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Disaster Risk Management Model for Enhancing the Preparedness of Pregnant Women in Response to the Eruption of Mount Agung: A Quasi-Experimental Study

Nengah Runiari [1,*], I Dewa Made Ruspawan [1], I Wayan Candra [1], I Nengah Sumirta [1], Ni Nyoman Hartati [1], Ni Made Wedri [1], I Gede Juanamasta [2], Yupin Aungsuroch [3]

[1] Department of Nursing, Health Polytechnic, Ministry of Health, Denpasar, Indonesia
[2] Nursing program, STIKes Wira Medika Bali, Denpasar, Indonesia
[3] Faculty of Nursing, Chulalongkorn University, Bangkok, Thailand

[*] *Corresponding author:* Department of Nursing, Health Polytechnic, Ministry of Health, Denpasar, Indonesia. Email: runiarijkp@gmail.com

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Abstract

Background: Volcanic eruptions can harm pregnant women in the absence of disaster risk management. Health personnel have not adequately prepared pregnant women for disaster-prone eruptions.
Objectives: This research aimed to evaluate the effectiveness of a disaster risk management model in enhancing the preparedness of pregnant women in anticipation of the eruption of Mount Agung.
Methods: The research employed a quasi-experimental design, utilizing a pre-test-post-test control group method. Conducted in Bali, Indonesia, in 2022, the study involved a sample of 200 participants, divided equally into two groups of 100 each. Participants were selected using quota sampling. Preparedness questionnaires were administered before the educational intervention (pre-test) and again after two weeks of education (post-test). The data were analyzed using the Wilcoxon Signed Rank Test and the Mann-Whitney U test.
Results: It was found that in the intervention group, the preparedness of most pregnant women was categorized as fair (55%) before the intervention and high (65%) after the intervention ($p < 0.001$). In the control group, most pregnant women's preparedness remained in the fair category both before (66%) and after (65%) the intervention ($P = 0.085$). Additionally, there was a significant difference in the preparedness levels between the groups after the intervention ($P = 0.015$).
Conclusions: Health workers can enhance the eruption emergency preparedness of pregnant women through educational classes specifically designed for them.

Keywords: Disasters, Health Personnel, Pregnancy, Risk Management

1. Background

Disaster risk management involves practical knowledge used to identify, monitor, and analyze disasters to enhance disaster prevention, mitigation, and preparedness (1). Several studies have indicated that a high number of victims in natural disasters results from a lack of awareness about disasters (2, 3). Consequently, it is essential for individuals to enhance their knowledge and capacity to manage disaster situations for themselves, their families, and vulnerable groups within their communities (4, 5).

Vulnerability refers to a condition or set of environmental factors within a community or society that contributes to or exacerbates the inability to cope with disaster threats (6). Vulnerability among women is compounded by physiological conditions such as menstruation, pregnancy, childbirth, and lactation (7). Pregnant women represent a particularly vulnerable population that requires special planning to address their needs during and after disasters (8, 9). Disasters pose significant risks to pregnant women and their fetuses, leading to potential physical trauma, miscarriages, and complications during pregnancy (10).

For fetuses, the impacts may include developmental disorders and premature birth due to maternal stress (11). In normal circumstances, both the maternal mortality rate (MMR) and infant mortality rate (IMR) in Indonesia are already high, and these figures tend to increase during health crises (12).

Natural disaster risk management can be achieved by increasing education and empowering communities to reduce vulnerability and isolation (13). Research has found a significant difference in pre-test and post-test scores of disaster preparedness among women who received a short educational intervention. The post-test scores were significantly higher than the pre-test scores, indicating that the intervention successfully increased pregnant women's preparedness for disasters (14).

A study conducted in 2021 in Indonesia revealed that 48% of pregnant women and their families were categorized as having insufficient preparedness (15). The preparedness of most pregnant women and their families to face an eruption of Mount Agung, Indonesia, was in the good category. Similarly, the preparedness of most health workers for an eruption of Mount Agung was also rated as good; however, unlike pregnant women, none fell into the poor category. Generally, it can be observed that the preparedness of health workers is better than that of pregnant women (15).

