

Evaluation of the Impact of Community Service Programs on Community Health Preparedness and Resilience

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ABSTRACT

Increasing disaster risks associated with climate change and environmental degradation require stronger community health preparedness and resilience, particularly in disaster-prone areas of Indonesia. Although university-led community service programs are widely implemented, evidence regarding their effects on both preparedness and resilience remains limited. Objective: This study evaluated the impact of an integrated university-led community service program on community health preparedness and resilience in a disaster-prone community in Indonesia. Methods: A quasi-experimental one-group pretest-posttest study was conducted among 120 adults recruited through purposive sampling. The intervention combined health education, disaster preparedness training, emergency response simulations, and community empowerment activities. Outcomes were assessed using a structured questionnaire and analyzed using paired-sample t-tests, Cohen's d, and 95% confidence intervals (95% CI). Results: Community preparedness increased from 3.12 ± 0.47 to 4.14 ± 0.42 (mean difference = 1.02; 95% CI: 0.89–1.15), while community health resilience increased from 3.13 ± 0.46 to 4.20 ± 0.39 (mean difference = 1.07; 95% CI: 0.94–1.20) (all $p < 0.001$). Large intervention effects were observed for preparedness ($d = 1.45$) and resilience ($d = 1.51$). Conclusions: The integrated community service program was associated with meaningful improvements in community health preparedness and resilience. These findings support the potential contribution of university-based community engagement to disaster risk reduction, although further controlled longitudinal studies are needed to confirm long-term effectiveness.

Keywords: Community Engagement, Community Health Preparedness, Community Resilience, Disaster Risk Reduction, Health Promotion, University Community Service



INTRODUCTION

The increasing frequency and complexity of disasters have become one of the most pressing challenges to global public health. Climate change, rapid urbanization, environmental degradation, population growth, and ecosystem disruption have intensified the occurrence of both natural and human-induced disasters, resulting in substantial health, social, and economic consequences worldwide (Agnesia & Ade Fitri, 2025; Amalia et al., 2024). Beyond immediate mortality and physical injuries, disasters frequently disrupt health systems, limit access to essential healthcare services, increase the transmission of communicable diseases, aggravate chronic illnesses, and contribute to long-term psychological distress. Consequently, disaster risk reduction has evolved from an emergency response strategy into a comprehensive public health priority that emphasizes preparedness, adaptation, and resilience at the community level.

Recent public health frameworks increasingly recognize that resilient communities constitute the cornerstone of effective disaster risk management. Rather than relying solely on institutional emergency response systems, contemporary approaches emphasize strengthening local capacity to anticipate hazards, respond effectively during emergencies, and recover efficiently following crises. Community-based strategies have therefore become central to sustainable disaster risk reduction because they integrate local knowledge, social participation, and adaptive capacity into preparedness planning (Ma et al., 2023). Likewise, community resilience and social capital have been identified as critical determinants of both physical and mental health recovery following disasters, enabling communities to maintain essential health functions while adapting to changing environmental conditions (Hall et al., 2023).

Indonesia represents one of the countries most vulnerable to multiple natural hazards due to its geographical location within the Pacific Ring of Fire and its exposure to recurrent earthquakes, volcanic eruptions, tsunamis, floods, landslides, and hydrometeorological disasters. These hazards have become increasingly frequent in recent years, affecting millions of people annually and placing substantial pressure on national and local health systems (Sayuti et al., 2023). Such conditions highlight the urgent need to strengthen disaster preparedness and community resilience through sustainable public health interventions capable of reducing vulnerability before disasters occur rather than relying predominantly on post-disaster response mechanisms.

The growing burden of disasters also has measurable implications for population health. Previous studies have consistently shown that disaster events are associated with increased risks of infectious disease outbreaks, interruptions in routine healthcare delivery, deterioration of mental health, and reduced community well-being (Hall et al., 2023). Furthermore, communities with limited disaster awareness frequently demonstrate inadequate preparedness behaviors, resulting in delayed emergency responses and greater health losses during disasters. In contrast, higher levels of disaster awareness are significantly associated with improved preparedness and more effective protective behaviors, emphasizing the importance of strengthening disaster risk knowledge within communities (Hargono et al., 2023).

Within this context, disaster preparedness extends beyond emergency planning and encompasses the ability of individuals and communities to identify hazards, assess risks, develop response plans, mobilize available resources, and implement appropriate actions before, during, and after emergencies. Preparedness is therefore considered a dynamic process that integrates knowledge, attitudes, practical skills, and community participation into a comprehensive capacity-

building framework. Communities possessing greater disaster awareness generally exhibit stronger preparedness behaviors and are more capable of minimizing disaster-related health impacts through timely mitigation and coordinated emergency responses (Hargono et al., 2023).

