

Review Article

A Systematic Review on an Optimal Dose of Disaster Preparedness Intervention Utilizing Health Belief Model Theory

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ABSTRACT

Disaster preparedness is an issue that receives little attention in the community. Communities must take preventative measures to overcome obstacles and improve community preparedness. This review identifies the optimal dose of disaster preparedness intervention in the community. A systematic literature search was conducted to examine a study about the optimal dose of disaster preparedness intervention developed for implementation at a community level. A scoping review based on the PRISMA diagram was conducted from four databases. A combination of keywords was adapted for each database. Inclusion and exclusion criteria were applied. A total of eight articles were

synthesized based on the intervention dose of disaster preparedness among community interventions. The summarized studies provided evidence that the optimal dose for disaster preparedness intervention in the community can be prevented with an educational intervention program with a minimal dosage of intervention. The Health Belief Model Theory was the most often cited theory by researchers. The best dose for disaster preparedness intervention in a community can be mitigated with a single dose of education. Nonetheless, we cannot

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disregard alternative disaster preparedness theories because each has its advantages and disadvantages.

Keywords: Community, disaster preparedness, flood, health belief model, health education, intervention, optimal dose, theory

BACKGROUND

Three hundred thirty-five natural disasters struck 95.6 million people in 2017, killing up to 9,697 and causing \$335 billion in damage. With 44% of all disastrous occurrences, 58% of deaths, and 70% of persons affected by events worldwide, Asia is the most disastrous continent for disasters like floods and storms. For example, between 1998 and August 2018, a period of two decades, Malaysia was hit by 51 natural disasters (MERCY Malaysia, 2019). During that time, 281 people perished, almost 3 million people were harmed, and approximately \$2 billion worth of damage was caused (MERCY Malaysia, 2019). A disaster is an occurrence that occurs when a significant number of people are exposed to hazards to which they are vulnerable, resulting in injury and death, as well as property destruction. According to United Nations Office for Disaster Risk Reduction research, China had the most catastrophes with 286 from 2005 to 2014, followed by the United States with 212 and the Philippines with 181 disasters (United Nations, 2015).

Problem Statement

One of the crucial decisions investigators must make when creating a behavioral intervention is selecting the best dose of the intervention in terms of duration, frequency, and volume (Voils et al., 2014). According to interventional researchers, optimizing prospective behavioral intervention theories is a good goal. Alternatively, the researcher must consider how the improved intervention will promote public health by reaching more people and providing more significant and long-term benefits to those who receive it. Optimized interventions also contribute to the body of knowledge by producing meaningful studies with higher statistical power to discover the true treatment effect. Although there is no commonly agreed process for optimizing intervention and delivery, investigating individual and component operations rather than the entire requires an efficient and scientific method (Voils et al., 2014). As a result, if this intervention proves beneficial, it will help improve the community's current disaster readiness.

Significance of Study

The optimal dose for multiple behavior treatments considerably impacts public health more than single-behavior interventions. The comparison of theories and substantial behavior studies, on the other hand, creates several additional issues. Among these are

adopting standard measures across behaviors, enhancing treatment fidelity, and finding novel strategies to promote recruitment and retention, particularly among diverse groups. In addition, it may improve behavioral change measurement and assessment and expand the reach and translation of practical intervention approaches (Nigg et al., 2002). As a result, to scientifically improve the influence of the outcome, it is necessary to establish the ideal dose in the behavioral intervention study. Individuals, health care providers, and the government rarely address disaster preparations in the community until issues develop. The community is ignorant that vulnerable people, such as women, children, and the elderly, require special consideration in disaster planning (Luna, 2001).

MATERIALS AND METHODS

The systematic review was conducted by searching available electronic databases and published research and review bibliographies. First, the databases were thoroughly searched, beginning with generic terms to identify relevant search terms. The PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) acronym stands for “Preferred Reporting Items for Systematic Review and Meta-Analysis” (Schulz et al., 2010).

Data Extraction and Quality Assessment

This systematic review used PubMed, Science Direct, Medline, and CINAHL databases. In addition, a comprehensive literature search was conducted systematically through an electronic database; PubMed, Ovid, ScienceDirect and Scopus. The articles reported for the past ten years were searched with the terms: “disaster preparedness,” “disaster preparedness intervention theory,” “disaster preparedness,” and “theory.” Boolean operator combined these exact phrases “and.” The literature searched was limited to articles and reports in the English language.

The study titles were initially screened, and the abstracts were analyzed to determine their relevance to this systematic review. The full text of the articles was then obtained, and only the studies that met the inclusion and exclusion criteria were chosen. The study’s population was a community. The respondents were divided into two groups: those who received the intervention and those who did not. The outcome was those who had increased their level of disaster preparedness. The systematic review included only experimental studies, randomized control trials (RCT) or quasi-experiments.

