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Original Article

School-Based Program for Improving Disaster Preparedness among Indonesian Adolescents in Earthquake Risk Area: A Randomized Control Trial

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Abstract

Background: Indonesia is known as the home of disasters and this condition threatens the safety of the Indonesian people. Strengthening community capacity is still not optimal and school-based programs need to be carried out to prepare the younger generation to face earthquakes. This study aimed to analyze the effect of the school-based program on improving disaster preparedness (SBPIDP) among Indonesian adolescents in the earthquake risk area.

Methods: A randomized control trial was performed among 140 (INT=70; CON=70) adolescents in Indonesia in 2022. The SBPIDP lasted for 10 wk providing eight sessions of education and training activities. Data collection tools included a three-part questionnaire that consisted of demographics, knowledge, and self-efficacy for earthquake preparedness. The inter-group and intra-group differences were evaluated using paired t-test analysis, and analysis of variance (ANOVA) used to assess intervention effectiveness.

Results: There were significant differences in disaster preparedness among adolescents after the SBPIDP program was implemented after follow-up in the 10th week (knowledge (P=0.001) and self-efficacy (P=0.001)). The intervention group showed better preparedness than the control group during the follow-up period.

Conclusion: The SBPIDP program can significantly improve disaster preparedness among Indonesian adolescents in earthquake-risk areas.

Keywords: School-based program; Disaster; Earthquake; Indonesia; Adolescents

Introduction

Across the globe, disasters stand out as some of the most pressing challenges encountered by all nations. In recent years, there has been a noticeable worldwide increase in fatalities, injuries, and economic losses from these events (1). Earthquakes have become a major concern of natural disasters since a great number of earthquakes occur yearly across the globe. The effect of an earthquake could be extremely destructive and the level of damage damages correlating to its magnitude (2). Asia ranks among the most active seismic areas globally. The interaction between

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the Indonesian archipelago and the Australian plate represents a significant epicenter for earthquakes in this region which makes Indonesia one of the most disaster-prone nations (2,3). Based on statistical data from the National Disaster Management Agency in Indonesia, the incidence of earthquakes from 2017 to 2021 was recorded to have increased. The rate of earthquakes in Indonesia is the highest in the world with a ratio of 10 times that of the movement of the earth's plates in America (4).

A comprehensive approach to disaster preparedness and injury prevention is essential not only to minimize potential losses but also to enhance resilience in the face of earthquakes (5). The disaster management cycle encompasses four key stages: mitigation, preparedness, response, and recovery. Among these phases, preparedness assumes paramount significance within the disaster management framework (6). Effective preparedness and coping strategies rely heavily on the availability and accessibility of essential knowledge, skills, and resources, such as household emergency plans, stored provisions, local rescue collaboration skills, and self-sufficiency. Consequently, disaster impact mitigation requires implementing safety measures at personal, community, and structural levels (7).

Despite these needs, Indonesian adolescents generally lack adequate awareness and knowledge about disaster preparedness in Indonesia (8-10). Although disaster education programs have been introduced in schools, their implementation remains suboptimal (11). This limitation is particularly concerning for adolescents residing in earthquake-prone areas, as insufficient disaster knowledge and skills can leave them feeling unprepared and vulnerable in the face of such events (12). Therefore, improving the quality and reach of school-based disaster education programs is essential to better prepare Indonesian adolescents for the threat of natural disasters, particularly earthquakes (13).

Higher education institutions must adapt to the changing job market by constantly updating knowledge and teaching, with a focus on disaster management. Increased autonomy in college comes with increased responsibility, particularly in emergency preparedness (14). Adolescents can actively assist in catastrophe response. However, crises can impair their schooling and life skill development, resulting in missed opportunities that may never be retrieved. Young individuals recognize the long-term consequences of these interruptions (15). Preparing pupils for disasters extends beyond teaching them how to survive local earthquakes. It entails training people on how to prevent and forecast earthquakes. Schools are especially vulnerable, therefore improving student readiness is critical.

We aimed to improve disaster preparedness among Indonesian adolescents through school-based programs.

Materials and Methods

Design

This study was a randomized control trial (RCT) based on school-based program interventions. We conducted this research at 2 state high schools in Indonesia (SMKN 1 Jember and SMA N 2 Jember).