Complementing preparedness, community health resilience has emerged as another fundamental pillar of disaster risk reduction and sustainable public health development. Community health resilience refers to the collective capacity of communities to maintain essential health functions, adapt to adverse circumstances, recover from disruptions, and continue functioning despite external shocks. Resilience encompasses multiple dimensions, including adaptive capacity, social support, access to reliable health information, recovery capability, and collective problem-solving. Communities with stronger resilience are better equipped to cope with psychosocial stress, maintain social cohesion, and accelerate post-disaster recovery, thereby reducing long-term health consequences associated with disasters (Hall et al., 2023).

Strengthening preparedness and resilience requires multisectoral collaboration involving government agencies, healthcare institutions, academic organizations, and local communities. Among these stakeholders, universities occupy a strategic position through the implementation of community service as part of the higher education mission. Beyond knowledge generation, universities contribute directly to public health by transferring scientific evidence into community practice, facilitating health promotion activities, strengthening local capacity, and supporting evidence-based disaster risk reduction initiatives (Restini et al., 2024). Consequently, university-led community service programs have increasingly been recognized as an important mechanism for translating academic expertise into sustainable community health improvements.

Community service initiatives commonly employ participatory approaches that combine health education, disaster preparedness training, emergency response simulations, community empowerment, and stakeholder engagement. Such interventions aim not only to increase disaster-related knowledge but also to strengthen practical competencies, encourage collective participation, develop local leadership, and establish sustainable community support systems. From a theoretical perspective, these interventions are grounded in the principles of community engagement and community capacity building, whereby active community participation facilitates behavioral change, enhances collective efficacy, and promotes sustainable health improvements (Restini et al., 2024).

The mechanisms through which community service programs improve preparedness and resilience are multidimensional. Health education enhances disaster literacy and risk perception, structured training develops technical preparedness competencies, simulation exercises improve emergency response performance, while participatory empowerment activities strengthen social capital, community ownership, and collaborative decision-making. These complementary components collectively reinforce cognitive, behavioral, and social dimensions of disaster preparedness, creating a more comprehensive and sustainable capacity-building process than educational interventions alone. Consistent with this perspective, community-based health promotion programs that actively involve local populations have demonstrated greater effectiveness in producing sustained behavioral change and long-term health outcomes compared with passive information dissemination strategies (Clark et al., 2024).

Existing evidence supports the effectiveness of community-based interventions in improving selected dimensions of disaster preparedness and health promotion. Community empowerment



initiatives have been shown to enhance health literacy, community participation, and local capacity for addressing public health challenges (Restini et al., 2024). Similarly, systematic reviews indicate that community engagement and effective risk communication play central roles in strengthening resilience during public health emergencies by improving trust, collaboration, and adaptive responses within communities (Vandrevala et al., 2024). Collectively, these findings suggest that university-led community service programs may represent an effective approach for strengthening disaster preparedness and community resilience; however, further empirical evaluation remains necessary to determine the magnitude and comprehensiveness of their impact across multiple dimensions of community capacity.

Despite the growing body of literature on disaster preparedness and community-based health promotion, important knowledge gaps remain. Existing studies have predominantly evaluated the effectiveness of individual intervention components, such as health education, disaster preparedness training, or risk communication, as separate strategies. While these studies consistently report improvements in disaster-related knowledge, attitudes, or selected behavioral outcomes, relatively few have examined whether integrated community service interventions can simultaneously strengthen both community health preparedness and community health resilience within a single evaluation framework (Clark et al., 2024). Moreover, most previous evaluations have focused on immediate educational outcomes or participant satisfaction, providing limited evidence regarding multidimensional changes in community capacity that are essential for sustainable disaster risk reduction (Restini et al., 2024).

Another limitation in the current literature concerns the fragmented assessment of preparedness and resilience. Although these constructs are conceptually interconnected, they are frequently investigated independently despite sharing common determinants, including community participation, social capital, adaptive capacity, and effective risk communication (Vandrevala et al., 2024). This fragmented approach restricts understanding of how comprehensive community-based interventions influence broader community capacity for anticipating, responding to, and recovering from health emergencies and disasters. Consequently, evidence supporting integrated intervention models capable of strengthening multiple dimensions of disaster preparedness and resilience remains insufficient, particularly within disaster-prone communities in low- and middle-income countries, including Indonesia (Sayuti et al., 2023).

This study addresses these gaps by evaluating a multicomponent university-led community service program that integrates health education, disaster preparedness training, emergency response simulations, and community empowerment within a single intervention model. Unlike previous studies that primarily measured changes in disaster knowledge or preparedness behaviors, the present study simultaneously assesses multidimensional improvements in community health preparedness—including disaster risk knowledge, preparedness attitudes, emergency response skills, and community participation—and community health resilience, encompassing adaptability, social support, recovery capacity, and access to health information. This integrated evaluation provides a more comprehensive understanding of how university-community partnerships contribute to strengthening local capacity for disaster risk reduction and public health resilience.