Inclusion and Exclusion Criteria

The systematic review used English full-text availability and was conducted among the community as inclusion criteria. Exclusion criteria included duplication of studies or studies

conducted among different groups. In addition, the author names, titles, and sample sizes of duplicate publications were compared. The details extracted include the author's name, the year of publication, and the research's location. Other information includes publication details (trial, acronym, enrollment period, year of publication), study design, sample size, inclusion and exclusion criteria, intervention used, and study outcome. Any disagreements among the reviewers were settled by consensus.

Search Result and Study Description

After removing duplicated studies, the electronic search strategy yielded 60 articles. Following a review of the title and abstract, twenty articles were removed. Twenty articles were obtained and reviewed for eligibility. After reviewing full articles, 15 articles that met the inclusion and exclusion criteria were reviewed for secondary screening. Eight articles were included in the systematic review after full articles were reviewed depicted in Figure 1. Seven papers were excluded due to duplicates, non-randomized studies, inappropriate control groups, and outcomes. The lack of quantitative evidence from local studies was a major issue due to the limited availability of databases with a wide scope.

RESULTS

After reviewing the complete text, more than 60 results were returned, eight relevant to this study. Next, the principal researcher reviewed all the full text to ensure its relevance,

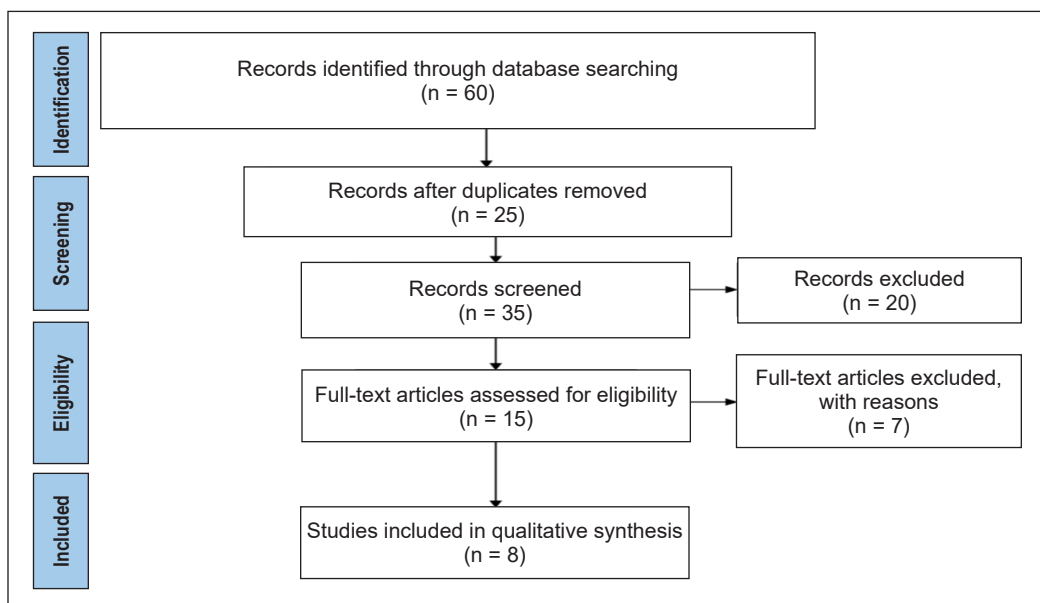


Figure 1. PRISMA Diagram of article reviews for the Optimal Dose of Disaster Preparedness Intervention Utilising Health Belief Model Theory

Source: Moher et al. (2009). For more information, visit www.prisma-statement.org.

