSUNAMI

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Abstract

The 2004 Aceh tsunami was one of the deadliest natural disasters in modern history, creating extreme environmental conditions that were predicted to trigger major disease outbreaks. However, despite concerns from the World Health Organization (WHO) about waterborne and infectious diseases, no widespread epidemic occurred. This study explores the community-driven health strategies that contributed to disease prevention in the aftermath of the disaster. Using a qualitative exploratory approach, data were collected through in-depth interviews with community members and local leaders across three sub-districts in Banda Aceh, each representing different levels of tsunami impact. Findings reveal that traditional knowledge, religious practices, and collective community actions played a crucial role in maintaining health and sanitation under crisis conditions. Behavioral adaptations included prioritizing clean water sources, boiling drinking water, filtering water through cloth, maintaining food hygiene, ensuring adequate nutrition, and emphasizing personal hygiene and sanitation. The study also highlights barriers to healthcare access, including infrastructure damage, medical staff shortages, and psychological distress, which affected post-disaster health-seeking behaviors. Despite these challenges, community resilience and social cohesion were instrumental in mitigating public health risks. The findings suggest that integrating local knowledge, religious teachings, and structured public health interventions can enhance disaster preparedness and disease prevention strategies in future crises. These insights provide valuable lessons for policymakers, humanitarian agencies, and public health professionals in designing culturally adaptive and community-based health resilience programs for post-disaster environments.

Keywords: Community resilience, disease prevention, public health, disaster response, Aceh tsunami, healthcare access

INTRODUCTION

The prevention of waterborne infectious disease outbreaks following the 2004 Aceh earthquake and tsunami stands as a remarkable example of community resilience and adaptive behavior. Despite initial concerns and predictions from the World Health Organization (WHO) that post-disaster conditions would lead to widespread outbreaks, Aceh did not experience the anticipated epidemic-scale disease outbreaks (Chan et al., 2021; Istiarsyah et al., 2023). This phenomenon presents a critical opportunity to explore the behavioral, cultural, and structural factors that contributed to the successful mitigation of waterborne diseases in the aftermath of a catastrophic event. Waterborne diseases such as cholera, dysentery, leptospirosis, and hepatitis are known to proliferate in post-disaster settings due to the disruption of water supplies, sanitation, and hygiene infrastructure (Caruso et al., 2022). The combination of environmental contamination, overcrowding in shelters, limited access to clean water, and inadequate health facilities significantly elevates the risk of disease transmission (Krishnan, 2019). In other post-disaster contexts, such as Haiti in 2010 and Japan in 2011, outbreaks of cholera and

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diarrheal diseases were widely documented, emphasizing the severity of such health crises when preventive measures are lacking (Dube et al., 2018; Saatchi et al., 2024). In Aceh, the immediate post-tsunami environment was severely compromised corpses, animal carcasses, and stagnant water pools contributed to an extremely high-risk setting for disease outbreaks (Hall et al., 2022; Hirono, 2024). Infrastructure damage and the destruction of healthcare facilities posed additional challenges in delivering emergency medical assistance and ensuring public health safety (Madon et al., 2018; Tseole et al., 2022). The humanitarian response included significant international assistance, which provided medical aid, temporary shelters, and access to essential hygiene supplies (Dery et al., 2020; Rosenfeld et al., 2021). However, beyond external interventions, the behaviors and practices of the Acehnese people themselves played a crucial role in preventing disease outbreaks.

According to WHO, infectious disease outbreaks often become the second "killing wave" following major natural disasters due to compromised sanitation, unclean water, and decaying organic matter (Venkataramanan et al., 2018; Mavrouli et al., 2023). In Aceh, cases of acute respiratory infections (ARI), wound infections, hepatitis A and E, measles, and diarrhea were reported; however, they did not escalate into epidemic levels (Lal et al., 2019; Salubi et al., 2025). The Indonesian government's legal framework, particularly Law No. 4 of 1984, designates the Minister of Health as the sole authority to declare outbreaks, and no such declaration was issued in the aftermath of the disaster (Subarno et al., 2025). This suggests that despite the dire circumstances, certain behavioral and environmental factors mitigated widespread disease transmission. The cultural and religious practices of the Acehnese people likely played a pivotal role in preventing an outbreak. Islam, deeply embedded in Acehnese daily life, emphasizes cleanliness and personal hygiene (Patra & Mukherjee, 2019; Valcourt et al., 2020). Ritual washing (wudu) performed multiple times a day for prayer, regular bathing, and strict dietary guidelines contribute to improved hygiene standards (Azis et al., 2023; Rosenfeld et al., 2021). Additionally, the immediate burial of bodies following Islamic customs may have reduced the risks associated with decomposing organic matter, which can serve as a disease vector (Dube et al., 2018). These daily habits, along with community resilience and a strong sense of collective responsibility, likely prevented the conditions necessary for an epidemic to emerge.