2. Objectives

The literature review indicates a lack of evidence regarding the preparedness of pregnant women facing volcanic eruptions. Health workers must ensure that pregnant women achieve high levels of preparedness, especially in disaster-prone areas (16). In response to these conditions, researchers developed a disaster risk management model that involves health professionals (midwives and nurses) in educating pregnant women. This research aimed to assess the effectiveness of the disaster risk management model in enhancing the preparedness of pregnant women in anticipation of the eruption of Mount Agung.

3. Methods

3.1. Design

The research utilized a quasi-experimental design, incorporating both pre- and post-tests with a control group. The study was conducted from April to October 2022 across two districts in Bali Province, Indonesia.

3.2. Sample and Setting

The research population consisted of pregnant women within the working areas of the Bebandem Public Health Center and the Selat Public Health Center in Bali, Indonesia. Sample selection employed quota sampling techniques to control for age, education, parity, and income of the respondents. Quota sampling was chosen to ensure demographic balance between the intervention and control groups, mitigating confounding factors and allowing the sample to be representative of the population (17). The total sample comprised 200 individuals. All eligible pregnant women in the selected centers were enrolled in the study, divided equally with 100 in the intervention group and 100 in the control group. The intervention was tailored to the educational levels of pregnant women in each village, with each group reaching 100 respondents.

Pregnant women were selected based on inclusion criteria: Being in the II or III trimesters of pregnancy, residing in Bebandem or Selat District, Karangasem Regency, and willingness to participate as respondents. The exclusion criteria included pregnant women suffering from disorders that impair communication and those unable to read and write.

3.3. Intervention

The research in this study is based on the PRECEDE-PROCEED health promotion model, which includes predisposing, reinforcing, and enabling factors, as well as organizational structure within the health education development model (18) (Figure 1). The application of the PRECEDE-PROCEED model is a suitable pedagogical strategy because it includes interventions that address public needs and provides practical recommendations for health programs (19). Having firsthand experience in managing disasters does not automatically improve a community's understanding and readiness. Therefore, establishing information and social frameworks to strengthen community resilience in the face of disasters is crucial (20). This approach aligns with the principles of disaster risk management, which start with pre-disaster management by enhancing community readiness to respond effectively to disasters (21).