Table 1
Dose and theory intervention of disaster preparedness

No.	Authors	Type of Study	Intervention's implementation, duration, follow-ups, and delivery	Theory	Intervention Dose	Results, Attrition rates, Intervention vs. Control
1	(Ardalan et al., 2013)	RCT	A controlled community intervention (health education) trial with pre-and post-assessments was conducted in 2011 in 3 provinces of Iran. In each province, two areas were chosen and randomly selected as an intervention or control group.	Community risk perception changes (Health Belief Model Theory)	One dose of intervention and post-assessment have given after three months of intervention. The total study duration of 6 months.	There were relative changes in awareness in intervention and control areas $p < 0.01$. Relative changes for readiness scores were 5.52 in intervention areas and 0.56 in control areas ($P < 0.01$). The result was significantly correlated with a community's baseline risk perception and previous experience with natural disasters ($P < 0.01$).
2	(Ebi & Semenza, 2008)	RCT	Divided into urban intervention and rural intervention.	Community-based adaptation (Health believes model)	One dose of intervention but not mentioned duration post-assessment and the study duration.	Improvements in mental health ($p=0.03$), a greater sense of community ($p < 0.01$), expansion of social interactions ($p=0.06$), and total growth of social capital ($p=0.01$) were all significant differences in the urban intervention.
3	(Ardalan et al. 2010)	RCT	Fifteen intervention villages and 16 control villages in Golestan province of Iran.	Health belief model (for perception component)	One dose of intervention and post-assessment have given after three months of intervention. 6-month study duration.	The adjusted odds ratio for participation in an evacuation drill in the intervention area in post-assessment compared with pre-assessment was 29.05 (95% confidence interval [CI]: 21.77-38.76), whereas in the control area, it was 2.69 (95% CI: 1.96-3.70) with $p < 0.01$.

Table 1 (continue)

No.	Authors	Type of Study	Intervention's implementation, duration, follow-ups, and delivery	Theory	Intervention Dose	Results, Attrition rates, Intervention vs. Control
4	(Pesiridis et al., 2015)	RCT	Two hundred seven hospital-based nurses were randomly assigned into intervention ($n = 112$) and original control ($n = 95$) groups.	Knowledge, Attitudes and Practices Theory	One dose of intervention and post-assessment was given immediately after training and six months later 6 month, the study duration.	The intervention increased nurses' knowledge and self-confidence but had no significant effect on behavioral intentions. The mean knowledge score increased significantly in both groups at times two and three as compared to time one [pre-test: 6.43 (2.8); post-test: 16.49 (1.7); follow-up test: 13.5 (2.8)], ($P < 0.002$). Between the intervention and control groups, changes in knowledge were significantly different ($P < 0.001$) and had a large effect size (eta-squared = 0.8). The overall model shows a moderate degree of significance [$F(9177) = 6$, $P < 0.000$, adjusted $r^2 = 0.23$] for changes in decision-making for the communication plan. Findings for changes in decision-making stages for disaster supplies are barely significant. The only significant predictor has perceived self-efficacy, with a marginal P-value.
5	(Glik et al., 2014)	RCT	Between 2006 and 2007, the study was done in Los Angeles in a low-income neighborhood with a high concentration of Latino residents. Only one adult per family was eligible, and 242 respondents were recruited in the initial sample. Once enrolled in the study, each participant was randomized to a block of six to ten persons depending on their zip code. A computer-generated random number determined which arm of the experiment they were randomly assigned to.	Precaution adoption process model	One dose of intervention and a questionnaire gave after three months of intervention. 6-month intervention.	

Table 1 (continue)

No.	Authors	Type of Study	Intervention's implementation, duration, follow-ups, and delivery	Theory	Intervention Dose	Results, Attrition rates, Intervention vs. Control
6	(Eisenman et al., 2009a)	RCT	This study was a community-based, randomized, longitudinal cohort design with two groups. Assessments were made at baseline and three months.	Health belief model (for perception component)	Two doses of intervention with pre-assessment at baseline, three months, and post-assessment at 6-month after the intervention. A total of 9-month study duration.	There was a significantly different before and after intervention through media education ($p < 0.01$).
7	(Thomas et al., 2018)	RCT	Two hundred eight respondents were included in this study, embarking on preparedness interventions that optimize the potential for individuals to adopt preparedness behavior.	Health believes model	Two doses of intervention with pre-assessment at baseline, three months, and post-assessment at 6-month after the intervention. A total of 9-month study duration.	Results suggest that the intervention was effective in improving participants' household disaster preparedness knowledge ($P < 0.01$), attitudes ($P < 0.01$), and community resiliency.
8	(James, et al., 2019)	RCT	The research included 480 randomly selected community members drawn from three disaster-affected communities. Randomize allocation to the control and intervention groups.	Community-based intervention with mental health intervention using a theoretical model (HBM)	Three doses of intervention with pre-assessment at baseline, three months, and post-assessment at 3-month after the last intervention. A total of 9-month study duration.	The intervention increased disaster preparedness, reduced symptoms associated with depression, post-traumatic stress disorder, anxiety, and functional impairment, and increased peer-based help-giving and help-seeking.

including bibliographic references and conducted critical author and grey literature searches. It proved an effective complementary approach to the original review, and the search was reverted to the original. This method resulted in a total of eight relevant full-text results. Table 1 summarizes the intervention dose for a health education-based intervention for disaster preparedness. Most studies were randomized controlled trials.