Comparisons with other disaster-affected regions further underscore the importance of behavioral factors in public health outcomes. For example, Haiti's 2010 cholera outbreak resulted in over 800,000 cases due to poor sanitation infrastructure and delayed public health interventions (Jedwab et al., 2021). Similarly, in post-tsunami Japan, widespread cases of influenza and diarrhea were reported, exacerbated by shelter conditions and population displacement (Daly et al., 2023; Wang et al., 2022). The absence of similar large-scale outbreaks in Aceh highlights the potential effectiveness of intrinsic community behaviors in disease prevention. This study aims to examine the community-driven health strategies employed by the Acehnese community to prevent disease outbreaks post-disaster. With understanding how cultural practices, hygiene behaviors, and local knowledge contributed to disease prevention, valuable lessons can be extracted for future disaster response efforts worldwide. The findings will provide insights into how community-based health behaviors can be leveraged in disaster-prone regions to strengthen public health resilience and disease prevention. Despite the devastating conditions in Aceh, the absence of a widespread disease outbreak presents a unique case study in disaster health resilience. By investigating the community behaviors and strategies that contributed to this outcome, this research seeks to inform global disaster preparedness strategies, ensuring that communities worldwide can develop effective, culturally appropriate, and behaviorally driven approaches to disease prevention following natural disasters.

RESEARCH METHODS

Research Design

This study employs a qualitative exploratory research design to analyze the behavioral strategies of the Acehnese community in preventing waterborne disease outbreaks post-tsunami (Makri & Neely, 2021). A descriptive qualitative approach was used to extract meaning and explanations from community

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behaviors and their effectiveness in preventing extraordinary health events (KLB) after the disaster. The study findings were compared with relevant theoretical frameworks before drawing final conclusions (Casula et al., 2021; Jain, 2021).

Study Area and Population

The research was conducted in Banda Aceh, specifically in three sub-districts selected based on the severity of tsunami impact. The target population consists of community members who lived in Banda Aceh during the 2004 earthquake and tsunami and remained in the area during the aftermath. The sub-districts were categorized as follows:

Tabel 1. Study Area

Tsunami Impact	Sub-District	Justification
Severe Impact	Meuraxa	Coastal, high population density, heavily affected by the tsunami
Moderate Impact	Syiah Kuala	Coastal, less damage but still affected
No Impact	Ulee Kareng	Inland, no direct tsunami effects, serves as a control area

Sampling Technique and Data Collection

A purposive sampling method was used to select 10 participants who provided valuable insights into community behaviors. Tabel 2 explain the breakdown of participants.

Tabel 2. Participants

Category	Number of Participants	Selection Criteria
General Public	9 (3 per sub-district)	Residents who experienced the disaster firsthand
Community Leaders	1	Village leaders (Keuchik, Imum, Tuhapeut) with extensive knowledge of post-disaster behaviors

Data were collected through participant observation and in-depth interviews using semi-structured probing questions (Adeoye-Olatunde & Olenik, 2021; Striepe, 2021).

Data Collection Techniques

The research utilized multiple qualitative data collection methods, ensuring triangulation for reliability and validity (Bellindo-Garcia et al., 2022). The data collection framework is illustrated in the Flow Chart (see Figure 1).

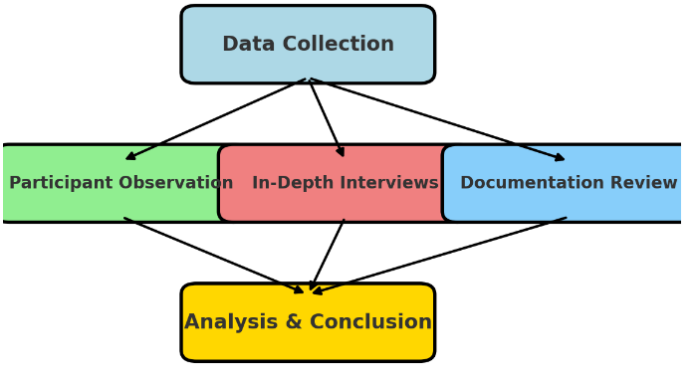

Figure 1: Data Collection Process

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The Figure 1 explain the systematic approach used in this study to gather, process, and analyze qualitative data on community behaviors in preventing waterborne disease outbreaks post-tsunami. The process begins with data collection, which incorporates three primary methods: participant observation, in-depth interviews, and documentation review. Participant observation allows researchers to directly examine hygiene practices, sanitation behaviors, and water treatment methods within the community, providing real-time insights into their daily routines. In-depth interviews are conducted with key informants, including community members, religious leaders, and village officials, to gain deeper perspectives on health practices, cultural influences, and adaptive strategies related to clean water consumption and sanitation. The documentation review complements these methods by analyzing official records, government policies, and disaster response reports, helping to cross-verify findings and understand broader systemic responses. Once data is collected, it undergoes integration and thematic analysis, ensuring that different sources of information are triangulated for accuracy and reliability. Findings from observations, interviews, and documentation are systematically categorized into themes such as hygiene practices, water safety, religious influences, and social adaptations. This process helps construct a holistic understanding of how the community effectively prevented a disease outbreak despite post-disaster challenges.

Data Analysis

The data analysis in this study followed a structured five-step qualitative approach to ensure accuracy, reliability, and theoretical alignment (see Tabel 3). The process began with transcription, where recorded interviews and observations were converted into written text to preserve the integrity of the data. Next, coding and categorization were performed to identify recurring themes related to hygiene, sanitation, water treatment, and cultural practices, allowing for systematic data organization. To enhance validity and reliability, a triangulation method was applied by cross-checking findings from three data sources participant observations, in-depth interviews, and documentation reviews ensuring consistency and eliminating biases.

