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A Qualitative Interview Pilot to Dig Experiences and Needs of Pharmacists' Role in Handling Disaster Management of the Mount Merapi Eruption in Yogyakarta

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Abstract

Background: *Indonesia is highly vulnerable to recurrent volcanic disasters, such as Mount Merapi's eruptions, which severely disrupt healthcare and cause profound psychosocial impacts. While pharmacists are essential to managing emergency medication logistics and patient safety, their operational constraints and frontline experiences remain significantly underexplored.* ***Objective:*** *This study aimed to develop, pilot, and refine a qualitative interview guide to explore the operational realities, interprofessional dynamics, and psychosocial contributions of the pharmacy workforce during the 2010 Mount Merapi eruption.* ***Methods:*** *A qualitative pilot study was conducted in Sleman Regency, Indonesia, from August to October 2025. Semi-structured interviews were used to collect data from eight participants—frontline pharmacists, physicians, nurses, and affected community members recruited through purposive maximum-variation and snowball sampling. The instrument underwent rigorous multidisciplinary expert validation and iterative field testing.* ***Results:*** *Cross-professional thematic analysis revealed that while pharmacists are vital for maintaining emergency medication supply chains and providing mental health first aid, their effectiveness is frequently hindered by critical workforce shortages and a lack of cross-sector coordination. Methodologically, the pilot phase refined the instrument by incorporating context-setting introductions, targeted probes, and simplified terminology to elicit experience-based narratives.* ***Conclusion:*** *This study produced a highly validated, culturally sensitive qualitative instrument tailored for disaster pharmacy research. Societally, the findings urge policymakers to formally integrate pharmacists into primary healthcare emergency frameworks. Empowering the profession through targeted disaster training and integrated standard operating procedures (SOPs) will optimize emergency medication safety, strengthen post-disaster community resilience, and directly advance the Sustainable Development Goals, specifically SDGs 3, 11, and 17.*

Keywords: *Disaster Planning; Interviews as Topic; Qualitative Research; Volcanic Eruptions*

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INTRODUCTION

Indonesia, located within the Pacific Ring of Fire, is highly susceptible to volcanic disasters that severely threaten both physical health and psychosocial well-being [1–4]. Specifically, recurrent eruptions of Mount Merapi in Yogyakarta have consistently disrupted access to healthcare, placing immense pressure on local public health systems. The urgency of this study stemmed from the critical need for a resilient, adaptive disaster management system capable of mitigating these immediate and long-term health crises [4,5]. While previous mitigation strategies emphasized general public health interventions, they frequently overlooked the specific readiness of the healthcare workforce, which was essential for reducing adverse impacts on affected communities [6].

Within this multidisciplinary emergency response, pharmacists played a vital, multifaceted role that extended beyond traditional medication distribution [7,8]. They were essential for ensuring the continuity of the medicine supply chain, managing complex pharmaceutical logistics, and promoting medication safety under crisis conditions. Recent evidence further highlighted that effective disaster risk management heavily relied on both individual preparedness and the structural integration of these professionals within primary healthcare systems [9,10]. During emergencies, community pharmacists increasingly bridged the gap between traditional clinical duties and psychosocial care. They emerged as accessible frontline responders who provided not only vital medication education but also essential emotional support to traumatized populations [11].

The need for pharmacist involvement became irrefutable as volcanic disaster responses demanded not only immediate medical care but also rigorous medication safety, complex logistics, and specialized psychosocial interventions for affected communities [3]. Despite this critical demand, a significant knowledge gap remained regarding the specific disaster preparedness, lived experiences, and unaddressed needs of pharmacists operating on the front lines [6,7]. Achieving optimal readiness required targeted disaster training and the seamless structural integration of pharmacists into primary healthcare systems, an endeavor that historically faced complex operational barriers and challenges in community participation [8]. Because most existing literature on Mount Merapi focused on general vulnerability or evacuation behaviors [11], the specific interprofessional dynamics and challenges faced by the pharmacy workforce remained profoundly underexplored. Qualitative research was therefore essential to uncover these contextual constraints and to demonstrate how optimizing the pharmacist's role could resolve critical bottlenecks in health emergency management [12].