DISCUSSION

Assessment Gap

Five of the eight articles used intervention only once during the study, two used interventions twice, and one used them extensively. As a result, most studies used a single intervention that lasted six months and was carried out concurrently. Most results are similar to the findings of the article study in Iran. The four research projects involved in the study included three provinces in Iran and analysis of urban and rural areas in countries such as the United States. The study was carried out in a remote city in Golestan, and the study was carried out in Los Angeles (Ardalan et al., 2010; Ebi & Semenza, 2008; Glik et al., 2014). All four of these studies found that there was still a significant level change for the researcher's items three months after the intervention.

Moreover, a similar intervention dose was studied with a six-month assessment gap showed a significant change immediately after the study and six months later. Finally, it demonstrated that an intervention dose with a study gap of six to nine months still shows significant changes in items measured compared to the study's control sample (Bostick et al., 2017; Pesiridis et al., 2015).

Theories

All five articles from a single dose intervention concerning disaster preparedness at the community level apply specific theories. Of the five articles, three used HBM theory, one used the precaution adoption process model, and one used the Theoretical model for KAP theory. Most articles use HBM theory to plan disaster intervention using a single intervention dose in the community. Among the articles that used HBM theory is the Republic of Iran, which used six months of intervention by developing intervention modules based on HBM theory. The research has found that community preparedness was highly significant before and after six months of the intervention program, with $p < 0.01$ for each component in the intervention module (Ardalan et al., 2010).

Intervention Dose

Two separate studies on two doses of intervention, one conducted on Latinos in Los Angeles and another on homemakers in the United States, lasted nine months (Chandler

et al., 2016; Eisenman et al., 2009). These studies were evaluated three to six months after the intervention, and both showed significant changes in the assessed things. As a result, even though the studies were conducted in two different locations, the differences measured revealed significant differences.

Furthermore, two doses of intervention were carried out for research in a Los Angeles community with 231 participants via social media and small group discussion. The study used the perceived concept from the HBM component. The small group discussion intervention based on HBM theory significantly improved disaster preparedness more than the social media arm (Eisenman et al., 2009). In other research, such as in Atlanta, an intervention involving the community and civil service exhibited a significant improvement in disaster preparedness after applying module and intervention components based on HBM theory with two doses of intervention (Thomas et al., 2018). Other studies, such as one conducted in Atlanta, which involved the community and civil service, revealed a significant improvement in disaster preparedness after implementing a module and intervention component based on HBM theory with two doses of intervention.

In addition, a study in Haiti explains three doses of interventions using the Health Belief Model Theory, with an assessment three months after the intervention. This study found that there were significant changes in the variables studied. As a result, if we look at all the interventions carried out, we can see that the intervention findings remained significant even though the dose varied. Furthermore, these articles demonstrated that even six months after the intervention, the assessment still revealed significant changes (Glik et al., 2014; James et al., 2019).

CONCLUSION

Each author or researcher provided evidence of a post-intervention assessment conducted within six months of the intervention. However, no author demonstrated or evaluated the intervention after one year, two years, or longer. As a result, the outcome may be unpredictable. Meanwhile, module characteristics and research location played a significant role in determining the estimated result because they influenced respondents' decision to use or not use the intervention. Nonetheless, most of the publications examined demonstrate that the authors' incorporated modules and components from HBM theory when developing modules and implementing the intervention.

Additionally, the investigation's findings indicate that all articles exhibited behavioral changes. It indicates that a single dose of disaster preparedness intervention can significantly alter an individual's behavior from unprepared to prepared. Nonetheless, we cannot dismiss alternative theories and methods for disaster preparedness because each has unique advantages and applicability in a community. The optimal dose for each intervention was generally irrelevant to the end result, whether one dose, two doses, or three doses or more.

Dose determination is difficult due to a lack of a dose framework and dose selection guidelines. Additional variables such as quantity, exposure, and engagement must be considered when assessing the effectiveness of subsequent interventions presented to the respondent. Community knowledge, skills, and preparedness significantly increased regardless of the methodology used. Thus, investigators should develop a strategy for assessing intervention quality prior to conducting research, which should include determining the number of intervention contacts and the duration of each contract.

Finally, this literature review demonstrates that research is being conducted to ascertain the optimal dose. It is well established that interventions focused on health education and utilizing HBM improve community knowledge, skills, and preparedness. A single treatment dose resulted in statistically significant changes in pre- and post-treatment periods. Future research may examine additional behavioral theories pertaining to community education interventions and their effectiveness. A complex program can be evaluated using the HBM theoretical framework. The determined intervention doses may be particularly advantageous in comparative trials. This information is valuable if a deviation from the protocol results in variation in outcomes both within and across treatment arms and trials using similar interventions.