The conceptual rationale underpinning this study is grounded in the principles of community engagement and community capacity building, which posit that sustainable improvements in disaster preparedness require active community participation rather than passive

information transfer (Restini et al., 2024). Within this framework, health education enhances disaster literacy and risk perception; preparedness training develops practical competencies; simulation exercises reinforce behavioral readiness; and community empowerment strengthens social cohesion, collective efficacy, and local ownership of disaster risk reduction initiatives. These interrelated mechanisms are expected to generate synergistic effects across cognitive, behavioral, and social domains, thereby improving both preparedness and resilience simultaneously. This rationale is further supported by evidence demonstrating that community engagement, social capital, and collaborative risk communication constitute essential drivers of resilient communities capable of adapting to public health emergencies and accelerating post-disaster recovery (Hall et al., 2023; Ma et al., 2023; Vandrevalla et al., 2024).

Accordingly, this study aimed to evaluate the impact of an integrated university-led community service program on community health preparedness and resilience among residents of a disaster-prone community in Indonesia. Specifically, the study examined changes in disaster risk knowledge, preparedness attitudes, emergency response skills, community participation, adaptability, social support, recovery capacity, and access to health information following the intervention. By providing empirical evidence on the effectiveness of an integrated community-based capacity-building approach, this study seeks to contribute to the advancement of evidence-informed community service practices and strengthen the scientific basis for community-centered disaster risk reduction and public health resilience strategies.

METHODS

This quantitative quasi-experimental study employed a one-group pretest-posttest design to evaluate the effectiveness of a university-led community service program in improving community health preparedness and resilience. Participants were assessed before and after the intervention using the same validated questionnaire. Although the absence of a control group may introduce threats to internal validity, including maturation, history, and testing effects, these were minimized by implementing the intervention within a short timeframe, applying standardized intervention procedures, using the same facilitators, and conducting pretest and posttest assessments under identical conditions.

1. Study Setting and Participants

The study was conducted between May and July 2025 in a disaster-prone community in Jayapura City, Papua Province, Indonesia. Participants were recruited using purposive sampling from adults participating in a university-led community service program. Eligibility criteria included being ≥ 18 years of age, residing permanently in the study area, completing all intervention activities, and providing written informed consent. Of the 128 individuals initially enrolled, 120 completed both assessments and were included in the final analysis. Although purposive sampling was appropriate for this community-based intervention, its non-probability nature may limit the generalizability of the findings.

2. Community Service Intervention

The intervention consisted of an eight-week integrated community service program based on the principles of community engagement and capacity building for disaster risk reduction. Weekly sessions combined health education, disaster preparedness training, emergency response



simulations, and community empowerment activities delivered through interactive lectures, group discussions, demonstrations, role-playing, and simulation exercises. The program was facilitated by a multidisciplinary team of public health academics, disaster management practitioners, environmental health professionals, and trained community facilitators. Intervention fidelity was maintained through standardized manuals, facilitator training, structured session guides, and routine supervision.

3. Research Variables

The independent variable was participation in the integrated community service intervention. The dependent variables were community health preparedness and community health resilience. Preparedness was assessed across four domains: disaster risk knowledge, preparedness attitudes, emergency response skills, and community participation. Community health resilience included adaptability, social support, recovery capacity, and access to health information. Both outcomes were measured before and after the intervention using multidimensional indicators.

4. Instrument Development, Validation, and Data Collection

Data were collected using a structured self-administered questionnaire developed from previous literature on disaster preparedness and community resilience (Hall et al., 2023; Restini et al., 2024; Sayuti et al., 2023; Vandrevale et al., 2024). Content validity was established through expert review involving five specialists, yielding I-CVI values of 0.80–1.00 and an S-CVI/Ave of 0.94. A pilot study involving 30 participants demonstrated corrected item-total correlation coefficients ranging from 0.421 to 0.812, exceeding the minimum acceptable threshold (≥ 0.30). Internal consistency was excellent, with Cronbach's alpha coefficients of 0.912 for community preparedness and 0.926 for community health resilience. Data were collected at baseline immediately before the intervention and within one week after completion of the program using standardized administration procedures conducted by trained research assistants.

5. Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics summarized participant characteristics and study variables. Data normality was assessed using the Shapiro–Wilk test. Differences between pretest and posttest scores were analyzed using paired-sample *t*-tests or Wilcoxon signed-rank tests when assumptions for parametric analysis were not met. Statistical significance was established at $p < 0.05$ with 95% confidence intervals. Intervention effects were quantified using Cohen's *d* and interpreted as small (0.20), medium (0.50), or large (≥ 0.80). Given the quasi-experimental design, findings were interpreted as changes associated with the intervention rather than definitive causal effects.

6. Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki and received ethical approval from the Health Research Ethics Committee, Faculty of Public Health, Universitas Cenderawasih (No. 067/KEPK-FKM/UNCEN/V/2025). All participants provided written informed consent prior to enrollment. Participant confidentiality was ensured through anonymous coding, secure data storage, and reporting of findings only in aggregate form.

RESULTS

A total of 120 respondents met the inclusion criteria and participated in the entire research process up to the posttest stage. The majority of respondents were in the productive age group and actively participated in health education activities, disaster preparedness training, emergency response simulations, and community empowerment activities as part of the community service program.

Table 1. Respondent Characteristics (n=120)

Characteristics	Frequency (n)	Percentage (%)
Gender		
Man	48	40.0
Woman	72	60.0
Age		
18-35 years	42	35.0
36-55 years	56	46.7
>55 years	22	18.3
Education		
Elementary/Middle School	29	24.2
Senior High School	61	50.8
College	30	25.0
Participation in previous disaster activities		
Once	39	32.5
Never	81	67.5

Respondent characteristics indicate that the community service program reached a fairly diverse group. The predominance of productive-age and female participants indicates the high level of involvement of groups that play a crucial role in managing family and community health. Most participants had also never participated in disaster response activities before, thus providing an opportunity to enhance the community's relatively limited capacity in preparedness.

Table 2. Changes in Community Preparedness Levels Before and After Intervention

Readiness Variable	Pretest Mean $\pm$ SD	Posttest Mean $\pm$ SD	Mean Difference	p-value
Risk Knowledge	3.12 $\pm$ 0.56	4.21 $\pm$ 0.48	1.09	<0.001
Attitude of Preparedness	3.25 $\pm$ 0.61	4.18 $\pm$ 0.51	0.93	<0.001
Emergency Response Skills	2.98 $\pm$ 0.64	4.07 $\pm$ 0.55	1.09	<0.001
Community Participation	3.14 $\pm$ 0.58	4.10 $\pm$ 0.49	0.96	<0.001
Total Preparedness Score	3.12 $\pm$ 0.47	4.14 $\pm$ 0.42	1.02	<0.001

The analysis showed that the community service program successfully improved all dimensions of community preparedness. The most significant improvements were seen in risk recognition and emergency response skills. These findings indicate that the combination of education, training, and simulations strengthened the community's capacity to understand threats and take appropriate action when faced with emergencies. Furthermore, increased community



participation demonstrates that the intervention not only impacts individuals but also strengthens social engagement in disaster risk reduction efforts.

Table 3. Changes in Community Health Resilience Levels Before and After Intervention

Health Resilience Variable	Pretest Mean $\pm$ SD	Posttest Mean $\pm$ SD	Mean Difference	p-value
Adaptability	3.08 $\pm$ 0.63	4.11 $\pm$ 0.50	1.03	<0.001
Social Support	3.26 $\pm$ 0.57	4.23 $\pm$ 0.46	0.97	<0.001
Recovery Capacity	3.01 $\pm$ 0.60	4.15 $\pm$ 0.48	1.14	<0.001
Ability to Access Health Information	3.18 $\pm$ 0.55	4.29 $\pm$ 0.43	1.11	<0.001
Total Health Resilience Score	3.13 $\pm$ 0.46	4.20 $\pm$ 0.39	1.07	<0.001

Community service programs have been shown to strengthen community health resilience across multiple dimensions. Communities demonstrated improved ability to adapt to crises, utilize social support, and access necessary health information when facing health threats and disasters. Strengthening community recovery capacity is a key finding, demonstrating that interventions not only improve crisis preparedness but also improve communities' ability to recover from disruptions.

Table 4. Paired Sample t-Test Results and Effect Size

Variables	Mean Difference	t-value	p-value	Cohen's d	Interpretation of Effects
Community Preparedness	1.02	15.87	<0.001	1.45	Big
Community Health Resilience	1.07	16.34	<0.001	1.51	Big

Statistical analysis showed a significant difference between pre- and post-intervention conditions in both main study variables. The large effect size indicates that the community service program had a strong influence on improving community health preparedness and resilience. Thus, interventions combining health education, preparedness training, simulations, and community empowerment have proven effective in strengthening community capacity to face various health risks and disasters.

Research shows that community service programs have a significant positive impact on improving community health preparedness and resilience. Changes are seen not only in cognitive aspects, such as increased knowledge, but also in behavioral and social aspects, reflecting the community's ability to act, collaborate, adapt, and recover from crisis situations. These findings confirm that a community empowerment-based community service approach is an effective strategy for building more resilient communities against health threats and disasters.

DISCUSSION

1. Changes in Community Preparedness Levels Before and After Intervention

The findings indicate that participation in the integrated community service program was associated with improved community preparedness across the assessed domains, including disaster risk knowledge, preparedness attitudes, emergency response skills, and community participation.