Building upon the previously mentioned operational bottlenecks, the primary novelty of this research lay in its exclusive focus on the lived experiences of the pharmacy workforce, a critical yet historically marginalized demographic in disaster mitigation literature [1,2]. Unlike prior investigations that broadly assessed general community vulnerability or evacuation patterns, this research uniquely explored the intricate dynamics of pharmaceutical service delivery, medication logistics, and interprofessional coordination during severe volcanic crises [3,4]. By meticulously mapping these specific professional constraints, the investigation offered a novel perspective necessary to formally and systematically integrate pharmacists into primary emergency response structures [5,6]. Furthermore, empowering the pharmacy profession in disaster management strongly aligned with the United Nations Sustainable Development Goals (SDGs). It directly supported SDG 3 (Good Health and Well-being) by ensuring continuous access to safe medications and vital psychosocial care, and SDG 11 (Sustainable Cities and Communities) by fostering resilient local health infrastructures capable of withstanding natural hazards. Driven by this profound novelty and potential for broad societal impact, this study ultimately aimed to pilot and refine a semi-structured qualitative interview guide tailored to capture the specific experiences and perceived needs of pharmacists and key stakeholders involved in the 2010 Mount Merapi eruption. The development of this validated methodological instrument served as a critical foundational step toward formulating robust, evidence-based policies that enhanced pharmaceutical preparedness and long-term disaster resilience [1,10,12].

Therefore, this study aimed to pilot and refine a semi-structured qualitative interview guide to explore the experiences and perceived needs of pharmacists and other stakeholders involved in the 2010 Mount Merapi eruption. Developing this validated instrument was a vital methodological step. Ultimately, this research carried a profound expected impact for society: by understanding and strengthening pharmaceutical preparedness, the findings aimed to inform more resilient disaster response policies, optimize medication safety during emergencies, and significantly enhance overall community resilience and well-being during post-disaster recovery.

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MATERIALS AND METHODS

Materials

This study targeted individuals directly involved in or affected by the 2010 Mount Merapi eruption in Sleman Regency, Special Region of Yogyakarta, Indonesia. Participants were recruited using a purposive sampling strategy that combined maximum variation and snowball sampling to capture comprehensive professional and community perspectives [1]. Initial participants were identified through professional networks and referrals from academic pharmacists at the Faculty of Pharmacy, Universitas Gadjah Mada. Potential candidates were then contacted via WhatsApp and provided with detailed study information.

The inclusion criteria comprised adults with direct experience in the disaster response, specifically frontline healthcare professionals and affected community members [2,3]. Individuals who declined participation or failed to provide written informed consent were explicitly excluded from the study. Ultimately, eight participants were recruited for this pilot phase, including two pharmacists (one practicing and one academic), two primary healthcare physicians, two community health center nurses, and two affected community members. One pharmacist also participated in a follow-up interview to clarify data. To prevent response bias and participant fatigue, all individuals involved in this pilot phase were strictly excluded from the subsequent main study**.**

Tools

The primary data collection instrument was a semi-structured pilot interview guide developed from relevant disaster management literature [4,5]. Before pilot testing, the preliminary guide underwent expert review by three independent practicing pharmacists and the research team to rigorously assess its content validity, contextual appropriateness, and clarity [9, 19]. As detailed in Table 1, the refined guide encompassed four core thematic domains: participant background and context, experiences with pharmacists' roles in disaster management, challenges encountered during disaster response, and expectations or recommendations for improving pharmaceutical services.

Consistent with qualitative research methodology, the principal investigator (AW) served as the primary analytical instrument, responsible for conducting the interviews, observing nonverbal cues, and interpreting the data. Supplementary data collection tools used during the field research included a digital voice recorder for audio capture, field notes, informed consent forms, participant information sheets, and demographic data collection forms [20,21].

Method

This study employed a qualitative research design using face-to-face, semi-structured pilot interviews to explore pharmaceutical preparedness and operational challenges in disaster settings [16]. Data collection took place over three months, from August to October 2025. Interviews lasted between 30 and 90 minutes and were held at participants' workplaces or other mutually agreed-upon, private locations to foster a comfortable, quiet, and open discussion environment. All interviews were conducted in Indonesian, the participants' preferred language, to maximize comfort and ensure clear communication [20,21].

During these sessions, the principal investigator used the semi-structured interview guide detailed in Table 1 to guide discussion across the four core thematic domains systematically. The researcher employed active listening and flexible probing strategies derived directly from the structured probes in Table 1 to clarify responses, explore emerging contextual issues, and elicit richer narratives without constraining participants' original perspectives.