Table 3: Summary of Data Analysis Process

No.	Step	Description	Purpose
1.	Transcription	Converting recorded interviews and observations into written form.	Ensures accuracy and completeness of collected data.
2.	Coding and Categorization	Identifying recurring themes related to hygiene, sanitation, water treatment, and cultural practices.	Organizes data into structured themes for analysis.
3.	Triangulation and Data Validation	Cross-checking data from three sources (observations, interviews, and documentation).	Enhances reliability and eliminates bias in findings.
4.	Interpretation Using HL Blum Public Health Model	Analyzing behaviors based on environment, health services, and behavior-related factors.	Provides a theoretical framework to contextualize findings.
5.	Drawing Conclusions and Reporting Findings	Synthesizing key insights and comparing with global disaster response literature.	Generates evidence-based conclusions applicable to future disaster health strategies.

The findings were then analyzed using the HL Blum Public Health Model, which assesses the influence of environment, health services, and behavioral factors on public health outcomes (Wartiningsih et al., 2022). Finally, the study proceeded to drawing conclusions, where key insights were synthesized and compared with existing disaster response literature, highlighting the unique success of Aceh in

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preventing a major waterborne disease outbreak. This methodological rigor ensures that the study provides evidence-based, globally relevant insights into the role of community behavior in post-disaster health resilience.

RESULTS AND DISCUSSION

This section presents the findings on the Banda Aceh community's behavioral strategies for preventing waterborne disease outbreaks after the 2004 tsunami. The discussion is structured according to key themes identified from qualitative data analysis: community knowledge, attitudes, and behaviors, environmental and sanitation practices, health-seeking behaviors, socio-cultural and religious influences, and barriers to healthcare access. The findings are further analyzed using the HL Blum Public Health Model, which emphasizes the interplay between environmental, behavioral, and healthcare factors in shaping public health outcomes.

1. Community Knowledge, Attitudes, and Health-Related Behaviors Post-Tsunami

Knowledge and Perception of Disease Risk

The Banda Aceh community exhibited varying levels of knowledge and perceptions regarding the potential risk of disease outbreaks post-tsunami. These perceptions were shaped by traditional beliefs, past experiences, religious values, and external health advisories. The majority of residents recognized that contaminated water sources, exposure to decaying bodies, and inadequate sanitation posed significant risks for waterborne and vector-borne diseases, including cholera, dysentery, leptospirosis, and malaria. This heightened awareness was likely reinforced by public health campaigns conducted by NGOs and government agencies in the aftermath of the disaster (Nelson et al., 2021; Saatchi et al., 2024). Despite this general awareness, differences in disease risk perception existed among sub-districts. Some residents in Syiah Kuala Sub-District believed that the high salinity of seawater naturally disinfected the environment, thereby reducing bacterial contamination. While high salinity can inhibit bacterial growth, this belief neglected the persistence of other pathogenic microorganisms that thrive in post-disaster water conditions (Salubi et al., 2025). Others expressed uncertainty about disease risks, citing the absence of any major outbreaks in the immediate weeks following the disaster. These variations highlight the need for targeted health education programs in post-disaster settings to correct misconceptions and reinforce evidence-based health knowledge (Kakalou & Tsiamis, 2021).

Table 4: Community Perception of Disease Risk Post-Tsunami

Perception	Community Response	Scientific Consensus
High Risk of Outbreak	Majority feared disease spread due to poor sanitation, contaminated water, and decaying bodies.	Confirmed as a major post-disaster risk (Nelson et al., 2021).
Seawater Disinfectant Theory	Some believed that saltwater reduced bacterial threats.	Limited validity; waterborne pathogens remain a concern (Salubi et al., 2025).
Vector and Airborne Transmission	Some feared diseases spreading via flies, mosquitoes, and decaying matter.	Confirmed as contributing factors to outbreaks post-disaster (Kakalou & Tsiamis, 2021).

Community Attitudes Toward Disease Prevention

Community attitudes toward disease prevention were shaped by cultural resilience, religious teachings, and prior knowledge of disaster risks. The Islamic faith, deeply embedded in the Acehnese community, played a central role in reinforcing hygiene practices and fostering psychological resilience. Many individuals expressed that maintaining personal cleanliness (taharah) was not only essential for health but also a fundamental aspect of religious observance. This belief encouraged frequent washing of

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hands, face, and body, which inadvertently helped prevent disease transmission. The collective responsibility of the community was another crucial factor in preventing disease. Many residents engaged in cleaning debris, improving sanitation, and ensuring access to clean water as part of a communal effort to restore normalcy. Local imams and community leaders also played a pivotal role in reinforcing the importance of hygiene and sanitation through Friday sermons and public discussions. While some residents initially relied on traditional beliefs, many eventually placed greater trust in the scientific recommendations provided by health authorities and NGOs. These attitudes significantly strengthened public health interventions and ensured greater compliance with hygiene recommendations, reducing the likelihood of an epidemic (Pascapurnama et al., 2018; Dwipayanti et al., 2021).

Behavioral Adaptations in Response to the Tsunami

The actions taken by the community to mitigate disease risks evolved over time, demonstrating an impressive capacity for adaptation and resilience in the face of adversity. The behavioral adaptations observed in the community can be categorized into immediate responses, mid-term adjustments, and long-term shifts, each representing a different phase of post-disaster recovery. Figure 2 visualized as a network diagram showing how the community adapted their behaviors in different phases. The immediate response involved evacuation and seeking medical aid, the mid-term adjustments included water purification and food hygiene practices, while the long-term shifts focused on strengthening sanitation, disaster preparedness, and trust in public health information. These adaptations played a crucial role in preventing disease outbreaks and improving resilience.