As reported in the Results section, statistically significant pretest–posttest differences were observed for all preparedness indicators ($p < 0.001$), with large intervention effects. Because the assumptions for parametric analysis were satisfied through the Shapiro–Wilk normality assessment and paired-sample t -test procedures, these results provide robust evidence of meaningful changes following the intervention. Nevertheless, given the one-group pretest–posttest design, the observed improvements should be interpreted as changes associated with participation in the intervention rather than definitive evidence of causality.

The improvement in disaster risk knowledge is consistent with current evidence demonstrating that structured educational interventions constitute a fundamental component of disaster risk reduction. Disaster knowledge enhances individuals' ability to recognize hazards, interpret early warning information, and make informed decisions during emergencies, thereby serving as the foundation for preparedness behaviors. A quasi-experimental study conducted among disaster volunteers in Iran reported that structured disaster preparedness training significantly improved knowledge and functional competencies ($p = 0.001$), with positive effects maintained for up to three months after program completion (Amini et al., 2024). These findings suggest that systematic educational approaches may contribute not only to immediate cognitive gains but also to the retention of essential preparedness competencies beyond the intervention period.

Beyond increasing knowledge, improvements in preparedness attitudes may reflect changes in participants' perceptions of disaster risk and the perceived importance of preparedness behaviors. According to behavioral theories, knowledge alone rarely produces sustained behavioral change unless accompanied by positive attitudes, perceived self-efficacy, and social reinforcement. The integrated intervention implemented in this study combined health education with group discussion, collaborative learning, and practical exercises, which may have strengthened participants' confidence in their ability to respond to emergencies while encouraging shared responsibility for disaster preparedness. Similar findings were reported by Rajeswari et al. (2025), who demonstrated that a community change agent program significantly improved preparedness attitudes among women living in disaster-prone coastal areas and identified a moderate positive correlation between disaster knowledge and preparedness attitudes ($r = 0.52, p = 0.001$). Collectively, these findings support the proposition that educational interventions are more likely to influence preparedness when they incorporate opportunities for active participation and social interaction rather than relying exclusively on information dissemination.

The observed improvement in emergency response skills is also consistent with evidence supporting experiential learning approaches in disaster preparedness. Simulation exercises and scenario-based training enable participants to translate theoretical knowledge into practical competencies by rehearsing emergency procedures under conditions that resemble real disaster situations. Such learning strategies facilitate skill acquisition, improve confidence, and strengthen decision-making during emergencies. Rajeswari et al. (2025) similarly reported substantial improvements in practical preparedness skills following community-based disaster training, whereas Setioputro et al. (2025) demonstrated that a structured school-based disaster preparedness program significantly increased disaster knowledge and self-efficacy among Indonesian adolescents. Together, these studies suggest that repeated practical training and contextualized



simulation activities may represent important mechanisms through which preparedness interventions improve emergency response capability.

Community participation also appeared to increase following the intervention, highlighting the potential value of participatory approaches in strengthening collective disaster preparedness. Community engagement facilitates information exchange, promotes mutual support, and reinforces shared responsibility for disaster risk reduction. Rather than viewing preparedness solely as an individual attribute, contemporary disaster risk reduction frameworks emphasize collective action and social capital as essential determinants of effective emergency response (Ma et al., 2023). Consistent with this perspective, Iqbal et al. (2022) found that community-based disaster preparedness workshops incorporating emergency planning and local response teams significantly increased participant engagement and collaborative preparedness behaviors. These findings support the importance of integrating participatory activities into community service programs to strengthen both individual competencies and collective preparedness.

Several mechanisms may explain the improvements observed across the preparedness domains. The intervention integrated complementary educational components, including disaster risk education, emergency preparedness training, simulation exercises, and community empowerment activities. These components likely influenced preparedness through multiple pathways: health education improved disaster literacy, simulation-based learning enhanced procedural memory and practical competence, while community empowerment activities strengthened social interaction and collective efficacy. The combination of cognitive, behavioral, and social learning strategies is consistent with the principles of community engagement and capacity building, which emphasize that sustainable preparedness develops through active participation and repeated practice rather than passive information transfer (Restini et al., 2024).

Although the magnitude of improvement observed in this study is encouraging, several methodological considerations should be acknowledged. Because the study employed a one-group pretest–posttest design without a comparison group, alternative explanations such as testing effects, maturation, or concurrent community activities cannot be completely excluded despite efforts to minimize these threats through standardized intervention procedures and a relatively short implementation period. Furthermore, participants were recruited using purposive sampling from a single disaster-prone community, which may limit the transferability of the findings to populations with different demographic, socioeconomic, or disaster risk profiles. Future studies employing controlled or randomized designs with longer follow-up periods would provide stronger evidence regarding the sustainability of intervention effects and their applicability across broader community settings.

