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# The Effect of Virtual Reality Simulation Training to Improve Disaster Preparedness for Cadre in Bandung West Java, Indonesia

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## ABSTRACT

**Background:** Despite improved governmental disaster management efforts, household preparedness remains insufficient, leaving communities vulnerable. Cadres are pivotal in promoting disaster preparedness at the grassroots level. Virtual Reality Simulation (VRS) offers novel approaches to improve training in disaster response by creating immersive, interactive environments that enhance skill acquisition. **Objective:** This study aims to assess the effectiveness of VRS training on improving disaster preparedness among Indonesian cadres, comparing outcomes with a control group receiving no such intervention. **Methods:** A quasi-experimental design with a control group and repeated measures was implemented in Bandung Regency, West Java. A total of 400 cadres participated, divided equally between the intervention group receiving VRS training and a control group. Disaster preparedness was measured using the Household Emergency Preparedness Scale (HEPS). Data analysis involved ANOVA and Generalised Estimating Equations (GEE) to compare preparedness scores across time points. **Results:** The intervention group demonstrated significant improvements in disaster preparedness scores post-intervention and at one-month follow-up ($p<0.001$), with a moderate effect size (Cohen's $d = 0.41$). The control group showed no significant change over time. GEE analysis confirmed a statistically significant increase in preparedness scores for the intervention group after controlling for baseline differences ($\beta = 10.2$, $p<0.001$). **Conclusion:** VRS training effectively enhances disaster preparedness among community health cadres by providing a scalable and immersive approach to improving disaster readiness. VR-based training presents a viable alternative to traditional methods, especially in resource-limited areas, with potential for widespread implementation in disaster-prone regions.

***Keywords: Community Health Workers; Disaster Preparedness; Quasi-Experimental Study; Virtual Reality Simulation***

## INTRODUCTION

Indonesia, situated within the Pacific Ring of Fire, is highly vulnerable to natural disasters such as earthquakes, tsunamis, and volcanic eruptions due to significant tectonic activity (BNPB, 2023). The country experienced 3,531 natural disasters in 2022 alone, with floods being the most prevalent (1,524 incidents), comprising 43.1% of total events (BNPB, 2023). Other significant occurrences included extreme weather events (1,062), landslides (634), and forest fires (252). These disasters, particularly concentrated in West, Central, and East Java, resulted in widespread displacement, over 850 fatalities, thousands of injuries, and extensive property damage, underlining the urgent need for effective disaster risk management.

As disaster-related losses worldwide continue to intensify, the importance of comprehensive disaster risk management has become increasingly evident, requiring not only government intervention but also robust community and household preparedness (Bogati & Gautam, 2021). While disaster management strategies in

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Indonesia have improved through enhanced planning, local government engagement, and policy adjustments, there remains a critical gap in household disaster preparedness, which is essential for immediate survival and resilience in disaster-prone communities (Ayuningtyas *et al*., 2021; Ryan *et al*., 2020).

Although individuals are advised to sustain themselves for at least 72 hours post-disaster and maintain emergency kits, awareness and preparedness at the household level in Indonesia remain limited (Alshowair *et al*., 2024). Given the critical role of individual and household readiness in minimising risk, this study seeks to examine current levels of disaster preparedness among Indonesian households and to identify key factors that influence preparedness behaviours.

Preparedness involves actions that mitigate potential harm, enhance response capabilities, and aid in managing disruptions following disasters (Yu, Sim & Qi, 2022). Such readiness encompasses multiple layers—from community to individual levels—making household preparedness particularly crucial for rural, low-resource areas frequently affected by natural hazards (Atreya, Ferreira & Kriesel, 2013). Cadres play a valuable role here by gathering data, fostering community resilience, and aiding in the organisation of local disaster responses (Miller *et al*., 2020). Effective involvement of these volunteers can boost community knowledge, adherence to preparedness guidelines, and resilience against future events (Tariq, Pathirage & Fernando, 2021).

Emerging technologies, such as virtual reality simulation (VRS), offer promising tools to enhance training for disaster response across various sectors, fostering skills development in immersive, interactive environments. VRS has been successfully applied in fields like healthcare and emergency services to simulate realistic disaster scenarios, allowing trainees to practice critical decision-making and emergency response actions in a controlled, repeatable setting (Alshowair *et al*., 2024; Brown *et al*., 2023). The immersive qualities of VRS, made possible by head-mounted displays, enhance trainee engagement and knowledge retention, which is essential for equipping disaster responders with practical skills under resource constraints (Lovreglio *et al*., 2018; Mallik *et al*., 2023).