Before implementation in the field, it was critical to validate the questions in Table 1 rigorously. The preliminary interview guide first underwent a comprehensive review by the multidisciplinary research team, followed by an independent assessment by three external practicing pharmacists. This expert validation process systematically evaluated the instrument to ensure content validity, contextual appropriateness, clarity, and alignment with the study aims. Based on their constructive feedback, the interview questions were refined and deemed highly feasible, relevant, and acceptable for use. This validation confirmed that the finalized instrument in Table 1 was a reliable and well-calibrated tool, capable of generating rich, meaningful data on the pharmacy workforce's experiences in disaster settings.

Table 1. Semi-structured pilot interview guide

Theme	Main Question	Probing Questions
Opening (Participant Background and Context)	Could you briefly describe your experience in disaster response or disaster management activities? What were your primary roles and responsibilities during those activities?	—
Experiences of Pharmacists' Roles in Disaster Management	How have you experienced or observed the role of pharmacists in disaster situations?	1. Did pharmacists play an active or passive role? 2. Were there specific situations where pharmacists' roles were particularly visible or not apparent? 3. Which pharmacist roles were most critical? 4. Can you provide a specific example?
Challenges in Disaster Response	What challenges did you encounter while working in disaster settings, either when collaborating with pharmacists or when pharmacists were not available?	1. What was the impact of pharmacists' absence on medication distribution or information? 2. What communication or coordination challenges did you encounter? 3. Were there differences in workflow with and without pharmacists? 4. Were there barriers related to personnel, procedures, logistics, infrastructure, or finances?
Expectations for Pharmacists' Roles in Disaster Management	What role do you believe pharmacists should play in disaster management?	1. What are the most important competencies or skills? 2. What is the most important stage of involvement: mitigation, preparedness, response, or recovery? 3. How can pharmacists' roles be strengthened? 4. Can you describe an ideal scenario for pharmacist involvement?
Recommendations for Improving Pharmaceutical Services in Disaster Settings	What recommendations would you provide to pharmacists regarding pharmaceutical services in disaster situations?	1. What improvements in education or training would you recommend? 2. What competency gaps or professional attitudes need improvement? 3. How can pharmacists strengthen interprofessional collaboration? 4. Can you provide examples of effective training or collaboration practices?
Closing Question	Is there anything else you would like to share that has not been discussed but you believe is important regarding pharmacists' roles and disaster management?	—

Consistent with qualitative research methodology, the principal investigator served as the primary analytical instrument (Table 1), responsible for conducting the interviews, observing participants' responses, and interpreting the data throughout the research process. Supplementary data collection tools utilized during the field research included a digital voice recorder for audio capture, field notes, informed consent forms, participant information sheets, and demographic data collection forms.

Throughout the pilot phase, the researcher meticulously documented field observations on communication dynamics, ambiguities in question wording, the logical progression of topics, and participants' nonverbal cues. After the interviews, the multidisciplinary research team systematically reviewed these findings alongside participant feedback [20,21]. This iterative evaluation led to essential methodological refinements, including revisions to question wording, the addition of introductory remarks, and the reorganization of the interview flow to enhance the instrument's overall analytical rigor [16,20]. The systematic, step-by-step procedure for pilot testing and instrument refinement is comprehensively illustrated in Figure 1.