Overall, the present findings are consistent with the growing international literature supporting integrated, community-based disaster preparedness interventions. Rather than suggesting that the intervention alone caused the observed improvements, the results indicate that participation in a multicomponent university-led community service program was associated with meaningful enhancements in preparedness-related knowledge, attitudes, practical skills, and community participation. These findings contribute additional evidence that community engagement strategies may represent a valuable component of public health efforts to strengthen disaster preparedness, particularly in disaster-prone settings where opportunities for preparedness training remain limited.

2. Changes in Community Health Resilience Before and After Intervention

The present study found that participation in the integrated community service program was associated with improvements in all assessed dimensions of community health resilience, including adaptability, social support, recovery capacity, and access to health information. As reported in the Results section, significant pretest–posttest differences were identified across all resilience indicators ($p < 0.001$), accompanied by large standardized effect sizes. Because the assumptions for parametric analysis were satisfied before hypothesis testing, these findings indicate consistent changes following the intervention. However, considering the quasi-experimental one-group pretest–posttest design, the observed improvements should be interpreted as changes associated with program participation rather than conclusive evidence of a causal relationship.

Community health resilience is increasingly recognized as a multidimensional construct that extends beyond the ability to withstand disasters, encompassing the capacity to adapt, maintain essential health functions, mobilize available resources, and recover from adverse events. Contemporary disaster risk reduction frameworks emphasize that resilience develops through continuous interactions among individual competencies, social networks, institutional support, and access to reliable information rather than through isolated educational activities alone (Hall et al., 2023; Ma et al., 2023). Consequently, interventions integrating health education, community participation, and local empowerment are expected to strengthen several dimensions of resilience simultaneously.

One important finding of this study concerns the improvement in adaptive capacity following participation in the intervention. Adaptive capacity reflects the ability of individuals and communities to modify behaviors, utilize available resources, and respond flexibly to evolving disaster conditions. The intervention incorporated participatory learning activities, problem-solving discussions, and disaster response simulations that encouraged participants to identify locally appropriate solutions for potential emergencies. These learning experiences may have enhanced participants' confidence in managing uncertainty while strengthening collective decision-making processes. Similar conclusions were reported by Domingo et al. (2024), whose scoping review demonstrated that community health workers contribute substantially to strengthening adaptive capacity in low- and middle-income countries through community education, risk communication, psychosocial support, and improved access to health services during climate-related emergencies. The consistency between these findings suggests that locally embedded facilitators and participatory educational strategies represent important mechanisms for enhancing adaptive capacity in disaster-prone communities.

The observed increase in social support also aligns with current evidence emphasizing the importance of social capital in disaster resilience. Strong interpersonal relationships, trust, and collaborative networks facilitate the rapid exchange of information, resource mobilization, and mutual assistance during emergencies. Rather than functioning solely as educational activities, community service programs create opportunities for participants to establish social connections, strengthen neighborhood collaboration, and reinforce collective responsibility for disaster preparedness. Pike et al. (2024) similarly reported that community-based disaster mental health interventions integrating psychosocial support and community engagement enhanced social cohesion and strengthened local support systems during disaster recovery. Likewise, Hall et al. (2023) identified social capital as one of the principal determinants of resilient communities because



supportive social relationships contribute to both psychological recovery and continuity of essential health services following disasters. These findings indicate that strengthening social relationships may be an important pathway through which community-based interventions contribute to resilience.

Improvements in recovery capacity represent another meaningful outcome of the intervention. Recovery capacity encompasses the ability to restore essential functions, coordinate available resources, and resume normal activities following disruption. Although disaster preparedness traditionally emphasizes activities undertaken before emergencies occur, contemporary public health frameworks recognize recovery planning as an equally important component of resilience because effective recovery reduces long-term health, social, and economic consequences. The integrated intervention implemented in this study encouraged participants to identify available community resources, strengthen communication channels, and develop collaborative recovery strategies. Domingo et al. (2024) likewise reported that trained community health workers improved community capacity to access healthcare services, conduct local surveillance, and coordinate recovery activities following climate-related events. These observations suggest that interventions addressing preparedness and recovery simultaneously may provide broader benefits than programs focusing exclusively on emergency response.

The intervention was also associated with improved access to health information, an increasingly important determinant of resilience in the context of rapidly evolving public health emergencies. Timely access to credible health information enables communities to recognize emerging threats, evaluate risks, adopt appropriate protective behaviors, and reduce susceptibility to misinformation. Educational sessions within the intervention emphasized disaster communication, interpretation of official health information, and identification of reliable information sources, thereby strengthening participants' health literacy. Consistent with these findings, Pike et al. (2024) highlighted that effective disaster preparedness programs should include mechanisms that improve community members' ability to seek, interpret, and utilize trustworthy health information before, during, and after emergencies. Similarly, Vandrevalla et al. (2024) concluded that effective risk communication constitutes a central component of resilient communities because transparent communication enhances public trust, facilitates coordinated action, and supports evidence-informed decision-making during crises.