Studies show that VRS can effectively simulate mass casualty incidents, providing experiences comparable to live drills in preparing first responders (Walls *et al*., 2024). Moreover, VR-based training can be repeated, updated with new scenarios, and conducted flexibly, making it a viable tool for developing disaster response skills in cost-effective and resource-limited ways (Khanal *et al*., 2022; Moslehi, Masoumi & Barghi-Shirazi, 2022). Despite substantial research on volunteer participation in disaster response, there is limited focus on systematically training volunteers through virtual simulations. By leveraging VR technology, this research will provide insights into how immersive simulation can enhance the readiness of cadres, ultimately strengthening local disaster resilience and preparedness in one of the world's most disaster-prone regions. This study aims to evaluate the effectiveness of VRS training in enhancing disaster preparedness among Indonesian cadres.

## METHODOLOGY

### Study Design and Setting

This study utilised a quasi-experimental design with a control group and repeated measures to examine the effects of virtual reality simulation training on disaster preparedness among community health volunteers (cadres) in Indonesia due to resource constraints and participant recruitment challenges. The study was conducted in Bandung Regency, a district in West Java Province, Indonesia, as one of the disaster-prone areas in West Java, Indonesia.

### Sample

Eligibility required participants to be over 18, literate, and to have served as a cadre for at least six months. Exclusion criteria ruled out individuals unwilling to participate, those with cognitive or mental disorders, and pregnant women (due to potential symptoms like nausea and vomiting). Using G-Power Software version 3.1.6, the required sample size was calculated for a *t*-test with a significance level ($\alpha$) of 0.05, an effect size of 0.40, a power level of 0.95, and two groups. The initial estimate of 328 was adjusted for a 20% expected attrition rate, yielding a target sample size of 400 (200 for each group). Convenience sampling was used for ease and accessibility.

### Instrument

Information such as age, gender, education, religion, marital status, working status, and source of information. The Household Emergency Preparedness Scale (HEPS) is a tool designed to assess how well households are prepared for emergencies. This scale was developed by Gina S. Lillibridge and colleagues in 2007 to provide a reliable and valid measure of a household's readiness for various potential emergencies, from natural disasters to man-made crises. HEPS consists of 50 items grouped into four primary domains: Emergency Supplies, Household Planning, Emergency Knowledge, and Household Communication. Each item on the scale represents an aspect of emergency preparedness, with the overall score indicating the extent to which households have taken appropriate steps to prepare for emergencies. Scoring the HEPS involves a straightforward summation, with each item rated on a scale from 0 to 2, where 0 indicates no preparedness, 1 reflects partial preparedness, and 2 indicates full preparedness for that specific item. Total scores can be used to categorise households based on their preparedness levels. The instrument was translated from English into Indonesian, then back translated into English to ensure linguistic accuracy. Content validity was evaluated by a panel of five experts, and reliability was assessed using Cronbach's alpha. The instrument demonstrated good internal consistency, with alpha values typically around 0.80 (Eisenman *et al*., 2009).

### Intervention Procedure

In preparation for the study, a training manual was created, and both a licensed nurse and research assistants (RAs) received mutual instruction to ensure readiness for their roles. Each RA has a bachelor's degree and is skilled in data analysis and communication. The training session focused on familiarising the RAs with the study's objectives and procedures, including topics such as participant eligibility, informed consent, data collection (questionnaires and blood pressure monitoring considering the potential side effect of using VR), and privacy protocols. RAs underwent an assessment to confirm they were equipped to carry out their duties before contributing to the research. Recruitment involved stakeholders in the community and public health nurses identifying eligible participants and obtaining written consent before they were assigned to either the intervention or control group. Baseline measurements captured demographic data and participants' readiness for emergencies. All participants were provided with detailed information about the study's objectives, procedures, potential risks, and benefits before their involvement. Written informed consent was obtained from each participant, emphasizing their voluntary participation and the freedom to withdraw at any stage without repercussions. Confidentiality and anonymity of participant data were strictly maintained, with all information securely stored and used exclusively for research purposes. The study prioritized the principle of beneficence by minimizing risks and ensuring that the virtual reality simulation training was safe and well-supervised. Additionally, cultural sensitivity and respect for local norms were upheld throughout the study to foster trust and engagement among the participants.

The intervention phase involved two groups: an experimental group receiving Virtual Reality Simulation Training (VRST) and a control group (Figure 1).