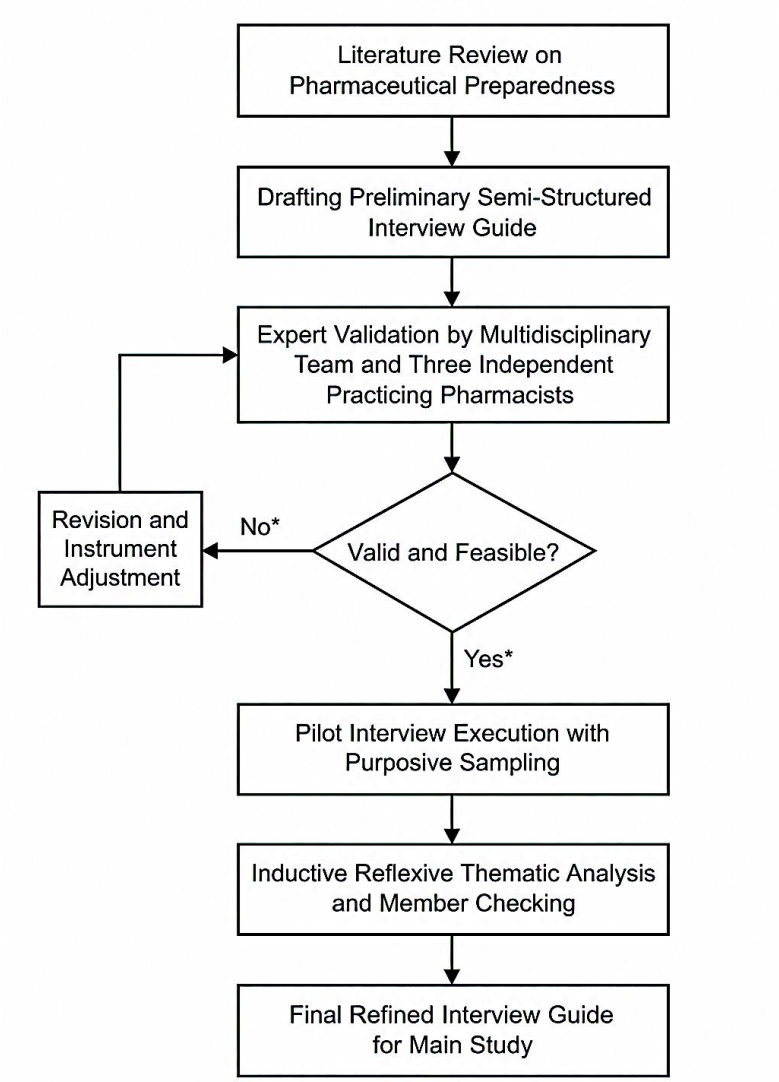

Figure 1. Qualitative research procedure for interview guide development

As depicted in the framework (Figure 1), the pilot study consisted of four sequential phases designed to maximize the instrument's rigor while explicitly capturing the pharmacy profession's vital role in disaster management [16]. Initially, the instrument development phase was conducted through a comprehensive literature review focused on structural pharmaceutical preparedness. In the subsequent expert validation phase, the preliminary guide was critically evaluated by three independent practicing pharmacists [19]. Their professional involvement was essential to ensure that the questions accurately reflected real-world pharmaceutical challenges, such as emergency medication logistics, supply chain disruptions, and interprofessional coordination.

During the third phase, pilot interviews were conducted with a purposive sample of eight participants, deliberately including both academic and frontline practicing pharmacists [17,18]. This inclusion was critical to test the guide's effectiveness in eliciting deep, profession-specific narratives. Finally, the data analysis and refinement phase involved a systematic review of the interview outcomes. This direct feedback loop allowed the research team to refine the instrument by adding targeted probing questions, particularly those addressing the critical impact of a pharmacist's absence on medication distribution and overall patient safety during the volcanic crisis [20,21].

Ethical Considerations

Before data collection began, the study protocol received formal ethical approval from the Medical and Health Research Ethics Committee of the Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada (Ref. No. KE/FK/1513/EC/2025). Comprehensive study information was provided, and written informed consent was obtained from all participants, ensuring their rights to voluntary participation, confidentiality, and withdrawal without consequence. All transcripts were strictly anonymized using unique identification codes to ensure secure data handling.

Data Analysis

Audio recordings of the pilot interviews were transcribed verbatim using Speechnotes software and then reviewed, verified, and manually corrected by the first author (AW) to ensure accurate transcription. To establish the credibility and authenticity of the findings, member checking was systematically conducted by returning the transcripts and preliminary interpretations to the participants for verification, clarification, and confirmation [20].

Following transcription, the data were analyzed using an inductive reflexive thematic analysis. This process strictly adhered to the six rigorous phases proposed by Braun and Clarke: data familiarization, initial coding, theme generation, theme review, defining and naming themes, and report production [21]. The first author (AW) immersed themselves repeatedly in the transcripts to achieve deep data familiarization before generating initial codes derived directly from participants' lived accounts, deliberately avoiding predetermined theoretical categories.

To ensure analytical rigor and mitigate individual bias, the coding and theme development processes were highly iterative and informed by researcher reflexivity. The principal investigator (AW), with a background in emergency pharmacy education, collaborated closely with a multidisciplinary research team comprising pharmacy (CW and NNW) and medical (DW) academics. Throughout the analysis, the team engaged in ongoing reflexive peer debriefings to critically examine how their distinct professional backgrounds and assumptions might influence data interpretation [22]. Any discrepancies in coding were actively debated and resolved, and the final themes and subthemes were established strictly through multidisciplinary consensus. This reflexive and collaborative approach ultimately ensured the depth, trustworthiness, and interpretive richness of the final findings.