Participants

The study population consisted of first-year high school students in an earthquake-risk area in Jember, Indonesia, in 2022. The required sample size was calculated using G*Power software, employing a t-test for two independent means. The parameters used included a medium effect size (Cohen's d = 0.5), an alpha level of 0.05, and a statistical power of 0.80. Using the formula:

$n = (2(Z_{\alpha/2} + Z_{\beta})^2) / d^2$

$Z_{\alpha/2}$ corresponds to the critical value at the 0.05 significance level (1.96 for a two-tailed test), Z_{β} corresponds to the desired power (0.84 for 80% power), and d represents the effect size, a total sample size of 128 students was obtained. To account for potential dropouts, we increased the sample by 10%, resulting in 140 students. These were equally divided into two groups: Intervention Group (IG) and Control group (CG), with 70 students each. The initial characteristics of

students in both groups were similar. Inclusion criteria were: 1) first-year high school students, 2) owning an Android smartphone, 3) no prior disaster training, and 4) willingness to sign a consent form. Some participants withdrew for health and personal reasons, leaving 66 in the IG and 65 in the CG as shown in the Fig. 1.

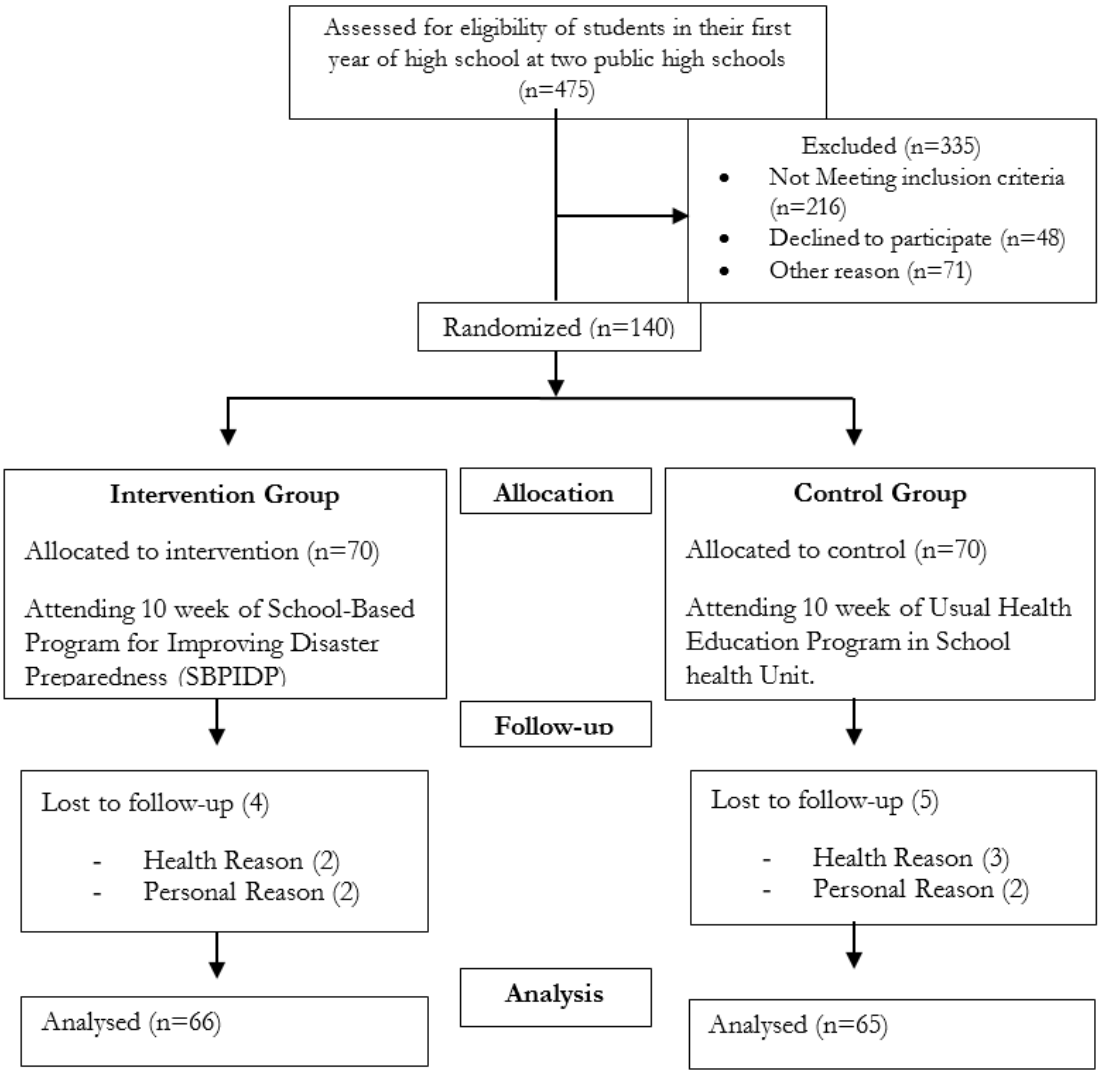

Fig. 1: Consort flow diagram for enrollment, allocation, and follow-up study participants