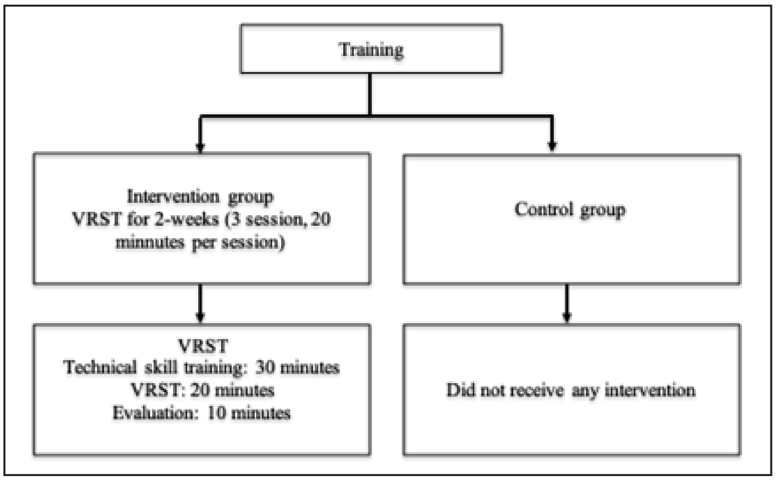


***Figure 1: Training Plan in Two Groups***

For the experimental group, VRST modules were designed to supplement web-based content, covering disaster preparedness concepts, disaster-prone mapping, triage, CPR and more (Figure 2).

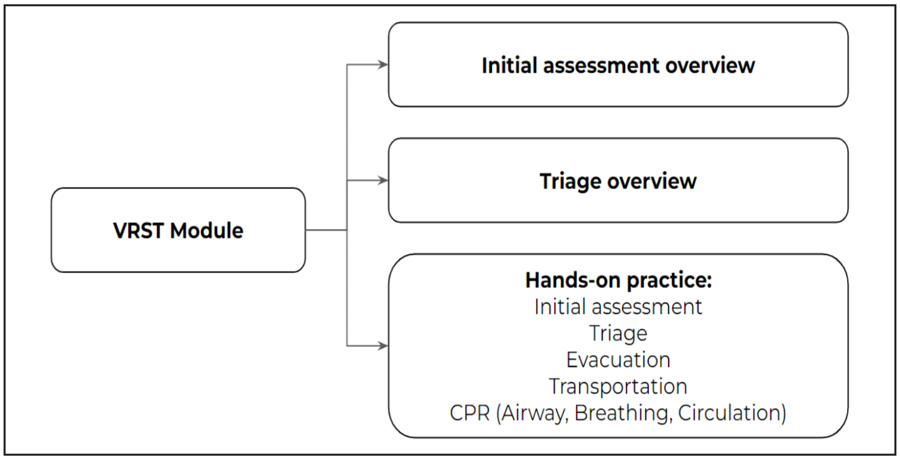


***Figure 2: Overview of the Educational Module Content of the Virtual Reality Simulation Training***

Using either a head-mounted display or a mouse and keyboard, participants engaged in virtual simulations that progressively increased in complexity. The VRST content was developed in collaboration with emergency response professionals and nursing experts to ensure clinical relevance and alignment with disaster nursing competencies. The scenarios were designed to reflect real-life nursing responsibilities during disaster situations, such as rapid patient assessment, triage decision-making, prioritisation of care, communication with interdisciplinary teams, and maintaining patient safety under pressure. This integration supports the development of critical thinking, situational awareness, and professional preparedness. A team of ten emergency nursing instructors led the sessions, covering theoretical material, technical skills, and emergency drills, as well as psychological support. Sessions were structured into short segments over two weeks, with hands-on training and assessments using an emergency care capability rating scale.

The control group did not receive any intervention during the study but was given the same training after the study concluded. In the post-intervention phase, assessments were conducted immediately following the intervention and again one month later to measure the program's impact. This approach aimed to evaluate the effectiveness of VRST on emergency preparedness, with post-test evaluations designed to track retention and application of skills over time.

## Data Analysis

A univariate analysis of demographic data, using frequency distribution, mean, and standard deviation. The Kolmogorov-Smirnov test was employed to assess whether the distribution of the continuous variables in this study conformed to a normal distribution, as the p-values were greater than 0.05 for all key variables. This finding justified the use of parametric statistical analyses for subsequent comparisons and hypothesis testing, including t-tests and ANOVA, which assume the normality of the data. The research further explores disaster preparedness and its associated factors at baseline through bivariate and multivariate analyses using Pearson correlation, chi-square, and linear regression. To assess improvement in preparedness, a paired *t*-test evaluates changes within intervention and control groups. Disaster preparedness before and after intervention is compared between groups using an independent *t*-test. Finally, changes over time in preparedness within the intervention and control groups are analysed through repeated ANOVA and the General Estimation Equations to determine longitudinal change of intervention on the dependent variable. The analysis of the data is done with SPSS 25.0.