RESULTS AND DISCUSSION

Participants were successfully recruited using a combination of purposive and snowball sampling strategies, encompassing telephone calls, email correspondence, and face-to-face invitations. The diverse demographic and professional characteristics of the eight pilot interview participants, comprising frontline clinicians, academics, and affected community members, are detailed in **Table 2**.

A cross-professional thematic analysis was conducted to integrate the perspectives of physicians, nurses, pharmacists, and the public. This integrated approach mapped the operational realities of the pharmacy workforce during the 2010 Mount Merapi eruption and provided critical feedback to refine the study's methodological instrument.

Table 2. Demographic and professional characteristics of pilot interview participants

Source person	Age	Gender	Education	Work Experience (years)
Pharmacist M	60	Woman	Pharmacist	25
Pharmacist I	61	Man	Master of Pharmacy	23
General Practitioner Y	42	Man	Medical	10
General Practitioner G	42	Man	Medical	10
Nurse E	53	Woman	Nurse	30
Nurse Y	58	Man	Nurse	31
Teacher P	37	Woman	Elementary School Class Teacher	20
Teacher S	40	Woman	Elementary School Class Teacher	19

Operational Realities and the Vital Role of Pharmacists. The primary theme that emerged from the data highlighted the vital yet often underutilized role of pharmacists in the disaster management system [22,23]. As shown in Table 3, participants across all professional groups recognized pharmacists as key contributors to medication safety, pharmaceutical logistics, and coordinated healthcare delivery. These findings align with recent global evidence confirming that clinical pharmacists bring indispensable skills to emergency response teams, particularly in mitigating medication errors and adapting therapies under crisis conditions.

Table 3. Cross-professional perspectives on the vital role of pharmacists in disaster management

Stakeholder	Conclusion
Doctor	Physicians perceived pharmacists as essential contributors to disaster response, particularly in ensuring medication availability, safety, and appropriate medication use.
Nurse	Nurses reported a strong reliance on pharmacists for medication supply management and consultation regarding the safe and effective use of medicines during disaster situations.
Pharmacist	Pharmacists emphasized their role in establishing emergency pharmacy services and managing medication logistics based on disaster characteristics.
Public	Community members acknowledged the benefits of pharmacists' contributions, particularly in maintaining access to medicines at disaster response posts.
Professional Organization	Professional representatives viewed pharmacists as key intermediaries linking pharmaceutical logistics systems with frontline healthcare services.

Despite this recognition, participants reported significant workforce shortages and logistical barriers during the Merapi eruption (see Supplementary Table S1 and Table S2). The chronic shortage of on-site pharmacists often forced other healthcare professionals, such as nurses, to assume medication distribution roles without direct pharmaceutical guidance. Furthermore, disrupted supply chains severely complicated inventory management in affected displacement camps. Such logistical bottlenecks are not unique to Indonesia; recent international studies similarly report that the absence of structured operations management for pharmaceutical supplies critically hampers healthcare continuity in internally displaced person (IDP) camps and volcanic disaster zones [23,24].

Pharmacists play a critical role in linking pharmaceutical logistics systems with frontline healthcare services during emergencies and disasters [5,6]. Their responsibilities encompass medication planning, procurement, storage, distribution, and inventory control to maintain the availability and quality of essential medicines. In disaster settings, particularly volcanic eruptions like Mount Merapi, medication planning must be meticulously tailored to the specific health conditions of affected populations. Volcanic exposure significantly increases the health burden, particularly regarding acute respiratory conditions and exacerbations of chronic diseases, demanding specific therapeutic interventions [7,8].

Furthermore, an effective and coordinated medication distribution system is essential, as disaster situations often involve complex supply chains and exponentially increased demand. These conditions significantly elevate the risk of medication shortages, which can severely impact patient outcomes, particularly in internally displaced person (IDP) camps [27]. Pharmacist-led or pharmacist-supervised distribution processes have been strongly associated with improved efficiency of healthcare logistics systems and a significant reduction in medication-related errors during crises [26,27].

Interprofessional Collaboration and Transformational Leadership

To overcome these structural barriers, participants strongly advocated for enhanced interprofessional collaboration and targeted disaster training (see Supplementary Table S3). Effective coordination among health authorities, professional organizations, and volunteer groups was perceived as suboptimal due to the absence of clear standard operating procedures (SOPs). As summarized in Table 4, all stakeholders demanded formalized communication mechanisms.