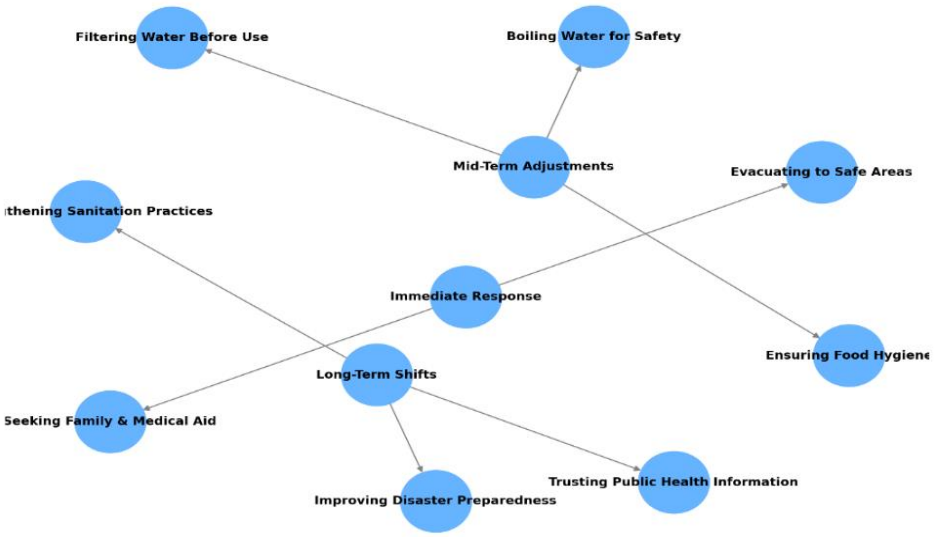

Figure 2: Community Behavioral Adaptations Post-Tsunami

In the immediate response phase, people prioritized evacuation to safe areas and seeking medical aid, ensuring survival in the chaotic aftermath (Saatchi et al., 2024). As they adjusted in the mid-term phase, they adopted boiling water, filtering drinking water, and ensuring food hygiene to prevent disease outbreaks, a common practice in post-disaster settings to minimize waterborne infections (Nelson et al., 2021). Over time, long-term shifts emerged, including improving sanitation, strengthening disaster preparedness, and increasing trust in public health guidelines, reinforcing the role of community-driven health resilience in reducing morbidity after disasters (Salubi et al., 2025). These behavioral adaptations highlight how local knowledge, religious practices, and external interventions shaped an effective community response to prevent major health crises.

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Summary of Findings on Community Knowledge, Attitudes, and Actions

The Banda Aceh community's knowledge, attitudes, and actions post-tsunami played a pivotal role in preventing widespread disease outbreaks. The majority of residents recognized the risks associated with contaminated water and poor sanitation, though some misconceptions about seawater's ability to disinfect remained. Islamic teachings reinforced hygiene practices, providing a strong foundation for public health measures. Additionally, the collective action undertaken by the community, supported by government and NGO interventions, ensured that critical disease prevention measures were followed. Rapid adoption of water and food safety measures further contributed to maintaining public health. These findings emphasize the importance of integrating public health education with cultural and religious frameworks in post-disaster settings. By aligning health interventions with community values and existing social structures, disaster response efforts can be more effective and widely accepted, leading to better health outcomes in affected populations (Daly et al., 2023; Subarno et al., 2025).

2. Behavioral Strategies for Disease Prevention

The Banda Aceh community employed a combination of hygiene maintenance, environmental sanitation, safe water practices, and community-driven initiatives to prevent disease outbreaks after the tsunami. These strategies evolved over time and were influenced by cultural traditions, religious values, and external health interventions.

Personal Hygiene Practices

Maintaining personal cleanliness was an essential behavioral strategy to prevent disease. Frequent handwashing was observed among survivors, often linked to religious practices such as wudu (ablution) before prayer. Additionally, survivors made concerted efforts to bathe regularly, particularly before meals and after engaging in debris-cleaning activities. Studies indicate that consistent hand hygiene is one of the most effective ways to prevent disease transmission in post-disaster settings (Valcourt et al., 2020; Saatchi et al., 2024).

Water Treatment and Safe Consumption Practices

The community took active measures to ensure safe drinking water, implementing strategies such as boiling water, filtering water with cloth, and utilizing bottled water from aid agencies. Table 5 outlines the different approaches used to secure clean water.

Table 5: Water Safety Measures Post-Tsunami

Method	Purpose	Effectiveness
Boiling water	Kills bacteria and pathogens	High
Filtering with cloth	Removes debris and large particles	Moderate
Using bottled water	Provides immediate safe drinking water	High
Accessing community wells	Alternative clean water source	Variable

These proactive water safety measures align with best practices in disaster-related public health interventions (Dery et al., 2020; Nelson et al., 2021). The section continues with community sanitation and environmental hygiene strategies, along with supporting evidence from recent studies.

3. Health-Seeking Behavior and Medical Care Access

The availability and accessibility of healthcare services in the aftermath of the tsunami played a critical role in disease prevention and overall community recovery. The Banda Aceh community demonstrated a mix of traditional and modern health-seeking behaviors, influenced by availability of healthcare

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facilities, religious beliefs, and past experiences with medical services. The response to health issues varied based on the proximity to healthcare centers, severity of illness, and access to medical assistance.