## Ethical Consideration

The researchers obtained ethical approval from an authorized institutional review board of STIKep PPNI Jawa Barat, Indonesia with reference no III/098/KEPK/STIKep/PPNI/Jabar/III/2024 on 4$^{th}$ March 2024.

## RESULTS

A total of 450 cadres were initially enrolled for baseline data collection, as shown in Figure 3. Of these, approximately 400 cadres participated, resulting in a response rate of 88.9% at baseline. About 35 cadres declined participation, and 15 did not complete the baseline pre-test. All participants who began the intervention completed both the intervention and follow-up measurements.

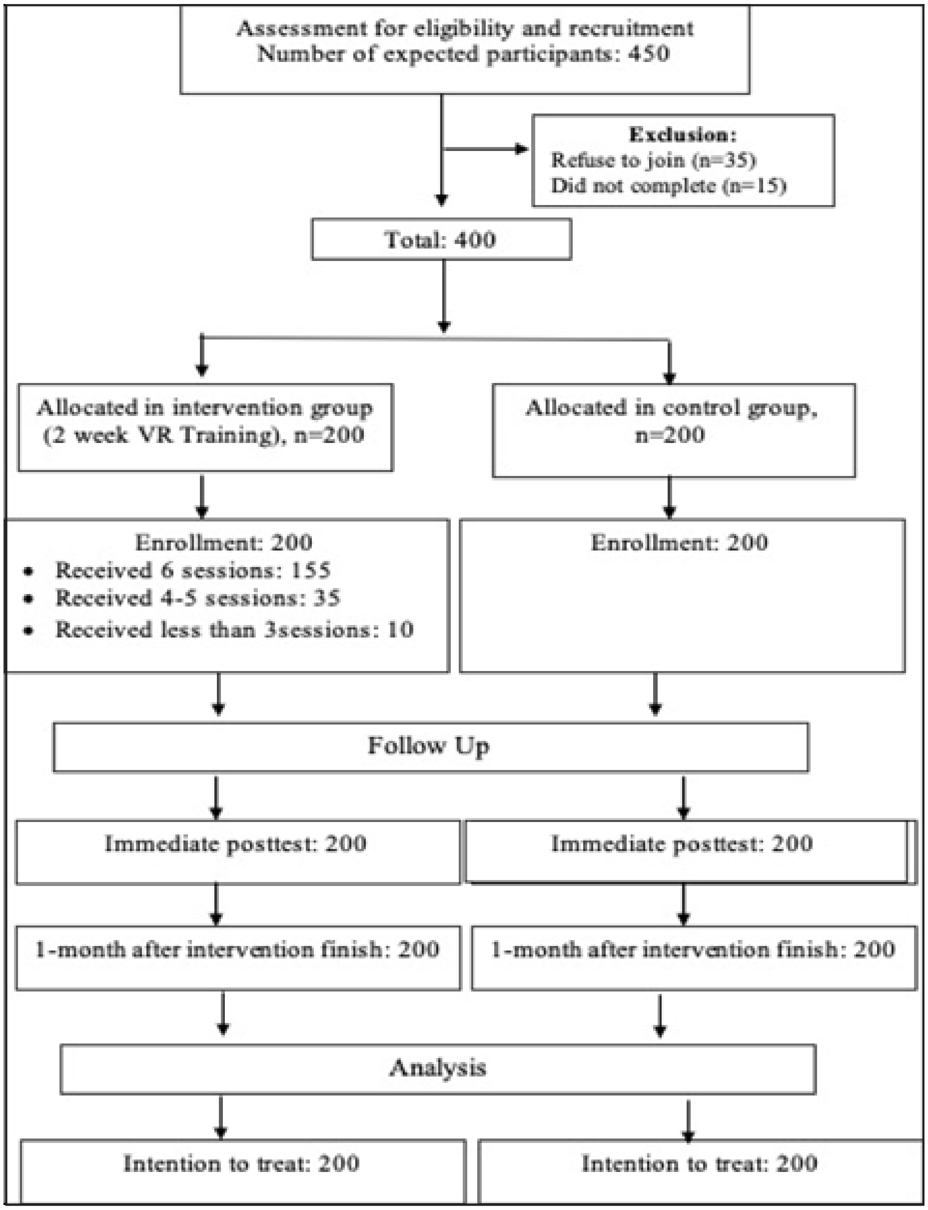


***Figure 3: Trial CONSORT Diagram***

Table 1 presents a demographic comparison between the intervention and control groups. In the intervention group (200 participants), the mean age was 31.15±5.31 years; 67% were female, 60% were married, 40% had an education level below junior high school, 54.5% were unemployed, and 87.5% had never received disaster training. In the control group, the mean age was 31.71±9.25 years; 73.5% were female, 63.3% were married, 53.3% had an education level below junior high school, 52% were unemployed, and 86% had never received disaster training. There were no statistically significant differences between the intervention and control groups in terms of age (independent *t*-test), gender, education level, marital status, employment status, or disaster training (chi-square tests), with all *p*-values greater than 0.05.