Table 4. Participants' perspectives on interprofessional collaboration and cross-sector coordination

Stakeholder	Conclusion
Doctor	Physicians recognized the importance of standard operating procedures (SOPs) and effective coordination among emergency response teams to ensure efficient disaster management.
Nurse	Nurses reported collaborating with pharmacists during disaster response; however, communication and coordination were perceived as suboptimal.
Pharmacist	Pharmacists emphasized the need for formalized SOPs and stronger coordination mechanisms among health authorities, professional organizations, and volunteer groups.
Public	Community members perceived interprofessional collaboration as essential for delivering effective and coordinated healthcare services.
Professional Organization	Professional representatives highlighted that regular communication and coordination among healthcare professionals are critical for strengthening interprofessional synergy.

The literature strongly supports this expectation, showing that integrated, cross-sectoral collaboration during crises significantly reduces service duplication and improves psychological safety and clinical outcomes. Furthermore, establishing a robust competency framework for transformational healthcare leadership and formalized interprofessional coordination among pharmacists, nurses, and physicians is now globally recognized as a critical prerequisite for an effective public health emergency response [28,29]. Future disaster policies must prioritize integrating specialized disaster management modules into pharmacy curricula to bridge these competency gaps.

Despite their clinical and logistical expertise, pharmacists are often perceived primarily as responsible for medication dispensing, limiting their strategic integration into emergency response command structures. To overcome these systemic barriers, regular interprofessional collaboration and effective communication are paramount. Coordinated communication among healthcare professionals, specifically physicians, nurses, and pharmacists, facilitates timely information exchange, clarifies professional roles, and reduces duplication of services. Evidence suggests that structured interprofessional collaboration significantly improves disaster response efficiency, continuity of care, and overall patient safety [30-31].

Moreover, establishing a robust competency framework for transformational healthcare leadership is now globally recognized as a critical prerequisite for an effective public health emergency response. Formal disaster training plays a fundamental role in enhancing pharmacists' preparedness and professional competence [32,33]. Therefore, integrating specialized disaster management modules into pharmacy curricula and providing participatory preparedness training are critical steps for building a resilient healthcare workforce capable of navigating interprofessional crisis dynamics [34]

Psychosocial Support and Community Engagement

Beyond clinical and logistical duties, the analysis revealed the profound educational and psychosocial impact pharmacists had on the community (see Supplementary Table S4 and Table S5). Pharmacists served as crucial providers of health literacy, educating disaster victims about rational drug use, disease prevention, and coping strategies. Extending pharmacy practice to include mental health first aid and psychosocial care proved

vital in alleviating trauma among Merapi survivors. This reflects a growing global paradigm in which pharmacists are increasingly integrated into primary community networks to manage common mental health conditions and provide person-centered humanitarian support during crises. Recent studies strongly corroborate this integration, demonstrating that actively bridging routine pharmacy practice and targeted psychosocial care significantly improves patient resilience during the disaster recovery phase [31-33].

Refinement of the Methodological Instrument

Beyond exploring the substantive roles of pharmacists, a primary objective of this pilot study was to refine the qualitative interview guide for future use. Initial testing revealed that participants occasionally provided normative, generalized answers rather than reflecting on their lived experiences [10,19]. The iterative evaluation led to critical methodological refinements, including adding introductory context-setting questions, simplifying academic jargon, and incorporating targeted probing strategies to elicit richer narratives. The comprehensive modifications to the interview guide are detailed in Table 5.

Table 5. Refinement of the interview guide following pilot interviews and rationale for modifications

Theme	Pilot Interview Questions	Main Study Questions (Revised)	Rationale for Revision
Opening (Context)	No opening questions were included.	Could you briefly describe your experience with disaster management activities? What were your primary roles?	Introductory questions were added to establish the participants' background, facilitate rapport-building, and encourage lived-experience reflections.
Experience	How have you experienced or observed the role of pharmacists in disaster situations?	Added probing questions on the specific extent of involvement and critical responsibilities.	Additional probes facilitated a deeper exploration and generated richer, more detailed descriptions of actual field contributions.
Challenges	What challenges did you encounter while working in disaster settings?	Added probes addressing medication distribution, workflow, operational procedures, and logistics.	Refined to explicitly identify the systemic impact of the presence or absence of pharmacists on disaster response efficiency.
Expectations	What are your expectations regarding pharmacists' roles in future disaster management efforts?	Added probes regarding essential competencies and specific disaster management phases.	Streamlined to focus on actionable expectations relevant to policy development and pharmacy workforce training.
Recommendations	What recommendations would you provide to pharmacists regarding pharmaceutical services?	Added non-directive probes exploring educational preparation, competency gaps, and interprofessional practices.	Rephrased to encourage constructive, solution-oriented identification of best practices and systemic shortcomings.
Closing	No closing question was included.	Is there anything else you would like to share that has not been discussed?	Added to enhance data completeness and recognize participants as the primary source of unexplored critical issues.