Intervention

This research followed three stages: preparation, implementation, and termination. In the preparation stage, the team developed media, informed consent, and questionnaires for participants. The media used was the "Remaja Siaga Gempa" App, a digital health education tool developed by professionals and tested for effectiveness. Version 0.0.1 of the app was designed in 2022, covering earthquake preparedness topics such as definition, causes, impact, scale, and preparedness before, during, and after evacuation (Fig. 2).

Fig. 2: The display of remaja siaga gempa application for adolescents in earthquake prone areas of indonesia

The intervention began with explaining research procedures and obtaining informed consent from participants. Once consent was given, participants returned the consent form. The SBPIDP intervention lasted 10 weeks in a school setting, with intervention in weeks 1-6 and follow-up in weeks 7-10. The intervention group received the SPIDP program to enhance earthquake preparedness, consisting of seven education and training sessions over six weeks (Table 1), while the

control group followed routine health procedures. Sessions were conducted in small groups of 10 participants. The intervention started with installing the "Remaja Siaga Gempa" app, followed by an explanation of its features and a step-by-step guided review within the allocated time.

Table 1: The Topic of Education and Training

Session	Topic	Objectives	Educational Time (minutes)
1	Definition and causes of earthquakes	Understand the fundamental concepts of earthquakes.	30
2	Impact of an Earthquake	Recognize the various impacts earthquakes.	40
3	Earthquake Scale	Grasp the concept of earthquake magnitude and its implications by exploring different levels on the Richter scale.	20
4	Preparedness before an earthquake occurs	Learn and implement proactive measures to secure homes and reduce potential hazards before an earthquake.	60
5	Preparedness during an earthquake	Develop the skills and knowledge necessary to respond effectively during an earthquake.	60
6	Preparedness in carrying out independent evacuation	Acquire the ability to independently and safely evacuate from a building or location during an earthquake.	60
7	Role Play of Earthquake Preparedness	Apply knowledge and skills in realistic scenarios through role-playing exercises.	90

This program is an individual intervention providing independent information on earthquakes and necessary preparations. Participants engage in active discussions using learning media. In week 6, they review the material and participate in role-playing, interacting with facilitators. Weeks 7-10 focus on independent learning, and in week 10, participants complete a post-test questionnaire.

Measurement

The outcome measure was assessed at pretest and post-test (week 10). The measurement instrument had two sections: (1) demographic data (age, gender, ethnicity, earthquake experience, information sources, and training history), and (2) two questionnaires: the Earthquake Disaster Preparedness Knowledge Questionnaire and the Self-Efficacy Questionnaire. The preparedness knowledge questionnaire comprised 27 multiple-choice questions based on the Earthquake Disaster Preparedness Guide by the Indonesian National Disaster Management Agency (16,17). It covered six indicators: 1) Definition and causes (2 items), 2) Impact (2 items), 3) Earthquake scale (2 items), 4) Preparedness before (7 items), 5) Preparedness during (7 items), and 6) Independent evacuation preparedness (7 items). Each correct answer scored 1, with a total possible score of 0–27. The validity test result was 0.250, and reliability was confirmed with Cronbach's Alpha 0.866 (>0.60). The General Self-Efficacy Scale (GSES)-12 (Indonesian version) measured farmers' self-efficacy (18). It included 12 items rated on a 4-point Likert scale: strongly agree (4 points), agree (3), almost agree (2), and disagree (1). The score range was 12–48.

Data analysis

Data analysis was performed using SPSS ver. 23 (IBM Corp., Armonk, NY, USA) after data collection, cleaning, and organization. Respondent characteristics (age, gender, ethnicity, earthquake-related information, experience, and training)

were described using mean ± standard deviation for numerical data and frequency distributions for categorical data. Data normality was tested with the Kolmogorov-Smirnov test. Group comparisons were analyzed using Fisher's exact test, chi-square test, and independent t-test. The dependent t-test assessed pre- and post-intervention changes within groups, while ANOVA evaluated the intervention's effectiveness by comparing mean differences.