***Table 1: Demographic Comparison between Intervention and Control Group (n=400)***

| Variables | Intervention Group | Control Group | *r/t/F* | *p*-value |
|---|---|---|---|---|
| | n=200 (%) | n=200 (%) | | |
| **Age, Year (Mean ± SD)** | 31.15±5.31 | 31.71±9.25 | 0.537 | 0.342[a] |
| **Gender** | | | | |
| Male | 66 (33) | 53 (26.5) | 0.261 | 0.256[b] |
| Female | 134 (67) | 147 (73.5) | | |
| **Marital Status** | | | | |
| Married | 120 (60) | 95 (63.3) | 1.274 | 0.185 [b] |
| Single/Divorce/Widow | 80 (40) | 55 (36.7) | | |
| **Education Level** | | | | |
| Below junior high school | 80 (40) | 85 (42.5) | 0.376 | 0.205 [b] |
| Senior high school | 90 (45) | 87 (43.5) | | |
| University | 30 (15) | 28 (14) | | |
| **Working Status** | | | | |
| Employed | 91 (45.5) | 96 (48) | 1.670 | 0.252 [b] |
| Unemployed | 109 (54.5) | 104 (52) | | |
| **Attaining Training of Disaster** | | | | |
| Yes | 25 (12.5) | 28 (14) | 0.275 | 0.243 [b] |
| No | 175 (87.5) | 172 (86) | | |

*Note: a=independent t test, b=chi-square test*

The ANOVA results in Table 2 show that the intervention group experienced a significant increase in disaster preparedness scores over time, with mean scores rising from 97.34 at baseline (T0) to 104.32 immediately after the intervention (T1), and further to 110.21 one month later (T2). This improvement was statistically significant ($p = 0.001$) and demonstrated a moderate effect size (Cohen's $d = 0.41$), indicating that the virtual reality simulation training (VRST) had a meaningful impact on participants' preparedness. In contrast, the control group showed no notable changes in preparedness scores across the same time points (T0 = 98.33, T1 = 99.56, T2 = 98.33), with a non-significant F value and a negligible effect size (Cohen's $d = 0.03$).

***Table 2: Comparison of Disaster Preparedness Scores in Control and Intervention Group at Different Time Points by ANOVA Test***

| Variable | T0 | T1 | T2 | F | ANOVA Test | Cohen's *d* | Interpretation |
|---|---|---|---|---|---|---|---|
| | Mean ± SD | Mean ± SD | Mean ± SD | | *p*-value | | |
| Intervention group[a] | 97.34±11.34 | 104.32±11.54 | 110.21±14.25 | 3.578 | 0.001 | 0.41 | Moderate effect size |
| Control group[b] | 98.33 ±9.29 | 99.56 ±10.21 | 98.33 ±9.29 | 0.897 | 0.001 | 0.03 | No effect size |

*Note: P < 0.05 are considered significant; baseline (T0), immediately after intervention (T1), and one month after intervention (T2)*

Based on GEE analyses, participants in the intervention group showed a significantly greater increase in the total mean disaster preparedness score at the one-month follow-up ($\beta = 10.2$, $p$=0.001) compared to the control group. This result was observed after adjusting for education level and prior disaster training (Table 3).

***Table 3: Evaluation of the Intervention on Disaster Preparedness Based on the Repeated Measure Analysis Using GEE Method***

| Variables | Within Group | | Between Group | | Interaction | | |
|---|---|---|---|---|---|---|---|
| | Ref: Baseline | | Ref: CG | | Group (EG) x Time<br>Reference group: (CG) xTime | | |
| | *β* | *p* | *β* | *p* | *β* | 95% CI | *p* |
| Total disaster preparedness score | 6.0 | 0.28 | 2.5 | 0.98 | 10.2 | 5.92-29.4 | 0.001 |

*Note: Covariate is a pre-test score of disaster preparedness, education level and prior disaster training CG: Control Group; EG: Experimental Group over Time*

## DISCUSSION

This study demonstrates that VR-based training significantly enhances disaster preparedness among participants compared to traditional methods. Immersive Virtual Reality (VR) provides unique advantages by simulating realistic disaster scenarios, offering a risk-free, cost-effective, and repeatable training environment. Previous research has explored the impact of VR on disaster preparedness in various contexts (Alshowair *et al*., 2024; Gout *et al*., 2020; Luo *et al*., 2021). For example, Fakhriyah (2024) examined triage training within a VR-simulated environment, where participants conducted patient assessments following an explosion scenario. This training allowed participants to assess breathing and heart rates, enhancing hands-on learning without the risks associated with real-world incidents.