Pharmaceutical education plays a vital role in clinical practice by promoting public awareness and supporting the safe use of medicines during public health emergencies. Additionally, pharmacists' involvement in psychosocial care expands the scope of pharmacy practice and reinforces the profession's humanitarian dimension. Volcanic eruptions, such as the eruption of Mount Merapi, are known to cause profound psychosocial distress and long-term mental health impacts on affected communities [24, 29].

During such emergencies, community pharmacists are often among the most accessible healthcare professionals. They provide essential initial psychosocial support and facilitate appropriate referrals for mental health conditions, which is crucial when routine healthcare access is severely disrupted. Actively bridging routine pharmacy practice and targeted psychosocial care significantly improves patient resilience during disaster recovery phases. Ultimately, optimizing the multifaceted roles of pharmacists, particularly within primary healthcare centers across Indonesia, ensures a holistic, patient-centered approach that profoundly strengthens community resilience and the overall preparedness of the national healthcare system against future hazards [30, 31, 32-34].

Study Strengths and Limitations

A major strength of this study is its rigorous qualitative methodology, which adhered to WHO guidance for disaster risk management research. The use of a cross-professional maximum-variation sampling strategy enabled robust triangulation of perspectives, effectively eliminating single-profession bias. Furthermore, the iterative refinement of the instrument, validated by multidisciplinary academics and independent practicing pharmacists, ensured high contextual relevance. However, several limitations must be acknowledged. First, the pilot study featured a small sample size (n=8), which is appropriate for instrument validation but limits broader generalizability. Second, because the study investigated experiences from the 2010 Mount Merapi eruption, the findings may be susceptible to recall bias, despite the event's profound and enduring nature. Lastly, the geographical focus on Sleman Regency implies that the refined instrument may require further cultural calibration if applied to disasters in distinctly different socio-geographical contexts [35].

Impact on Sustainable Development Goals (SDGs) and Healthcare Resilience

Ultimately, the findings of this study directly contribute to advancing several United Nations Sustainable Development Goals (SDGs). By optimizing emergency medication safety and emphasizing pharmacists' roles in combating disease outbreaks in disaster zones, this research strongly supports SDG 3 (Good Health and Well-being), specifically Target 3.d on the capacity for early warning, risk reduction, and management of national health risks. Furthermore, the study's advocacy for building disaster-ready healthcare infrastructure and integrating community pharmacists into emergency frameworks reinforces SDG 11 (Sustainable Cities and Communities), aiming to significantly reduce the number of affected people and economic losses caused by disasters. Lastly, the emphasis on cross-sector coordination among health authorities, NGOs, and academia embodies the spirit of SDG 17 (Partnerships for the Goals) [33, 34].

Methodologically, this study produced a highly validated, culturally sensitive instrument that comprehensively maps disaster pharmacy dynamics. Societally, the findings provide an evidence-based foundation for policymakers to formally integrate pharmacists into the national disaster response framework, particularly by optimizing their roles in primary healthcare centers across Indonesia. By addressing the identified gaps in interprofessional collaboration, specialized training, and psychosocial care, health systems can develop a comprehensive resilience framework that significantly protects communities from future volcanic hazards.

CONCLUSION AND SUGGESTION

This pilot study developed and refined a highly valid, contextually sensitive qualitative instrument to explore disaster pharmacy dynamics. Cross-professional findings confirmed that while pharmacists are vital to emergency medication logistics, patient safety, and psychosocial support, their operational impact is often constrained by workforce shortages and a lack of formalized cross-sector coordination. A major strength of this study is its rigorous cross-professional triangulation and iterative multidisciplinary validation, which effectively minimized single-profession bias. However, the study is limited by its small pilot sample size, potential recall bias regarding the 2010 eruption, and geographical specificity. Based on these findings, future research should apply this refined instrument in broader, large-scale multicenter studies. Furthermore, policymakers and educational institutions

should formalize pharmacists' roles within national disaster response frameworks by developing integrated standard operating procedures (SOPs) and embedding specialized disaster management modules into pharmacy curricula.