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REFERENCES

- Ardalan, A., Naieni, K. H., Mahmoodi, M., Zanganeh, A. M., Keshtkar, A. A., Honarvar, M. R., & Kabir, M. J. (2010). Flash flood preparedness in Golestan province of Iran: A community intervention trial. *American Journal of Disaster Medicine*, 5(4), 197-214. <https://doi.org/10.5055/ajdm.2010.0025>
- Bostick, T. P., Holzer, T. H., & Sarkani, S. (2017). Enabling stakeholder involvement in coastal disaster resilience planning. *Risk Analysis*, 37(6), 1181-1200. <https://doi.org/10.1111/risa.12737>
- Chandler, T., Abramson, D. M., Panigrahi, B., Schlegelmilch, J., & Frye, N. (2016). Crisis decision-making during hurricane sandy: An analysis of established and emergent disaster response behaviors in the New York Metro Area. *Disaster Medicine and Public Health Preparedness*, 10(3), 436-442. <https://doi.org/10.1017/dmp.2016.68>
- Ebi, K. L., & Semenza, J. C. (2008). Community-based adaptation to the health impacts of climate change. *American Journal of Preventive Medicine*, 35(5), 501-507. <https://doi.org/10.1016/J.AMEPRE.2008.08.018>

- Eisenman, D. P., Glik, D., Gonzalez, L., Maranon, R., Zhou, Q., Tseng, C.H., & Asch, S. M. (2009). Improving Latino disaster preparedness using social networks. *American Journal of Preventive Medicine*, 37(6), 512-517. <https://doi.org/10.1016/J.AMEPRE.2009.07.022>
- Glik, D. C., Eisenman, D. P., Zhou, Q., Tseng, C. H., & Asch, S. M. (2014). Using the precaution adoption process model to describe a disaster preparedness intervention among low-income Latinos. *Health Education Research*, 29(2), 272-283. <https://doi.org/10.1093/her/cyt109>
- James, L. E., Welton-Mitchell, C., Noel, J. R., & James, A. S. (2019). Integrating mental health and disaster preparedness in intervention: A randomized controlled trial with earthquake and flood-affected communities in Haiti. *Psychological Medicine*, 50(2), 342-352. <https://doi.org/10.1017/S0033291719000163>
- Luna, E. M. (2001). Disaster mitigation and preparedness: The case of NGOs in the Philippines. *Disasters*, 25(3), 216-226. <https://doi.org/10.1111/1467-7717.00173>
- MERCY Malaysia. (2019). *Malaysia: Disaster management reference handbook (June 2019) Malaysia*. ReliefWeb. <https://reliefweb.int/report/malaysia/malaysia-disaster-management-reference-handbook-june-2019>
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med* 6(7): e100097. doi:10.1371/journal.pmed100097
- Nigg, C. R., Allegrante, J. P., & Ory, M. (2002). Theory-comparison and multiple-behavior research: Common themes advancing health behavior research. *Health Education Research*, 17(5), 670-679. <https://doi.org/10.1093/her/17.5.670>
- Pesiridis, T., Sourtzi, P., Galanis, P., & Kalokairinou, A. (2015). Development, implementation and evaluation of a disaster training programme for nurses: A switching replications randomized controlled trial. *Nurse Education in Practice*, 15(1), 63-67. <https://doi.org/10.1016/J.NEPR.2014.02.001>
- Schulz, K. F., Altman, D. G., & Moher, D. (2010). CONSORT 2010 statement: Updated guidelines for reporting parallel group randomized trials. *Annals of Internal Medicine*, 152(11), 726-732. <https://doi.org/10.7326/0003-4819-152-11-201006010-00232>
- Thomas, T. N., Sobelson, R. K., Wigington, C. J., Davis, A. L., Harp, V. H., Leander-Griffith, M., & Cioffi, J. P. (2018). Applying Instructional design strategies and behavior theory to household disaster preparedness training. *Journal of Public Health Management and Practice*, 24(1), e16-e25. <https://doi.org/10.1097/PHH.0000000000000511>
- United Nations. (July 29, 2015). *World population projected to reach 9.7 billion by 2050*. United Nations Department of Economic and Social Affairs. <http://www.un.org/en/development/desa/news/population/2015-report.html>
- Voils, C. I., King, H. A., Maciejewski, M. L., Allen, K. D., Yancy, W. S., & Shaffer, J. A. (2014). Approaches for informing optimal dose of behavioral interventions. *Annals of Behavioral Medicine*, 48(3), 392-401. <https://doi.org/10.1007/s12160-014-9618-7>