Utilization of Health Services

Following the tsunami, many residents sought medical assistance at hospitals, temporary health posts, and mobile clinics established by NGOs and the government. Those with severe conditions, including injuries and infections, were prioritized for treatment in these facilities. However, due to overcrowding and limited medical personnel, many individuals had to rely on self-care practices and traditional medicine while waiting for formal treatment (Dwipayanti et al., 2021; Subarno et al., 2025).

Table 6: Health-Seeking Behavior Post-Tsunami

Health-Seeking Behavior	Description	Effectiveness
Visiting hospitals and health posts	Seeking medical care for injuries and infections	High, but limited by accessibility and overcrowding
Using traditional medicine	Herbal remedies and home treatments for minor ailments	Moderate, based on cultural acceptance and experience
Relying on NGO-provided medical aid	Free medical services from foreign and domestic aid organizations	High, though temporary
Self-medication	Use of leftover medications and community knowledge	Low to moderate, depending on accuracy

Barriers to Healthcare Access

Despite the presence of medical assistance programs, several barriers impacted healthcare accessibility, including damage to health infrastructure, limited personnel, financial constraints, and psychological reluctance to seek care. Many survivors faced difficulties in reaching healthcare facilities due to damaged roads and transportation issues, which further delayed medical treatment. Psychological trauma also played a role, as many residents prioritized immediate survival needs over seeking healthcare.

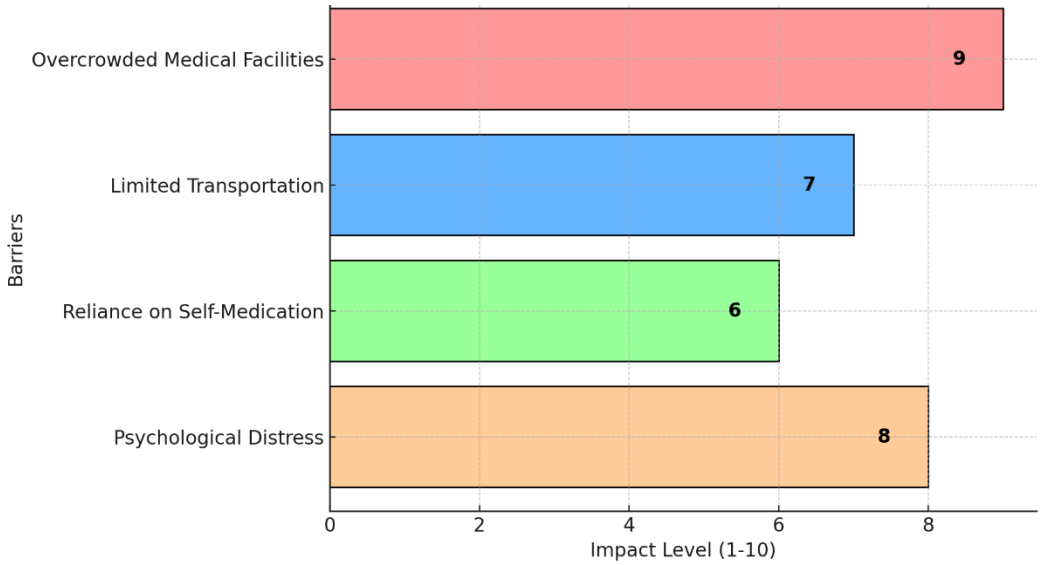

Figure 3: Barriers to Healthcare Access Post-Tsunami

Figure 3 illustrates the primary barriers faced by the Banda Aceh community in accessing healthcare services following the tsunami. The most significant obstacle was overcrowding in medical facilities, as

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the sudden influx of patients overwhelmed available health centers, leading to long wait times and constrained resources. Limited transportation further compounded the problem, as damaged roads and disrupted infrastructure hindered the mobility of survivors, preventing many from reaching medical aid in a timely manner. Additionally, reliance on self-medication emerged as a key issue, with many individuals resorting to traditional remedies and leftover medications due to difficulties in obtaining formal healthcare. Lastly, psychological distress played a crucial role in delaying medical attention, as trauma and fear led some individuals to prioritize survival needs over seeking professional treatment. These barriers underscore the urgent need for decentralized emergency healthcare services, improved logistical planning, and integrated mental health support in post-disaster response efforts. The findings align with global disaster health research, highlighting the importance of resilient healthcare systems that can rapidly adapt to crisis situations (Krishnan, 2019; Rosenfeld et al., 2021).

Long-Term Impact on Health Systems

The 2004 tsunami significantly transformed Banda Aceh's healthcare system, leading to major improvements in medical infrastructure, emergency response, and public health policies. In the aftermath, hospitals, clinics, and community health centers (Puskesmas) were rebuilt through collaborations between international aid organizations and the Indonesian government. Mobile health services were also introduced to ensure remote and vulnerable populations could access care (Pascapurnama et al., 2018; Mavrouli et al., 2023). A key change was the integration of disaster preparedness into public health policies. The government established emergency medical training, disease surveillance, and rapid response teams to improve future crisis management. These efforts were complemented by community-based health initiatives, which promoted disease prevention, mental health support, and sanitation education (Rosenfeld et al., 2021). Mental health services also became a priority. The psychological impact of the disaster led to the creation of mental health support networks and counseling programs, particularly for children and families who lost loved ones. Psycho-social rehabilitation programs provided long-term support to help survivors cope (Asher et al., 2017; Onishchenko et al., 2024). Public health education also improved, with greater emphasis on hygiene, clean water access, and vector control. Schools and community centers expanded health literacy programs, while public health campaigns reinforced sanitation, food safety, and immunization to prepare future generations for disaster resilience. Overall, the tsunami reshaped Banda Aceh's healthcare landscape, strengthening emergency preparedness, community engagement, and mental health care. These advancements continue to influence global post-disaster health policies, emphasizing the need for robust healthcare infrastructure, trained medical personnel, and long-term investment in community health programs to improve disaster resilience.