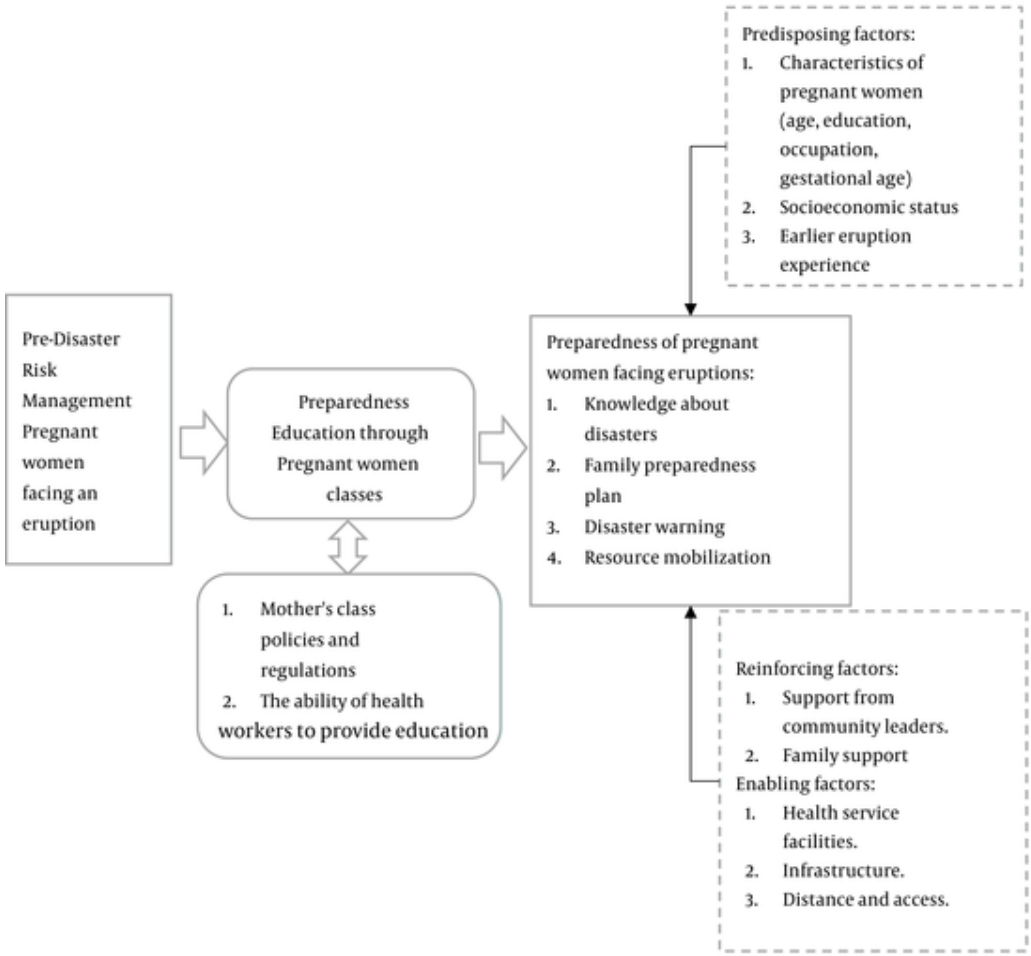

Figure 1. Disaster risk management model for improving pregnant women's preparedness facing an eruption

The study conducted an educational class on disaster risk management to increase the preparedness of pregnant women for the eruption of Mount Agung, in collaboration with the Karangasem Regional Disaster Management Agency and health workers.

Initially, the researchers and the Regional Disaster Management Agency trained 15 healthcare workers on preparedness for pregnant women facing volcanic eruptions. The training spanned two days; the first day involved 8 hours of theoretical instruction on volcano eruption preparedness for pregnant women. This was followed by four hours of practical training on evacuation protocols for pregnant women facing volcanic eruptions.

The trained health workers were divided into six groups to provide education in the villages. They delivered educational material covering four main topics: Knowledge about disasters, disaster activity plans, disaster warnings, and resource mobilization. These four components were the key parameters used to assess the preparedness of pregnant women for eruptions. The education on preparedness for pregnant women facing volcanic eruptions lasted for one hour. Additionally, a booklet was provided that contained information on disasters, disaster activity plans, disaster warnings, and resource mobilization.

Table 1. Demographic Characteristics [a]

Characteristics	Education Group	Control Group	P-Value
Mother's age (y)			0.548
< 20	1 (1)	3 (3)	
20 - 35	85 (85)	82 (82)	
> 35	14 (14)	15 (15)	
Education			0.219
Elementary school	27 (27)	32 (32)	
Junior high school	28 (28)	34 (34)	
Senior high school	38 (38)	33 (33)	
Diploma	1 (1)	1 (1)	
Work			0.145
Employment	44 (44)	69 (69)	
Unemployment	56 (56)	31 (31)	
Parity			0.365
Primigravida	15 (15)	23 (23)	
Multigravida (2 - 5)	65 (65)	60 (60)	
Grand multigravida (> 5)	20 (20)	17 (17)	
Monthly income (husband and wife)			0.430
Inadequate	94 (94)	97 (97)	
Adequate	6 (6)	3 (3)	
Gestational Age			0.634
Trimester II (13 - < 28 weeks)	73 (73)	88 (88)	
Trimester III (≥ 28 weeks)	27 (27)	12 (12)	
Pregnancy check-up place			0.953
Public health center	22 (22)	37 (37)	
Medical specialist	68 (68)	36 (36)	
Practicing midwife	10 (10)	27 (27)	
Have you ever received information about disaster preparedness?			0.212
Once	39 (39)	41 (41)	
Never	61 (61)	59 (59)	

[a] Values are expressed as No. (%).

3.4. Data Collection

Pre-tests were administered to both groups using questionnaires to assess the preparedness of pregnant women to face an eruption of Mount Agung before the intervention. A post-test followed two weeks after the intervention.

The questionnaire comprised two sections: Demographic variables (age, education, employment, parity, income, gestational age, location of pregnancy check-ups, and eruption preparedness information) and preparedness in anticipating the eruption. The preparedness measurement tool was developed by modifying the community preparedness measurement tool created by Lembaga Ilmu Pengetahuan Indonesia (LIPI) in collaboration with UNESCO/ISDR in 2006 (22). Four parameters were used to assess the level of community preparedness in anticipating disasters: Knowledge and attitudes about disaster risks, emergency response plans, disaster warning systems, and resource mobilization. The original instrument primarily focused on earthquakes and tsunamis. After obtaining permission from LIPI to adapt the instruments, the principal investigator (PI) modified several questions to better gauge a mother's preparedness for a volcanic eruption.