Based on these findings, future research should use this refined instrument in broader, large-scale multicenter studies. Furthermore, policymakers and educational institutions should formalize pharmacists' roles within national disaster response frameworks by developing integrated standard operating procedures (SOPs) and embedding specialized disaster management modules into pharmacy curricula.

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CONFLICT OF INTEREST
The authors declare that they have no conflicts of interest.

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Supplementary (S)

Table S1. Participants' perspectives on workforce limitations and the visibility of pharmacists in disaster management

Stakeholder	Conclusion
Doctor	Physicians perceived the number of pharmacists involved in disaster response as insufficient to adequately support healthcare needs in the field.
Nurse	Nurses reported that pharmacists were rarely present at disaster response sites, limiting opportunities for direct collaboration and pharmaceutical support.
Pharmacist	Pharmacists acknowledged constraints related to limited human resources and high administrative workloads, which may restrict their participation in disaster response activities.
Public	Members of the public demonstrated limited awareness of pharmacists' roles beyond conventional pharmacy services, particularly in disaster management contexts.
Professional Organization	Professional representatives emphasized the need for strategies to strengthen pharmacist involvement and enhance recognition of their roles within emergency and disaster response systems.

Table S2. Participants' perspectives on medication distribution challenges and reliance on medical staff without direct pharmaceutical guidance

Stakeholder	Conclusion
Doctor	Physicians reported challenges related to the distribution and monitoring of donated medications during disaster response activities.
Nurse	Nurses contributed to medication distribution efforts; however, they emphasized the need for pharmaceutical guidance to ensure appropriate medication management.
Pharmacist	Pharmacists highlighted their responsibility in ensuring medication quality, proper storage conditions, and the rational use of medicines throughout disaster response operations.
Public	Community members often relied on healthcare teams for medication distribution and information, with limited direct access to pharmaceutical guidance.
Professional Organization	Professional representatives emphasized the need for a coordinated medication distribution system in which pharmacists play a central role in ensuring medication quality, safety, and rational use.

Table S3. Participants' perspectives on educational and training needs for pharmacists in disaster management

Stakeholder	Conclusion
Doctor	Physicians emphasized the importance of disaster preparedness training for healthcare professionals to enhance the effectiveness of disaster response activities.
Nurse	Nurses highlighted the need for interprofessional training programs that include pharmacists to strengthen collaboration and coordination during disaster management.
Pharmacist	Pharmacists identified the limited integration of disaster-related content within pharmacy curricula as a significant barrier to preparedness and effective participation in disaster response.
Public	Community members expressed expectations for pharmacists to be better prepared and more actively involved in disaster response efforts.
Professional Organization	Professional representatives emphasized that integrating disaster management training into pharmacy education and continuing professional development programs could enhance pharmacists' competence, professionalism, and disaster preparedness.

Table S4. Participants' perspectives on the educational and social roles of pharmacists in disaster management

Stakeholder	Conclusion
Doctor	Physicians supported the involvement of pharmacists in providing medication-related education and counseling to patients during disaster response activities.
Nurse	Nurses acknowledged the value of pharmacists' guidance in promoting the safe and appropriate use of medications among patients and healthcare teams.
Pharmacist	Pharmacists emphasized their educational role in delivering medication-related information to volunteers, community members, and other stakeholders involved in disaster response.
Public	Community members reported benefiting from pharmacists' education on the appropriate and safe use of medicines during emergencies.
Professional Organization	Professional representatives highlighted that pharmaceutical education initiatives can enhance public awareness, promote medication safety, and support rational medicine use during disasters and other emergencies.

Table S5. Participants' perspectives on community engagement and psychosocial support following disasters

Stakeholder	Conclusion
Doctor	Physicians recognized the importance of providing direct patient support to facilitate both physical and psychological recovery following disaster events.
Nurse	Nurses highlighted the need for emotional support and continuous accompaniment of disaster victims during emergency response and recovery phases.
Pharmacist	Pharmacists acknowledged their potential contribution to psychosocial support through patient counseling, health education, and community engagement activities.
Public	Community members reported experiencing both physical and psychological impacts of disasters and expressed the need for emotional support in addition to medication-related assistance.
Professional Organization	Professional representatives emphasized that pharmacists' involvement in psychosocial support could broaden the scope of pharmacy practice and strengthen the humanitarian dimension of the profession during disaster response.