VR technology enables learners to acquire practical experience through realistic simulations that mirror real-life challenges, surpassing traditional methods in interactivity and adaptability (Liu *et al*., 2023). For instance, VR systems employ teleportation and haptic feedback to mimic expert tasks, allowing users to make quicker decisions crucial in disaster recovery with minimal time and financial investment (Kiegaldie & Shaw, 2023). Studies show that VR-trained groups excel in live evacuation drills compared to those trained traditionally, highlighting VR's effectiveness in skill transfer (Collier *et al*., 2023). While VR offers substantial advantages in disaster preparedness, real-world applications in disaster zones demand considerable infrastructure investment, raising questions about scalability and cost (Dong *et al*., 2024). Traditional drills, like fire simulations, require substantial resources and may pose injury risks to first responders. In contrast, VR offers a safer, more economical alternative for training in environments that closely mimic real-life disasters (Calandra *et al.*, 2024). Participants in VR simulations also report high satisfaction levels and find the immersive experience beneficial for skill acquisition.

Research comparing (VR) with mixed reality (MR) and augmented reality (AR) highlights the unique strengths of each technology. For example Koutitas *et al*., (2019) found that AR training using see-through headsets for ambulance bus orientation allowed trainees to interact with holographic objects, though VR yielded slightly better results in realism and task efficiency. In addition, immersive VR systems, such as those utilising head-mounted displays and motion tracking, have been shown to be effective for disaster response training, particularly for first responders and degree-seeking students preparing for mass casualty triage, fire response, and decontamination (Chang *et al*., 2022; Dorozhkin *et al.*, 2017; Gunshin, Doi & Morimura., 2020; Price *et al.*, 2018). Overall, immersive VR simulations have proven to be accessible, cost-effective, and highly efficient for disaster preparedness training. VR platforms are adaptable, allowing for low-cost setup and rapid scenario reconfiguration, making them ideal for training on disaster-specific skills that require precision in high-risk, low-frequency situations (Abbas *et al.*, 2023; Gunshin, Doi & Morimura., 2020). Furthermore, full-scale VR simulations using high-fidelity manikins and wireless connectivity replicate catastrophe-like conditions, supporting both effective learning and information retention essential for disaster response (Hung, Lin & Hsiao, 2025).

The results of this study highlight the potential of VR-based training as an effective tool for enhancing disaster preparedness among healthcare cadres. By providing immersive, hands-on training experiences, VR can help cadres develop critical skills and responses needed during disasters, potentially leading to better outcomes in real-world emergency situations. Implementing VR training modules may be especially beneficial in regions where access to traditional, in-person disaster training is limited, making it a scalable option for strengthening disaster readiness across different healthcare levels.

### Limitation

This study has several limitations. First, the sample size was relatively small, which may limit the generalisability of the findings to broader healthcare cadres. Second, the study only evaluated short-term improvements in disaster preparedness; long-term retention of skills and knowledge gained through VR training was not assessed. Additionally, the study did not control for potential confounding variables, such as prior experience with disaster scenarios, which might have affected the training outcomes. Lastly, the technical requirements and costs associated with VR may pose challenges for widespread adoption, particularly in resource-limited settings.

## CONCLUSION

The findings suggest that VR-based training can significantly improve disaster preparedness skills among healthcare cadres compared to traditional training methods. This innovative approach offers a promising supplement to existing disaster training programs, leveraging immersive technology to enhance skill acquisition in critical scenarios. VR-based modules could play a vital role in bridging gaps in disaster readiness, particularly in areas with limited training resources. Future research should explore the long-term retention of skills acquired through VR-based training and evaluate its effectiveness in real-life disaster scenarios. Additionally, studies could investigate the adaptability of VR modules for diverse healthcare settings, including rural and resource-constrained areas. The integration of artificial intelligence (AI) in VR training to provide personalised feedback and real-time scenario adjustments could also enhance training outcomes. Expanding the scope of VR-based training to include multidisciplinary disaster response teams and incorporating feedback from end-users would further refine its application and effectiveness.

### Conflict of Interest

The authors declare that they have no competing interests.