4. Socio-Cultural and Religious Influences on Health Behavior

Role of Religion in Hygiene and Health Practices

The Islamic faith is deeply embedded in the daily lives of the Banda Aceh community, influencing various aspects of hygiene and health-related behavior. The practice of wudu (ablution), which requires Muslims to wash their hands, face, and feet multiple times a day before prayer, served as an inherent disease prevention mechanism in the post-tsunami period. This religious obligation, combined with the heightened awareness of hygiene, contributed to reducing the risk of infections and disease transmission in disaster-affected areas (Kabir et al., 2024; Saatchi et al., 2024). Additionally, religious teachings emphasized cleanliness and the sanctity of water, encouraging the community to maintain proper sanitation despite limited resources. The ritualistic washing of hands before and after meals, as well as the prohibition of consuming impure or contaminated food, reinforced food safety measures and played a role in minimizing waterborne and foodborne illnesses (Pascapurnama et al., 2018).

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Collective Action and Community Support

Religious and socio-cultural values encouraged mutual aid, cooperation, and collective responsibility in the wake of the disaster. Mosques and religious leaders served as centers for disaster relief and coordination, providing guidance on health practices and mobilizing support for the affected population. Many survivors sought shelter in places of worship, where community-led initiatives facilitated the distribution of clean water, food, and medical aid (Nelson et al., 2021; Caruso et al., 2022). The concept of gotong royong (mutual cooperation) was highly evident in post-disaster recovery efforts. Community members worked together to clean up debris, repair damaged homes, and restore basic sanitation services. This collective action was instrumental in preventing disease outbreaks and improving living conditions in makeshift shelters and temporary housing units (Daly et al., 2023; Istiarsyah et al., 2023). The spirit of solidarity and communal care strengthened resilience and helped rebuild the community's physical and psychological well-being. The Figure 4 ilustrates the different ways in which religion and socio-cultural influences contributed to public health improvements after the disaster.

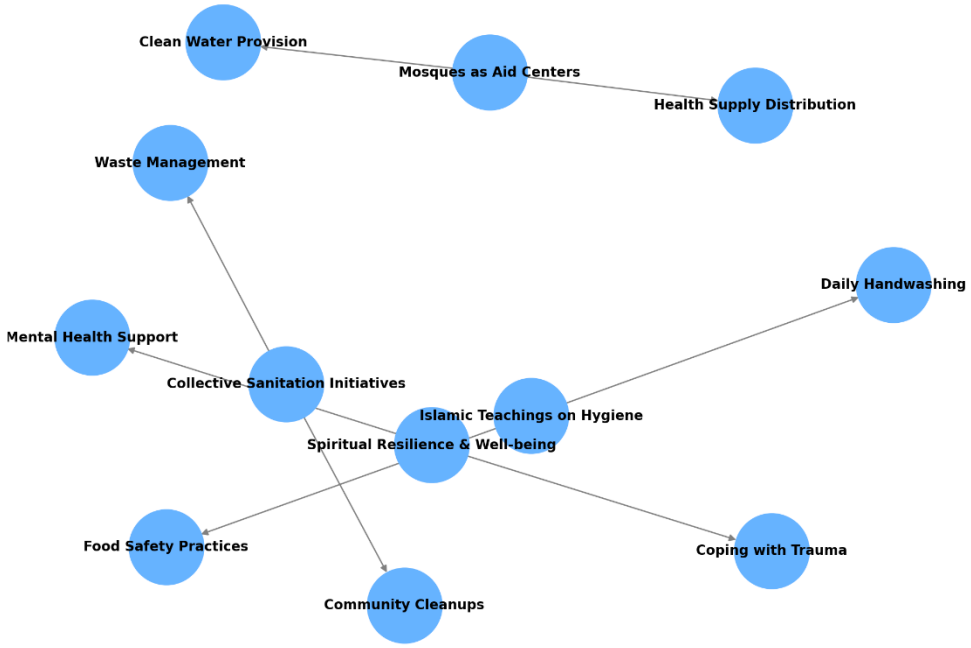

Figure 3: Community-Driven Health and Hygiene Efforts Post-Tsunami

Figure 4 explain the interconnected contributions of religious and socio-cultural influences in promoting health and hygiene in the aftermath of the tsunami. Islamic teachings on hygiene played a central role, reinforcing daily handwashing and food safety practices, which significantly reduced the risk of disease transmission. Mosques served as critical centers for aid distribution, facilitating access to clean water and essential health supplies for displaced communities. The importance of collective sanitation initiatives was also evident, as the community engaged in waste management and large-scale cleanup efforts to prevent the spread of infection. Additionally, spiritual resilience and well-being emerged as crucial factors in mental health recovery, helping survivors cope with trauma through faith-based psychological support and communal solidarity. This holistic approach, which integrated religious principles, communal cooperation, and structured health interventions, proved vital in strengthening public health resilience and preventing widespread disease outbreaks post-tsunami. These findings align with research emphasizing the importance of culturally embedded health behaviors in disaster recovery efforts (Topcu Akduman & Figen Türkçapar, 2024) and also the findings align with studies emphasizing the role of socio-cultural factors in post-disaster public health resilience (Veenema et al., 2017; Kakalou & Tsiamis, 2021).

