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Innovation Article

Development and evaluation of an Android-based application to enhance disaster preparedness among maternal populations

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A B S T R A C T

Background: Natural disasters pose significant risks to vulnerable populations, particularly pregnant, postpartum, and breastfeeding women, who face increased health and safety challenges during emergencies. Strengthening disaster preparedness through accessible educational strategies is essential to improve resilience and reduce adverse outcomes.

Objective: This study aimed to develop and evaluate an Android-based application as an educational tool to enhance disaster preparedness among maternal populations.

Methods: This study employed a Research and Development (R&D) approach based on the Borg and Gall model, followed by feasibility and effectiveness evaluation. Data were collected through interviews, validation assessments, and structured questionnaires. The application was tested among pregnant, postpartum, and breastfeeding women using a pretest–posttest design to assess changes in disaster preparedness knowledge.

Results: The developed application, named “Ibu Siaga Bencana,” demonstrated high content and media validity. Preliminary testing showed good usability and practicality. Effectiveness evaluation indicated a 40% increase in participants' disaster preparedness knowledge following application use, suggesting a substantial improvement in understanding.

Conclusion: The application is a feasible and effective educational tool for improving disaster preparedness among maternal populations. Further studies with larger samples and more rigorous designs are needed to confirm its effectiveness and long-term impact.

INTRODUCTION

Indonesia is widely recognized as one of the most disaster-prone countries in the world due to its complex geographical, geological, hydrological, and demographic characteristics. West Sumatera, in particular, is a high-risk province where hydrometeorological and geomorphological hazards frequently occur.[1] Disasters generate multidimensional consequences, including mortality, injury, displacement, economic loss, and long-term social vulnerability.[2,3] In reproductive health settings, emergencies increase the risks of sexual violence, sexually transmitted infections, unintended pregnancies, and mortality.[4,5] Natural disasters also create stressors that affect pregnant women, increasing susceptibility to complications such as preterm birth, low birth weight, cesarean delivery, neonatal abnormalities, and maternal and infant mortality.[6]

Empirical evidence indicates that health service delivery during disasters is often insufficient.[7,8] For example, a Rapid Health Assessment conducted after the 2006 Bantul earthquake revealed substantial nutritional deficiencies among children under five and pregnant women, as well as a significant number of postpartum mothers still requiring essential healthcare services.[9] These findings highlight systemic gaps in preparedness and response mechanisms, particularly in maternal and child health services.

Maternal populations, including pregnant, postpartum, and breastfeeding women, are particularly vulnerable in disaster situations. Despite various initiatives aimed at strengthening preparedness among healthcare providers

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and the general population, readiness to deliver maternal and child health services during disasters remains suboptimal. Previous studies reported that 52.1% of midwives were inadequately prepared to respond to earthquake and tsunami events, and 49.9% lacked sufficient knowledge of disaster preparedness competencies.[10,11] At the household level, maternal populations also demonstrate limited knowledge and readiness.[12,13]

Several studies have developed educational media to improve disaster preparedness. Conventional tools, such as leaflets, handouts, and checklists, have been shown to improve family preparedness.[14] However, these approaches may be limited in terms of accessibility, scalability, and sustainability. In contrast, application-based health education platforms offer advantages including accessibility, adaptability, and long-term usability.[15] Previous studies have shown that Android-based applications can enhance health knowledge and preparedness in various populations.[16] Nevertheless, application-based interventions specifically tailored to maternal populations remain limited and insufficiently adapted to their unique needs.[17,18] This study addresses this gap by developing and evaluating an Android-based educational application to improve disaster preparedness among pregnant, postpartum, and breastfeeding women.

METHOD

Study Design

This study employed a Research and Development (R&D) design based on the Borg and Gall model to develop and evaluate an Android-based application to enhance disaster preparedness among maternal populations.[19,20]

Phase 1: Needs Analysis and Literature Review

A structured needs assessment was conducted through in-depth interviews with key stakeholders, including provincial and city health officers and maternal health program coordinators. A literature review was also performed to identify evidence-based practices in disaster preparedness for maternal populations. Findings were used to determine user needs and core application content.

Phase 2: Application Design and Development

Based on the analysis findings, an Android-based application was developed in collaboration with an information technology specialist. The application included educational content on disaster preparedness, maternal health risks, and emergency response strategies, with a user-friendly interface.

Phase 3: Content and Media Validation

Content and media validation were conducted by four experts. Content validity assessed relevance and accuracy, while media validation evaluated usability and design. All components met the predefined validity criteria.

Phase 4: Usability and Feasibility Testing

Preliminary testing was conducted among 12 participants using purposive sampling. Participants included pregnant, postpartum, and breastfeeding women who could use Android devices. Feedback was collected using structured questionnaires to assess usability and practicality.

Phase 5: Effectiveness Evaluation

Effectiveness was evaluated using a quasi-experimental design with a control group (application vs leaflet) and a one-group pretest–posttest design. A total of 30 participants were included in the comparative study, and 40 in the pre–post evaluation. Outcomes included knowledge and preparedness related to disaster response. Data were analyzed using descriptive and inferential statistics. Differences between groups were analyzed using the Mann–Whitney U test, while pre–post comparisons were analyzed using the paired t-test. A p-value < 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for this study was obtained from the Research Ethics Committee of the Medical Faculty, Andalas University (No. 116/UN.16.2/KEP-FK/2020). Informed consent was obtained from all participants, ensuring that they understood the study's objectives and voluntarily agreed to participate. Participant confidentiality and privacy were maintained throughout the research process.