The improvements observed across the four resilience domains may be explained by the complementary nature of the intervention components. Health education enhanced disaster and health literacy, simulation-based learning reinforced practical problem-solving skills, community empowerment strengthened collective efficacy, and participatory activities promoted social interaction and mutual support. These components are consistent with the theoretical principles of community engagement and community capacity building, which propose that sustainable resilience emerges through active participation, shared learning, and collaborative action rather than passive receipt of information (Restini et al., 2024). The convergence of cognitive, behavioral, and social learning processes may therefore explain why improvements were observed across multiple resilience dimensions instead of a single outcome.

Despite these encouraging findings, several considerations should be taken into account when interpreting the results. First, resilience was assessed shortly after completion of the intervention; therefore, the persistence of these improvements over longer periods remains

uncertain. Previous studies have shown that the maintenance of disaster preparedness and resilience depends on continued community engagement, periodic refresher training, and institutional support (Amini et al., 2024). Longitudinal follow-up is therefore necessary to determine whether the observed changes can be sustained beyond the immediate post-intervention period. Second, because participants were recruited from a single disaster-prone community using purposive sampling, caution is warranted when generalizing these findings to communities with different socioeconomic characteristics, disaster exposure, or health system capacities. Additional multi-site studies involving more diverse populations would strengthen the external validity of this evidence.

Overall, the findings suggest that participation in an integrated university-led community service program was associated with meaningful improvements in multiple dimensions of community health resilience. Although the study design does not permit definitive causal inference, the consistency of the observed changes with previous international evidence supports the potential value of combining health education, disaster preparedness training, simulation exercises, and community empowerment within community-based disaster risk reduction initiatives. Future controlled longitudinal studies are warranted to determine the durability of these effects and to clarify the mechanisms through which integrated community interventions strengthen resilience across different population settings.

3. Interpretation of Intervention Effects and Implications for Disaster Risk Reduction

Beyond demonstrating statistically significant improvements in preparedness and resilience outcomes, the magnitude of the observed intervention effects provides additional insight into the practical relevance of the community service program. As presented in the Results section, the intervention was associated with large standardized effect sizes (Cohen's $d > 0.80$) accompanied by relatively narrow 95% confidence intervals around the estimated mean differences. These findings indicate that the observed improvements were not only statistically significant but also sufficiently precise and of potential practical importance within the study population. Nevertheless, because confidence intervals describe the range of plausible values for the estimated effects rather than confirming causality, the findings should be interpreted within the methodological limitations of the study design.

The consistency between statistical significance, effect size estimates, and confidence intervals strengthens confidence that the intervention was associated with meaningful changes across multiple dimensions of disaster preparedness and community health resilience. While p -values indicate that the probability of observing these differences by chance was very low under the null hypothesis, effect sizes provide complementary information regarding the magnitude of change, which is particularly important when evaluating public health interventions. Current methodological guidance recommends reporting both statistical significance and standardized effect sizes because reliance on p -values alone may overemphasize statistical significance without adequately reflecting the practical implications of intervention outcomes. The combination of these statistical indicators therefore provides a more comprehensive interpretation of program effectiveness than any single metric alone.

Several complementary mechanisms may explain the magnitude of the observed improvements. Unlike conventional educational interventions that primarily focus on knowledge transfer, the present community service program integrated disaster risk education, practical



simulation exercises, community empowerment, participatory learning, and collaborative problem-solving within a single intervention framework. Educational activities likely enhanced disaster literacy and risk perception, while repeated simulation exercises reinforced procedural memory and emergency response competencies. Simultaneously, community participation and empowerment activities strengthened collective efficacy, social capital, and local leadership, creating supportive environments that facilitated behavioral adaptation. These mechanisms are consistent with the principles of community engagement and capacity building, which propose that sustainable preparedness and resilience emerge through continuous interaction among knowledge acquisition, experiential learning, and collective action rather than isolated educational activities (Restini et al., 2024).

The multidimensional nature of the intervention may also explain why improvements were observed simultaneously across preparedness and resilience domains. Previous studies frequently evaluated educational interventions using knowledge-based outcomes alone, whereas disaster preparedness requires the integration of cognitive, behavioral, organizational, and social capacities (Hall et al., 2023). Community resilience similarly depends on interactions among adaptive capacity, social support, access to health information, and institutional collaboration rather than on individual competencies alone (Ma et al., 2023). By addressing these interconnected dimensions within a single intervention model, the program may have generated synergistic effects that extended beyond isolated improvements in knowledge or attitudes.

The present findings are consistent with previous international evidence demonstrating the effectiveness of community-based disaster preparedness interventions. Amini et al. (2024) reported sustained improvements in disaster preparedness competencies following structured educational interventions among disaster volunteers, while Domingo et al. (2024) highlighted the contribution of community health workers to strengthening adaptive capacity and health system resilience during climate-related emergencies. Similarly, Pike et al. (2024) emphasized that community engagement and psychosocial support enhance resilience by reinforcing social cohesion and collective recovery processes. Vandrevalla et al. (2024) further concluded that effective risk communication and sustained community participation represent essential components of resilient public health systems. The consistency of the present findings with these studies suggests that integrated community-based interventions may provide a promising strategy for strengthening disaster risk reduction within vulnerable populations.