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Spiritual Resilience and Mental Health

Religious beliefs played a pivotal role in psychological healing and resilience among tsunami survivors. The concept of sabar (patience) and tawakkul (trust in God) helped individuals cope with the immense loss of life and property, mitigating the risk of post-traumatic stress disorders (PTSD) and depression. The act of prayer, communal gatherings, and religious discourses provided emotional and social support, fostering a sense of hope and solidarity (Mavrouli et al., 2023). Moreover, traditional Islamic funeral rites, which emphasize the immediate burial of the deceased, were strictly followed despite the challenging conditions. This practice not only provided psychological closure for families but also helped in reducing the health risks associated with decaying bodies (Chan et al., 2021). Faith-based counseling initiatives were also introduced, integrating spiritual healing with modern psychological support programs to address mental health challenges post-disaster (Krishnan, 2019; Nelson et al., 2021).

Cultural Practices and Dietary Habits in Disease Prevention

Cultural food preparation habits also played a significant role in disease prevention after the tsunami. The community adhered to the practice of thoroughly cooking food, avoiding spoiled or contaminated items, and consuming meals in a hygienic manner. Many households ensured that their food was properly heated before consumption, reducing the risk of bacterial infections and foodborne illnesses (Suk et al., 2020). Additionally, the use of right hand for eating and left hand for hygiene purposes was another cultural norm that inadvertently reduced the spread of disease in communal living spaces. Public health officials and NGOs capitalized on these cultural strengths by incorporating them into post-disaster health campaigns. Educational programs were designed to reinforce hygiene-related religious teachings and traditional health practices, ensuring that existing community habits were leveraged to promote long-term public health sustainability (Wartiningsih et al., 2022).

Summary of Socio-Cultural and Religious Influences on Health

The interplay between religious faith, cultural values, and health behavior in the Banda Aceh community had a profound impact on post-tsunami disease prevention and recovery. The adherence to Islamic hygiene practices, communal cooperation, and faith-based psychological resilience contributed to lower infection rates, improved sanitation, and enhanced mental well-being in disaster-affected areas. The integration of socio-cultural frameworks into disaster response strategies is crucial for public health resilience and effective recovery planning. Future post-disaster interventions should recognize the role of religion and community networks in reinforcing health behaviors, ensuring that culturally appropriate health policies are developed to maximize long-term benefits for affected populations (Saatchi et al., 2024; Salubi et al., 2025). These insights reinforce the importance of cultural competence in disaster health management, demonstrating that faith-based and traditional health strategies can complement scientific interventions to enhance community well-being in crisis settings.

5. Challenges in Health Service Access

The aftermath of the 2004 tsunami severely disrupted health service access in Banda Aceh, leading to significant challenges in medical care delivery, infrastructure, and patient outreach. Health facilities were destroyed, transportation networks were cut off, and medical personnel were overwhelmed by the scale of injuries and disease risks. Addressing these challenges required coordinated efforts from the government, international aid organizations, and local communities (Tseole et al., 2022; Wang et al., 2022).

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Damage to Healthcare Infrastructure

One of the most immediate barriers was the destruction of hospitals, clinics, and pharmacies, leaving thousands without access to urgent medical care. The loss of critical medical equipment and supplies further complicated the response. In the weeks following the disaster, temporary medical tents and field hospitals were set up by NGOs and international relief teams to compensate for the damage (Nelson et al., 2021; Hirono, 2024).

Table 7: Impact of Infrastructure Damage on Health Services

No.	Challenge	Impact on Health Service Access
1.	Hospital Destruction	Reduced inpatient and emergency care availability
2.	Loss of Medical Supplies	Shortage of essential medications and equipment
3.	Damaged Transportation Networks	Delayed emergency response and medical evacuations
4.	Communication Disruptions	Limited coordination between aid agencies and local health workers

Rebuilding efforts took years, with health facilities redesigned to withstand future disasters. The integration of disaster resilience into healthcare planning ensured that new hospitals and clinics were better prepared for emergencies (Subarno et al., 2025).

Shortage of Medical Personnel and Overcrowding

The tsunami also caused a severe shortage of trained medical personnel, as many health workers were injured, displaced, or killed. The remaining staff faced extreme workloads, leading to burnout and inefficiencies in service delivery. The sudden influx of injured and sick patients overwhelmed emergency rooms and temporary clinics, leading to delays in treatment (Kakalou & Tsiamis, 2021). To address these issues, international volunteer doctors, nurses, and medical teams were deployed to support local efforts. Training programs were introduced to upskill local health workers in emergency response and trauma care, ensuring better preparedness for future disasters (Istiarsyah et al., 2023; Saatchi et al., 2024).