Ethical considerations

This research was carried out after the Health Research Ethics Committee of the Faculty of Nursing, Jember University approved the research proposal number 088/UN25.1.14/KEPK/2022. This research has considered ethical feasibility as an important aspect of the research.

Results

Table 2 provides insights into the demographics and experiences of participants in a school-based disaster preparedness program for Indonesian adolescents. The mean ages for the control group (16.21±1.23) and intervention group (16.02±1.02) were similar, with minor variability.

Table 2: Baseline participant characteristics

Characteristic	Control Group (n=67)		Intervention Group (n=68)	
	n	%	n	%
Age (yr) (Mn±SD)	16,21	1,23	16,02	1,02
Gender				
Male	16	24,2	20	30,8
Female	50	75,8	45	69,2
Total	66	100	65	100
Religion				
Islam	66	100	65	100
Total	66	100	65	100
Ethnic group				
Javanese	21	31,8	29	42,6
Madurese	45	68,2	36	57,4
Total	66	100	65	100
Ever felt an earthquake				
None	0	0	0	0
<1 yr	56	84,9	60	92,3
>1 yr - < 5 yr	5	7,6	4	6,2
>5 yr	5	7,6	1	1,5
Total	66	100	65	100
Follow disaster news				
Often	15	22,7	11	16,9
Seldom	41	62,1	46	70,8
Never	10	15,2	8	12,3
Total	66	100	65	100
Source of earthquakes information				
Television				
Social Media	25	37,9	22	33,9
Close Friend	34	51,5	37	56,9
Family	1	1,5	2	3,1
Newspaper	0	0	1	1,5
Radio	6	9,0	1	1,5
Total	0	0	2	3,1
	66	100	65	100

Note: n refers to the actual number of responses to each team, % refers to percentage

Most participants were female, and all were Muslim. The ethnic distribution included primarily Javanese and Madurese participants. Most had experienced an earthquake in the past year, highlighting their vulnerability. Social media and television were the participants' primary sources of earthquake information.

The results of the SBPIDP program intervention in the group can be seen in Table 3 which shows that the IG group experienced a significant increase in knowledge of earthquake disaster preparedness after following up in the 10th week (18.21±3.41 to 24.51 ± 4.48, *P*= 0.001) and general self-efficacy (28.81±4.51 to 39.81±3.92, *P*<0.001). Meanwhile, the control group only showed insignificant changes in knowledge (18.33±3.02 to 17.89±3.44, *P*=0.089) and self-efficacy (27.93±3.99 to 29.46±5.67, *P*=0.052). The SBPIDP intervention program successfully increased the knowledge and self-efficacy of teenagers in the IG group regarding preparedness for earthquake disasters.

Table 3: Change in control and intervention group after 10 wk and Comparison of final adjusted mean according to group

Variables (Groups)	Baseline	Immediately (6th Week)	Follow Up (10th Week)	*P*-value[2]	Δ	CI (95%)	P-value[3]
Earthquake Disaster Preparedness Knowledge							
Intervention Group (IG)	18,21 ± 3,41	25,49 ± 2,41	24,51 ± 4,48	0,001*	6.30	4.98 ; 7.62	0,001*
Control Group (CG)	18,33 ± 3,02	18,43 ± 3,81	17,89 ± 3,44	0,089	-0.44	-1.51 ; 0.63	
p-value[1]	0,848	0,021*	0,001*				
General Self-Efficacy							
Intervention Group (IG)	28,81 ± 4,51	37,02 ± 5,71	39,81 ± 3,92	<0,001*	11.00	9.60 ; 12.40	0,001*
Control Group (CG)	27,93 ± 3,99	28,02 ± 5,02	29,46 ± 5,67	0,052	1.53	-0.09 ; 3.15	
p-value[1]	0,587	0,001*	0,001*				

Note: Mean±Standart Deviation; [1]Independent t-test; [2]Dependent t-test; [3]Repeated Measure ANOVA;
Δ = difference between Posttest and Pretest

Table 3 also illustrates the effectiveness of the school-based intervention over 10 wk. Regarding earthquake disaster preparedness knowledge, the intervention group showed a significant increase from baseline (18.21±3.41) to follow-up at week 10 (24.51±4.48). In contrast, the control group showed relatively smaller improvements from baseline (18.33±3.02) to follow-up (17.89±3.44). Similarly, general self-efficacy scores showed substantial improvement in the intervention group (28.81±4.51 to 39.81±3.92) compared with little change in the control group (27.93 ± 3.99 to 29.46 ± 5.67) at week 10. The Repeated Measures ANOVA test revealed the statistical significance of the changes in each group (*P*<0.05). School-based programs significantly improve earthquake preparedness knowledge and self-confidence among young people in high-risk locations.