The natural disaster preparedness questionnaire offered three response options: “Yes,” with a score of 2; “No,” with a score of 1; and “don't know,” with a score of 0. The Category Index Values were: 80 - 100 for High Preparedness, 60 - 79 for Medium Preparedness, and less than 60 for Low Preparedness.

The questionnaire was conducted at the Rendang Community Health Center, Karangasem Regency, with a sample size of 50 people. Concurrent validity was assessed by measuring the correlation with community preparedness instruments (22). A Pearson correlation confirmed the items were valid (r = 0.621). The reliability test results indicated a Cronbach's alpha of 0.832, confirming the questionnaire's reliability.

3.5. Data Analysis

The researchers meticulously examined the completeness of the respondents' questionnaires and processed the acquired data using SPSS 24 software (IBM Corp., Armonk, NY, USA). Descriptive analysis was conducted to describe the respondents' characteristics, such as age, gender, education, work experience, expertise, and compliance. Data were presented as frequencies and percentages. The chi-square test was used to compare demographic variables between the groups for a homogeneity test. The Wilcoxon Signed Rank Test analyzed the differences in pre-post test scores within each group, and the Mann-Whitney U test was used to analyze differences between groups. A significance level of $P < 0.05$ was considered statistically significant.

3.6. Ethical Consideration

Ethical approval was obtained from the Health Research Ethics Committee of the Health Polytechnic of the Ministry of Health in Denpasar, Bali Province, Indonesia (Number LB.02.03/EA/KEPK/0451/2022). Before data collection began, written informed consent was obtained from all participants.

4. Results

4.1. Participants' Characteristics

The study was completed by 100 pregnant women in the intervention group and 100 in the control group. Table 1 indicates that the most common maternal age in both the intervention and control groups was 20 - 35 years. The highest level of maternal education in the intervention group was high school, while in the control group it was middle school. Most mothers in the intervention group were unemployed, whereas the majority in the control group were employed. Most of the mothers were multigravida in both groups. The respondents' monthly income in both groups was predominantly inadequate. The most frequent gestational age was the second trimester. Pregnancy check-ups in the intervention group were mostly conducted by specialist doctors, whereas in the control group, they were conducted at community health centers. In both groups, the majority of women had not received information about preparedness for pregnant women. There were no significant differences between the groups regarding demographic characteristics (Table 1).

4.2. Preparedness of Pregnant Women Facing an Eruption of Mount Agung in the Intervention Group and Control Groups

Based on Table 2, it was observed that in the intervention group, most pregnant women's preparedness was categorized as fair before the education and high after the education. Meanwhile, in the control group, most pregnant women's preparedness remained in the fair category both before and after.

There was a significant difference in the preparedness of pregnant women in the intervention group to face an eruption of Mount Agung before and after the education ($P = 0.000$). Conversely, there was no significant difference in the preparedness of pregnant women in the control group ($P = 0.085$). Additionally, there was a significant difference between the groups ($p = 0.015$).

5. Discussion

This research aimed to determine the effectiveness of a disaster risk management model in increasing the preparedness of pregnant women facing an eruption of Mount Agung. Significant improvements were found in the preparedness of pregnant women to face the eruption before and after the educational intervention. These results are consistent with a study from Indonesia, which identified a relationship between training for residents and the level of community preparedness in facing eruptions (23). Similarly, a study from Japan found that educational programs were effective in promoting disaster preparedness behavior among pregnant women (24).

A previous scoping review highlighted that educational methods tailored to the targeted individual or community can increase their knowledge in facing

Table 2. Comparison of Pregnant Women' Preparedness Within and Between the Education and Control Groups

Groups and Pregnant Women's Preparedness	Pre (n = 100)	Post (n = 100)	Pre-post Test Within Group	Post-post Test Between Groups
Education			0.000	0.015
High	38 (38)	65 (65)		
Fair	55 (55)	35 (35)		
Low	7 (7)	0		
Control			0.083	
High	29 (29)	31 (31)		
Fair	66 (66)	65 (65)		
Low	5 (5)	4 (4)		

natural disasters (25). Another literature review found a link between knowledge and attitudes toward community preparedness for volcanic eruptions (26). An android-based educational game aimed at high school students' preparedness for the Merapi eruption demonstrated that educational games could enhance knowledge levels (27).