Barriers to Healthcare Access in Remote and Affected Areas

Remote communities faced even greater obstacles in reaching health services. Damaged roads, collapsed bridges, and limited communication left many survivors stranded without medical assistance. Humanitarian airlifts and boat deliveries became critical in reaching isolated populations. Figure 4 illustrates the major obstacles that hindered healthcare access in Banda Aceh after the tsunami. Infrastructure damage, including destroyed hospitals and impassable roads, severely limited medical services. Medical staff shortages overwhelmed healthcare personnel, while transportation limitations prevented emergency evacuations. A lack of medical supplies, such as essential medications and equipment, further strained healthcare delivery. Additionally, psychological barriers, including trauma and fear, caused delays in seeking medical care. These challenges highlight the urgent need for resilient healthcare infrastructure, emergency preparedness, and mental health support in disaster-affected areas. Long-term strategies included mobile health clinics, telemedicine solutions, and rebuilding essential road networks, allowing more efficient medical outreach to remote and underserved areas (Dube et al., 2018; Nelson et al., 2021).

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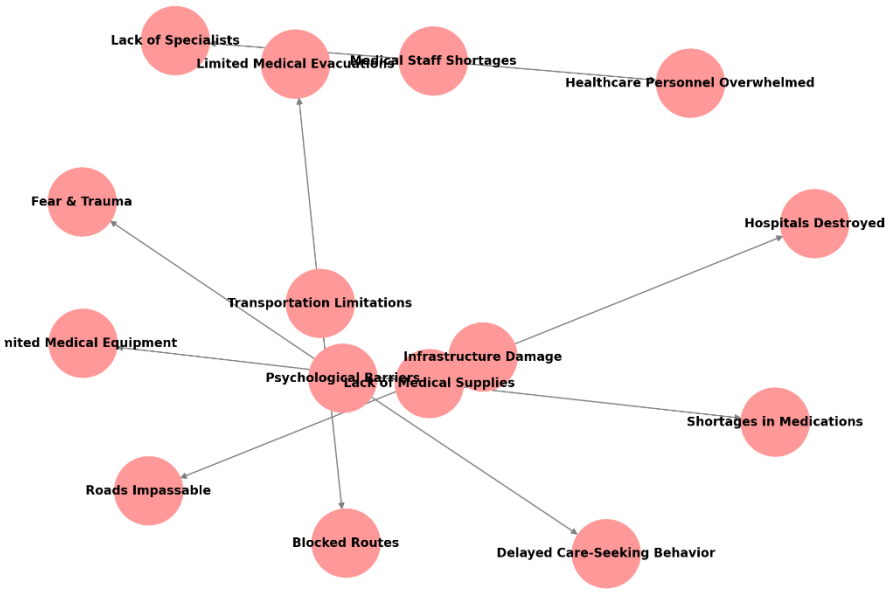

Figure 5: Barriers to Healthcare Access Post-Tsunami

Financial Constraints and Economic Burden on Patients

The economic impact of the tsunami also limited access to healthcare. Many families lost their livelihoods, homes, and financial stability, making it difficult to afford medical treatments. Although international aid and government subsidies covered many costs in the short term, long-term healthcare access required affordable healthcare solutions. To address these economic challenges, free healthcare programs and community-based health insurance models were introduced, reducing the financial burden on vulnerable populations. These initiatives improved health equity and ensured broader access to medical services (Madon et al., 2018; Azis et al., 2023).

Psychological Barriers and Hesitancy in Seeking Care

Trauma and fear also played a significant role in delaying healthcare access. Many survivors, especially those who lost family members, experienced psychological distress, PTSD, and anxiety, making them hesitant to seek medical attention. The stigma surrounding mental health issues further prevented individuals from accessing counseling or psychiatric care (Chan et al., 2021). Public health campaigns emphasized the importance of mental well-being, integrating psychosocial support programs into post-disaster health interventions. The introduction of community mental health centers and culturally sensitive counseling services encouraged more individuals to seek help, reducing the long-term psychological impact of the disaster (Caruso et al., 2022).

Summary of Challenges and Future Recommendations

The Banda Aceh tsunami exposed severe weaknesses in healthcare infrastructure, medical personnel availability, access to remote areas, financial barriers, and mental health support. While recovery efforts led to significant improvements, ongoing investment in disaster-resistant healthcare systems, training programs, and equitable health policies remains essential. Future disaster preparedness should prioritize integrated healthcare solutions, including mobile clinics, telemedicine, community-based mental health support, and resilient hospital infrastructure. Strengthening coordination between government agencies, NGOs, and local communities is key to ensuring that future health crises are managed effectively and equitably (Nelson et al., 2021; Daly et al., 2023; Saatchi et al., 2024).

CONCLUSION AND SUGGESTIONS

The study highlights how the Banda Aceh community successfully adapted behavioral strategies to prevent disease outbreaks following the 2004 tsunami. The results demonstrate that community-driven health initiatives, religious practices, and sanitation measures were instrumental in mitigating public health risks. The ability to rapidly implement clean water management, food safety practices, and proper waste disposal significantly contributed to reducing waterborne and foodborne diseases. However, challenges such as damaged healthcare infrastructure, medical staff shortages, limited access to remote areas, financial burdens, and psychological trauma were evident. While external aid and government support played a crucial role in health service recovery, long-term resilience requires continued investment in disaster-prepared healthcare infrastructure, mental health support systems, and community-based health education. To strengthen future disaster responses, efforts should focus on improving healthcare infrastructure, expanding emergency medical training, and integrating disaster preparedness into public health policies. Increasing access to mental health services and ensuring financial sustainability for vulnerable populations will further enhance disaster resilience. Strengthening community engagement, religious-based health education, and modern medical interventions will create a more effective and culturally relevant public health strategy. Collaborative partnerships between government agencies, international organizations, and local communities remain essential in building a robust, inclusive, and prepared healthcare system capable of withstanding future crises.

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