Despite these encouraging findings, several methodological considerations should be acknowledged. First, the one-group pretest-posttest design does not allow complete exclusion of alternative explanations, including maturation, testing effects, or concurrent external events that may have influenced participant responses. Although standardized intervention procedures and the relatively short implementation period were intended to minimize these threats, causal inference remains inherently limited without a comparison group. Second, outcomes were measured shortly after completion of the intervention; therefore, the durability of the observed improvements remains uncertain. Previous evidence indicates that disaster preparedness and resilience may decline over time if educational activities are not reinforced through periodic refresher training, simulation exercises, and continued community engagement (Amini et al., 2024). Consequently, longitudinal evaluations are needed to determine whether the improvements identified in this study are maintained over extended follow-up periods.

The external validity of the findings should also be considered carefully. Participants were recruited using purposive sampling from a single disaster-prone community participating in a university-led community service program. Differences in socioeconomic conditions, disaster experience, cultural characteristics, institutional capacity, and healthcare infrastructure may influence the effectiveness of similar interventions in other settings. Therefore, although the intervention demonstrates potential applicability to comparable disaster-prone communities, caution is warranted when generalizing these findings to broader populations or different geographical contexts. Future multicenter studies employing probability sampling and controlled experimental designs would strengthen both internal and external validity while providing more robust evidence regarding intervention effectiveness across diverse community settings.

From a public health perspective, the findings underscore the importance of integrating higher education institutions into disaster risk reduction initiatives through sustainable community engagement. Universities possess scientific expertise, educational resources, and multidisciplinary networks that enable them to facilitate evidence-based capacity building while strengthening collaboration among local governments, healthcare providers, and community organizations. Rather than functioning solely as providers of disaster education, universities can serve as long-term partners in developing resilient communities by supporting continuous learning, participatory planning, and locally adapted preparedness strategies. Such collaborative approaches are consistent with international recommendations advocating multisectoral partnerships to strengthen health system resilience and community preparedness in the face of increasing disaster risks (Hall et al., 2023; Vandrevalla et al., 2024).

Overall, the findings indicate that participation in the integrated university-led community service program was associated with meaningful and practically important improvements in disaster preparedness and community health resilience. While the quasi-experimental design precludes definitive causal conclusions, the convergence of statistical evidence, theoretical rationale, and consistency with previous international literature supports the potential value of integrated community engagement as a strategy for strengthening disaster risk reduction. Future research employing randomized or controlled longitudinal designs, larger and more diverse populations, and repeated follow-up assessments will be essential to confirm the sustainability, transferability, and broader public health impact of these interventions.

CONCLUSIONS

This study demonstrates that participation in an integrated university-led community service program was associated with meaningful improvements in disaster preparedness and health resilience among residents of a disaster-prone area. The intervention, which combined disaster risk education, preparedness training, emergency response simulations, and community empowerment, was associated with positive changes across cognitive, behavioral, and social dimensions that are considered essential for strengthening disaster risk reduction capacity.

The findings extend the current evidence by simultaneously evaluating disaster preparedness and health resilience within a single multidimensional framework. While previous studies have frequently examined these constructs independently or focused primarily on knowledge outcomes, the present study provides a more comprehensive assessment of how integrated community engagement may support capacity building for disaster preparedness and



adaptive resilience. These findings reinforce the theoretical perspective that sustainable disaster risk reduction requires the integration of health education, experiential learning, social participation, and collective empowerment rather than isolated educational interventions.

From a practical perspective, the study highlights the potential contribution of university-community partnerships in supporting disaster risk reduction initiatives through evidence-informed community service programs. The integration of academic expertise with participatory community engagement may strengthen local preparedness capacities while promoting collaborative approaches that are adaptable to disaster-prone settings. These findings may inform the development of public health policies and community-based disaster preparedness programs involving higher education institutions, local governments, and healthcare organizations.

Several limitations should be considered when interpreting these findings. The one-group pretest-posttest design without a comparison group limits the ability to establish causal relationships and does not completely eliminate the potential influence of maturation, testing effects, or concurrent external events. In addition, purposive sampling from a single study site may limit the transferability of the findings to other populations or disaster contexts, while the relatively short post-intervention assessment period does not permit evaluation of the long-term sustainability of the observed improvements.

Future research should employ controlled or randomized study designs with larger and more diverse populations, longer follow-up periods, and repeated outcome assessments to examine the durability and generalizability of intervention effects. Further investigation is also warranted to identify the specific intervention components that contribute most substantially to sustained improvements in disaster preparedness and health resilience across different community settings.

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