RESULTS

Needs Assessment Findings

The needs assessment identified several key gaps in maternal disaster preparedness. First, disaster preparedness programs for healthcare personnel were available but lacked continuity and systematic implementation. Second, no targeted preparedness programs were specifically designed for pregnant, postpartum, and breastfeeding women. Third, maternal populations required comprehensive preparedness strategies covering pre-disaster, response, and post-disaster phases.

During the pre-disaster phase, participants emphasized the importance of preparing essential supplies, including food, water, hygiene items, and medications. During disaster response, the need for clear evacuation routes and assembly points was highlighted. In the post-disaster phase, continuity of maternal healthcare and medical assessment were considered critical. These findings informed the core content and structure of the application.

Application Development

Based on these findings, an Android-based application named "Ibu Siaga Bencana" was developed as a digital educational tool to enhance disaster preparedness among maternal populations. The application integrates disaster preparedness guidelines across pre-disaster, response, and recovery phases, with a focus on maternal health

needs. Key features of the application are presented in Figure 1.

Content Validity and Usability

Content and media validation showed that the application achieved content validity of 82% and media validity of 89%, indicating that it was valid and appropriate for use. Preliminary usability testing with 12 participants showed that 83.3% of users found the application practical. However, 50% of participants reported that visual elements needed improvement, and 33.3% indicated that the workflow was suboptimal. These findings informed revisions to enhance visual design and user interaction. Following the revision, improvements included integrating animated educational videos and enhancing the interface design to improve user engagement.

Effectiveness Evaluation

In the quasi-experimental evaluation, participants who used the application demonstrated greater improvements in disaster preparedness knowledge than those who received leaflet-based education. Further operational testing among 40 participants, using a pretest–posttest design, showed a 40% increase in knowledge after application use, indicating a substantial improvement in understanding of disaster preparedness among maternal populations.

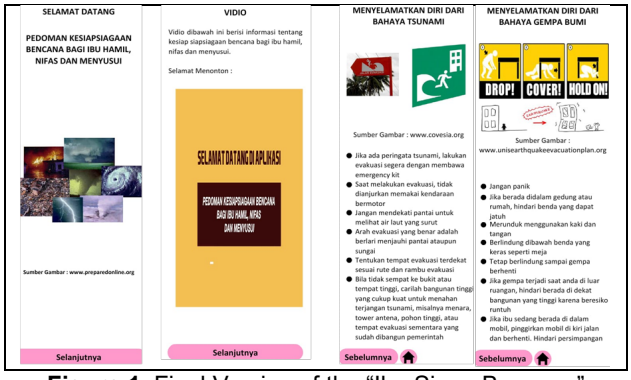

Figure 1. Final Version of the "Ibu Siaga Bencana" Application Interface

DISCUSSION

This study developed and evaluated an Android-based application to improve disaster preparedness among pregnant, postpartum, and breastfeeding women. The findings demonstrated that the application significantly improved disaster preparedness knowledge, with a 40% increase observed following its use. These results suggest that mobile-based educational interventions can play an important role in strengthening preparedness among vulnerable maternal populations.

The observed improvement in knowledge may be attributed to the integration of structured educational content, visual media, and interactive features within the application. Compared with conventional educational approaches, such as printed leaflets, digital applications provide more flexible and engaging learning experiences. The ability to access information repeatedly and at any time may enhance comprehension and knowledge retention, particularly in emergency preparedness contexts.[14,15]

These findings are consistent with previous studies demonstrating the effectiveness of mobile health (mHealth) interventions in improving knowledge and preparedness.[21,22] Prior research has also shown that Android-based applications can significantly enhance knowledge in various health domains, including reproductive health and disaster preparedness.[16,23] Similar improvements have been reported among vulnerable populations, such as individuals with disabilities, indicating the adaptability of mobile-based education across different user groups.[18]

In the context of disaster preparedness, mobile applications offer several advantages, including accessibility, scalability, and interactivity.[24,25] In countries such as Indonesia, where smartphone usage is widespread, Android-based platforms provide a practical and efficient means of delivering health education.[26] These tools enable users to access critical information in real time, which is particularly important in disaster-prone areas.

From a maternal health perspective, improving disaster preparedness is essential due to the increased vulnerability of pregnant, postpartum, and breastfeeding women during emergencies.[6,27] The application developed in this study addresses this need by providing targeted, phase-based guidance covering pre-disaster, response, and recovery stages. This structured approach may help users better understand risks and appropriate actions, thereby enhancing overall preparedness and resilience.

This study also highlights the potential of digital health tools to support healthcare providers. The application can serve as an educational aid for midwives and other health professionals in delivering standardized disaster preparedness information to maternal populations, thereby improving consistency and reach of health education.However, several limitations should be considered. The sample size was relatively small, and the study design lacked randomization, which may limit the generalizability of the findings. In addition, the study focused on short-term knowledge outcomes and did not assess long-term retention or behavioral changes. Future studies should employ randomized controlled designs, include larger and more diverse populations, and evaluate long-term outcomes, including actual preparedness behavior and disaster response readiness.

CONCLUSIONS AND RECOMMENDATION

This study demonstrates that the developed Android-based application can improve disaster preparedness knowledge among pregnant, postpartum, and breastfeeding women. The application shows potential as a feasible digital educational tool to support disaster preparedness in maternal populations. Future studies with larger sample sizes, more rigorous study designs, and longer follow-up

periods are needed to confirm its effectiveness and evaluate its impact on long-term preparedness and behavioral outcomes.

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