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## REFERENCES

Abbas, J. R., Chu, M. M. H., Jeyarajah, C., Isba, R., Payton, A., McGrath, B., Tolley, N., & Bruce, I. (2023). Virtual reality in simulation-based emergency skills training: A systematic review with a narrative synthesis. *Resuscitation Plus, 16*, 1-11. https://doi.org/10.1016/j.resplu.2023.100484

Alshowair, A., Bail, J., AlSuwailem, F., Mostafa, A., & Abdel-Azeem, A. (2024). Use of virtual reality exercises in disaster preparedness training: A scoping review. *SAGE Open Medicine, 12*. https://doi.org/10.1177/20503121241241936

Atreya, A., Ferreira, S., & Kriesel, W. (2013). Forgetting the flood? An analysis of the flood risk discount over time. *Land Economics, 89*(4), 577–596. https://doi.org/10.3368/le.89.4.577

Ayuningtyas, D., Windiarti, S., Hadi, M. S., Fasrini, U. U., & Barinda, S. (2021). Disaster preparedness and mitigation in Indonesia: A narrative review. *Iranian Journal of Public Health, 50*(8), 1536-1546. https://doi.org/10.18502/ijph.v50i8.6799

Badan Nasional Penanggulangan Bencana (BNPB). (2023, October 25). *Jumlah Kejadian Bencana Berdasarkan Jenis Bencana di Jawa Barat [Number of Disaster Incidents Based on Disaster Type in West Java]*. Retrieved from https://data.bnpb.go.id/ja/dataset/jumlah-kejadian-bencana-berdasarkan-jenis-bencana-di-jawa-barat. Accessed on 24th March 2024.

Bogati, R., & Gautam, M. S. (2021). Disaster recovery toward attaining sustainable development goals. In *No Poverty* (pp. 211–220). Springer, Germany. https://doi.org/10.1007/978-3-319-95714-2_56.

Brown, N., Margus, C., Hart, A., Sarin, R., Hertelendy, A., & Ciottone, G. (2023). Virtual reality training in disaster medicine: a systematic review of the literature. *Simulation in Healthcare, 18*(4), 255–261. https://doi.org/10.1097/SIH.0000000000000675

Calandra, D., Pratticò, F. G., Cannavò, A., Casetti, C., & Lamberti, F. (2024). Digital twin-and extended reality-based telepresence for collaborative robot programming in the 6G perspective. *Digital Communications and Networks, 10*(2), 315–327. https://doi.org/10.1016/j.dcan.2022.10.007

Chang, C.-W., Lin, C.-W., Huang, C.-Y., Hsu, C.-W., Sung, H.-Y., & Cheng, S.-F. (2022). Effectiveness of the virtual reality chemical disaster training program in emergency nurses: a quasi-experimental study. *Nurse Education Today, 119*. https://doi.org/10.1016/j.nedt.2022.105613

Collier, R., Darling, R., Sprague, L.-M., & Murphy, J. (2023). The development and feasibility of an empathy virtual reality scenario in healthcare education. *CIN: Computers, Informatics, Nursing, 41*(10), 759–764. https://doi.org/10.1097/CIN.0000000000001034

Dorozhkin, D., Olasky, J., Jones, D. B., Schwaitzberg, S. D., Jones, S. B., Cao, C. G. L., Molina, M., Henriques, S., Wang, J., & Flinn, J. (2017). OR fire virtual training simulator: design and face validity. *Surgical Endoscopy, 31*, 3527–3533. https://doi.org/10.1007/s00464-016-5379-7

Eisenman, D. P., Zhou, Q., Ong, M., Asch, S., Glik, D., & Long, A. (2009). Variations in disaster preparedness by mental health, perceived general health, and disability status. *Disaster Medicine and Public Health Preparedness, 3*(1), 33-41. https://doi.org/10.1097/DMP.0b013e318193be89

Fakhriyah, F. (2024). Virtual Reality-Based learning environments for enhancing interpersonal communication and decision making in crisis management training. *Journal of Blended and Technical Education, 1*(1), 45–53. Retrieved from: https://generatedp.com/index.php/jbte/article/download/8/6 . Accessed on 18th June 2024.