Discussion

This study assessed Indonesian adolescents' preparedness perception in earthquake-prone areas before and after the SBPIDP disaster education program. The program effectively enhanced their knowledge and self-efficacy. Adolescents who participated showed better preparedness than those who did not (Table 3). Both groups started with similar knowledge levels, but significant differences appeared after the intervention. The SBPIDP program, incorporating the "Remaja Siaga Gempa" Android app, successfully utilized digital media to improve disaster preparedness.

Similar results were found in previous studies with comparable programs (13,19). The SBPIDP program utilized digital health technology with audiovisual media, including interactive seismic

demonstrations and Android-based materials, to help Indonesian adolescents visualize local risks. This dynamic approach enhances enthusiasm for independent learning (20-23). By integrating media, the SBPIDP program encourages adolescents to actively seek essential information and engage in self-directed learning (24). This training helps sustain earthquake preparedness knowledge. The second posttest at week ten matched the sixth-week posttest score, showing that the six-week SBPIDP program effectively retains knowledge. Application-based educational media, with audiovisual content, enables deeper processing and longer retention (25). Digital health education enhances cognitive stimulation and strengthens memory in disaster learning (26,27). The 6-week SBPIDP program uses independent learning with visual aids to teach preparedness. Audiovisual media optimizes sight and hearing, while movement-based media stimulates the brain, improving cognition and memory (28).

Richard Mayer's Multimedia Learning Theory (MMLT) states that combining audio and visual information enhances learning and retention (29). This aligns with the SBPIDP disaster education program, which uses audiovisual content to improve disaster preparedness. Similarly, Paivio's Dual Coding Theory supports this by highlighting two interconnected channels—verbal (words) and nonverbal (images). Processing both simultaneously improves understanding and memory (30), reinforcing the effectiveness of SBPIDP's audiovisual approach in enhancing preparedness knowledge and self-efficacy among adolescents. The SBPIDP program also encourages independent learning. Self-Determination Theory (SDT) explains that autonomy, competence, and social relatedness foster intrinsic motivation (31). Research shows that intrinsic and well-internalized extrinsic motivation predict positive learning outcomes across different contexts (32). The SBPIDP application supports this by allowing students to regulate their own learning, enhancing autonomy and competence.

This study also investigated the impact of the SBPIDP program on the self-efficacy of Indonesian adolescents. The self-efficacy of the intervention group increased significantly through the SBPIDP program. The SBPIDP program provides a more in-depth and engaging learning experience through application-based learning methods. In addition, the practical concept of self-directed learning gives adolescents greater control over their education, which increases their confidence in facing potential disasters (33). These results are also supported by previous studies showing that changes in self-efficacy in facing disasters can also occur in adolescents before and after a disaster education program is conducted (33,34).

Albert Bandura's Social Cognitive Theory (SCT) provides a powerful framework for understanding how these learning experiences can enhance students' self-efficacy. Bandura explains that symbolic modeling, which involves conveying experiences or behaviors through symbolic representations such as pictures or videos, can strengthen individuals' beliefs about their abilities (35, 36). The symbolic modeling and exposure of the application provide visual experiences and enhance self-confidence, which serve as sources of self-efficacy. Symbolic modeling allows users to imitate visual experiences to prepare for an earthquake. Symbolic exposure uses emotional cues to inspire courage and confidence in their ability to withstand an earthquake (37,38). Good self-efficacy tends to change a person's confidence in dealing with disaster situations appropriately (39).

The SBPIDP program effectively increases earthquake knowledge and preparedness among Indonesian youth. The SBPIDP program allows students to learn through a technology-based application that presents realistic disaster preparedness scenarios. This can facilitate lasting knowledge transfer, allowing students to apply their preparedness skills later in life, even after the program has completed. Technology in learning can improve long-term retention if the content is designed interactively and contextually (40). Through audiovisual content and interactive simulations, the SBPIDP application can help students remember lessons about preparedness

better, potentially forming more sustainable habits and preparedness.

Conclusion

The research results showed that the program SBPIDP effectively increased knowledge of earthquake disaster preparedness and general self-efficacy of adolescents in Indonesia earthquake-risk areas, compared to the control group. The program has the potential to be an effective strategy in increasing community preparedness for disasters in areas vulnerable to earthquakes based on the school program.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interests.

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