The research results indicated that the most common level of preparedness was categorized as fair. This outcome aligns with a previous study in Indonesia, where the general level of preparedness among residents of Srunen Hamlet (Disaster Prone Areas Level 3) facing an eruption was also categorized as fair (23). Moreover, there was an increase in the preparedness of pregnant women after the educational intervention. The study from Japan corroborates this finding, showing that pregnant women's knowledge was fair before the intervention and increased to high afterwards (24). This improvement could be attributed to the dissemination of information by health officials about disaster preparedness for the eruption of Mount Agung. Although people are informed about how to handle disasters, not everyone is ready to face them or adapt to post-disaster conditions (4). After a disaster, some individuals may experience symptoms such as excessive fear and anxiety (11).

According to researchers, several factors contribute to community preparedness when facing eruptions, including the experience and information about disasters that respondents have received (15). Various interpersonal factors such as employment, economic status, disaster experience, anxiety, knowledge of disaster preparedness, and community resilience also influence community preparedness to face disasters (28).

The disaster risk management paradigm incorporates three elements: Disaster threat, vulnerability, and capability (29). Threats are identified by observing volcanoes and mapping disaster-prone areas. Vulnerability reduction is achieved through establishing adequate evacuation routes. Meanwhile, community capabilities are strengthened through education and training.

The results of this study are in line with research conducted in Iran, which found that disaster education is a functional, operational, and cost-effective tool for risk management (5). While there are various methods for educating vulnerable groups, including women, no single method is superior (5). Women have shown significant interest in receiving education and preparing for emergencies and disasters. Providing disaster education to women can enhance awareness and preparedness among all family members (5, 30, 31).

This research was limited by the fact that different village midwives provided instruction in six villages, potentially leading to inconsistencies in the training. Although participants were provided with booklets during their education, variations in the communication skills of health practitioners might have influenced the results. The measurement of preparedness was conducted only once after the intervention, which does not allow for the evaluation of its long-term efficacy. Additionally, the study was conducted in two public health work areas near Mount Agung, which means the findings cannot be generalized to all pregnant women living near volcanoes; thus, further research is required.

This study offers several advantages because most preparedness research has focused on the general public or schools, whereas this study targeted a vulnerable population—pregnant women. It utilized

class-based disaster risk management specifically designed for pregnant women. Public health programs have consistently run class programs for pregnant women, enabling this study to be integrated seamlessly. These programs typically encompass care for pregnant women, mothers during and after delivery, and babies. Classes for pregnant women can also include preparations for volcanic eruptions, particularly for those residing near volcanoes.

Additionally, other areas near Mount Agung could benefit from health education for pregnant mothers. An online application featuring a readiness questionnaire, instructive videos, and pamphlets is also necessary. This app could monitor pregnant women's preparedness for eruptions through online assessments. By accessing the app multiple times, mothers can obtain clearer information and achieve greater preparedness.

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Footnotes

Authors' Contribution: Study concept and design: Nengah Runiari, and I Dewa Made Ruspawan; acquisition of data: Nengah Runiari, and I Wayan Candra; analysis and interpretation of data: I Dewa Made Ruspawan, and Ni Nyoman Hartati; drafting of the manuscript: Ni Made Wedri, and I Gede Juanamasta; critical revision of the manuscript for important intellectual content: I Gede Juanamasta, and Yupin Aungsuroch; statistical analysis: Ni Nyoman Hartati, and Ni Made Wedri; administrative, technical, and material support: Nengah Runiari, and I Wayan Candra; study supervision: Nengah Runiari, and I Dewa Made Ruspawan.

Conflict of Interests Statement: The authors declare no conflicts of interest.

Data Availability: The dataset presented in the study is available on request from the corresponding author during submission or after publication. The data are not publicly available due to funding requirements.

Ethical Approval: Ethical approval was obtained from the Health Research Ethics Committee of the Health Polytechnic of the Ministry of Health of Denpasar (No LB.02.03/EA/KEPK/0451 /2022).

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Informed Consent: Before data collection, written informed consent was obtained from respondents.

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