Gout, L., Hart, A., Houze-Cerfon, C.-H., Sarin, R., Ciottone, G. R., & Bounes, V. (2020). Creating a novel disaster medicine virtual reality training environment. *Prehospital and Disaster Medicine, 35*(2), 225–228. https://doi.org/10.1017/S1049023X20000230

Gunshin, M., Doi, K., & Morimura, N. (2020). Use of high-fidelity simulation technology in disasters: An integrative literature review. *Acute Medicine & Surgery, 7*(1), 1-11. https://doi.org/10.1002/ams2.596

Hung, M.-C., Lin, C.-Y., & Hsiao, G. L.-K. (2025). Virtual reality in building evacuation: A review. *Fire, 8*(2), 80, 1-23. https://doi.org/10.3390/fire8020080

Khanal, S., Medasetti, U. S., Mashal, M., Savage, B., & Khadka, R. (2022). Virtual and augmented reality in the disaster management technology: a literature review of the past 11 years. *Frontiers in Virtual Reality, 3*, 1-21. https://doi.org/10.3389/frvir.2022.843195

Kiegaldie, D., & Shaw, L. (2023). Virtual reality simulation for nursing education: effectiveness and feasibility. *BMC Nursing, 22*(1), 1-13. https://doi.org/10.1186/s12912-023-01639-5

Koutitas, G., Smith, K. S., Lawrence, G., Metsis, V., Stamper, C., Trahan, M., & Lehr, T. (2019). A virtual and augmented reality platform for the training of first responders of the ambulance bus. *Proceedings of the 12th ACM International Conference on Pervasive Technologies Related to Assistive Environments*, 299–302. https://doi.org/10.1145/3316782.3321542

Liu, K., Zhang, W., Li, W., Wang, T., & Zheng, Y. (2023). Effectiveness of virtual reality in nursing education: A systematic review and meta-analysis. *BMC Medical Education, 23*(1), 1-10. https://doi.org/10.1186/s12909-023-04662-x

Lovreglio, R., Gonzalez, V., Feng, Z., Amor, R., Spearpoint, M., Thomas, J., Trotter, M., & Sacks, R. (2018). Prototyping virtual reality serious games for building earthquake preparedness: The Auckland City Hospital case study. *Advanced Engineering Informatics, 38*, 670–682. https://doi.org/10.1016/j.aei.2018.08.018

Luo, Y., Li, M., Tang, J., Ren, J., Zheng, Y., Yu, X., Jiang, L., Fan, D., & Chen, Y. (2021). Design of a virtual reality interactive training system for public health emergency preparedness for major emerging infectious diseases:

Theory and framework. *JMIR Serious Games, 9*(4). https://doi.org/10.2196/29956

Mallik, R., Pottle, J., Atkinson, B., Kar, P., & Patel, M. (2023). Using virtual reality-based learning to provide education on the management of diabetes emergencies for doctors in training. *Practical Diabetes, 40*(5), 7–12. http://dx.doi.org/10.1002/pdi.2473

Miller, N. P., Ardestani, F. B., Dini, H. S., Shafique, F., & Zunong, N. (2020). Community health workers in humanitarian settings: scoping review. *Journal of Global Health, 10*(2), 1-21. https://doi.org/10.7189/jogh.10.020602

Moslehi, S., Masoumi, G., & Barghi-Shirazi, F. (2022). Benefits of simulation-based education in hospital emergency departments: A systematic review. *Journal of Education and Health Promotion, 11*(1), 40. https://doi.org/10.4103/jehp.jehp_558_21

Price, M. F., Tortosa, D. E., Fernandez-Pacheco, A. N., Alonso, N. P., Madrigal, J. J. C., Melendreras-Ruiz, R., García-Collado, Á. J., Rios, M. P., & Rodriguez, L. J. (2018). Comparative study of a simulated incident with multiple victims and immersive virtual reality. *Nurse Education Today, 71*, 48–53. http://dx.doi.org/10.1016/j.nedt.2018.09.006

Ryan, B., Johnston, K. A., Taylor, M., & McAndrew, R. (2020). Community engagement for disaster preparedness: A systematic literature review. *International Journal of Disaster Risk Reduction, 49*. https://doi.org/10.1016/j.ijdrr.2020.101655

Tariq, H., Pathirage, C., & Fernando, T. (2021). Measuring community disaster resilience at local levels: An adaptable resilience framework. *International Journal of Disaster Risk Reduction, 62*, 1-16. https://doi.org/10.1016/j.ijdrr.2021.102358

Walls, R., Nageswaran, P., Cowell, A., Sehgal, T., White, T., McVeigh, J., Staykov, S., Basett, P., Mitelpunkt, D., & Sam, A. H. (2024). Virtual reality as an engaging and enjoyable method for delivering emergency clinical simulation training: A prospective, interventional study of medical undergraduates. *BMC Medicine, 22*(1), 1-8. http://dx.doi.org/10.1186/s12916-024-03433-9

Yu, J., Sim, T., & Qi, W. (2022). Informal social support and disaster preparedness: Mediating roles of perceived collective efficacy and self-efficacy. *International Journal of Disaster Risk Reduction, 68*. https://doi.org/10.1016/j.ijdrr.2021.102734