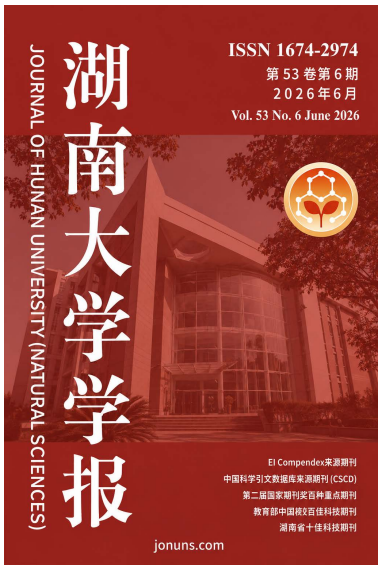

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Disaster Preparedness Competencies in Undergraduate Healthcare Education: A Systematic Review

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Abstract: Background: Disasters pose substantial and growing challenges to healthcare systems worldwide, requiring a workforce adequately prepared to respond in complex, resource-constrained environments. Despite the critical role of healthcare professionals in disaster response, existing evidence consistently indicates suboptimal preparedness among students and graduates. One contributing factor is the absence of clearly defined and consistently applied teaching competencies to guide disaster preparedness education across healthcare curricula.

Methods: An integrative systematic review was conducted in accordance with PRISMA guidance to identify teaching competencies used in disaster preparedness education for healthcare students. A comprehensive search of seven electronic databases (Embase, Scopus, Cochrane Library, PubMed, ERIC, ProQuest, and ResearchGate) was undertaken for English-language studies published between January 2013 and January 2023. Database-specific search strategies were applied, and reference management and screening were performed using EndNote 20 and Rayyan®. Two reviewers independently screened studies, extracted data, and appraised methodological quality using design-appropriate tools. A third reviewer validated the whole process. Qualitative content analysis was employed to synthesize findings across heterogeneous study designs.

Results: Of 5,372 records screened, 12 studies met the inclusion criteria. Across these studies, 24 distinct disaster preparedness competencies were identified and classified into three educational domains: cognitive, affective, and psychomotor. Cognitive competencies—particularly disaster-related knowledge and situational understanding—were most frequently assessed, followed by affective competencies such as confidence and willingness to participate. Psychomotor competencies, including communication, teamwork, triage, and technical performance, were primarily evaluated through simulation- and drill-based interventions. All included studies reported significant improvement in at least one competency following educational interventions. However, most studies focused on nursing students and were conducted in Asian settings, with limited representation of interprofessional cohorts and regions bearing high disaster burdens.

Conclusions: This review identifies a broad yet uneven set of competencies underpinning disaster preparedness education for healthcare students, with a strong emphasis on cognitive outcomes and comparatively limited attention to affective and psychomotor domains. Greater integration of competency-based, interprofessional, and context-sensitive educational approaches is needed to enhance curriculum transferability and global relevance. Future research should prioritize skills-based training, interprofessional education, and evidence generation from underrepresented regions to strengthen disaster preparedness education worldwide.

Keywords: healthcare students, disaster preparedness, disaster medicine, competencies, education.

本科医疗卫生教育中的灾害准备能力：系统综述

摘要：

背景：灾害对全球医疗卫生系统构成了重大且日益严峻的挑战，这要求医疗卫生工作队伍具备在复杂且资源受限环境中有效应对的充分准备。尽管医疗卫生专业人员在灾害响应中发挥着关键作用，现有证据仍一致表明，学生和毕业生的灾害准备水平尚不理想。其中一个重要原因是缺乏明确界定并在医疗卫生课程中一致应用的教学能力框架，以指导灾害准备教育。

方法：本研究依据 PRISMA 指南开展了一项整合性系统综述，旨在识别用于医疗卫生专业学生灾害准备教育中的教学能力。研究对七个电子数据库（Embase、Scopus、Cochrane Library、PubMed、ERIC、ProQuest 和 ResearchGate）进行了全面检索，纳入 2013 年 1 月至 2023 年 1 月期间发表的英文研究。检索过程中采用了针对不同数据库的检索策略，并使用 EndNote 20 和 Rayyan® 进行文献管理与筛选。两名评审者独立完成文献筛选、数据提取以及基于研究设计的适用工具进行方法学质量评价。第三名评审者对整个过程进行了验证。研究采用定性内容分析方法，对不同研究设计下的发现进行综合分析。

结果：在筛选的 5,372 条记录中，共有 12 项研究符合纳入标准。这些研究共识别出 24 项不同的灾害准备能力，并将其归类为三个教育领域：认知领域、情感领域和精神运动领域。认知能力，尤其是与灾害相关的知识和情境理解，是最常被评估的能力；其次是情感能力，如信心和参与意愿。精神运动能力，包括沟通、团队合作、分诊和技术操作表现，主要通过模拟和演练类干预进行评估。所有纳入研究均报告称，教育干预后至少有一项能力得到了显著提升。然而，大多数研究集中于护理专业学生，并主要在亚洲地区开展，对跨专业群体以及灾害负担较高地区的代表性仍然有限。

结论：本综述确定了支撑医疗卫生专业学生灾害准备教育的一系列广泛但发展不均衡的能力，其中对认知结果的关注较为突出，而对情感和精神运动领域的关注相对不足。未来有必要进一步整合基于能力、跨专业且符合具体情境的教育方法，以提高课程的可迁移性和全球适用性。后续研究应优先关注技能导向培训、跨专业教育以及来自代表性不足地区的证据生成，从而在全球范围内加强灾害准备教育。

关键词：医疗卫生专业学生；灾害准备；灾害医学；能力；教育。

1. Introduction

In recent decades, the frequency and severity of natural and human-caused disasters have increased, posing unprecedented challenges to public health systems. From catastrophic floods and earthquakes to industrial accidents and armed conflicts, these events inflict significant human suffering, strain infrastructure, and overwhelm local response capacities (1). The dynamic and complex nature of disasters makes prediction and prevention inherently difficult, shifting the strategic focus towards mitigation, preparedness, response, and recovery—the four cornerstone phases of disaster management described by the World Health Organization (WHO) (2). In this context, WHO defines preparedness in public health emergencies and disasters as encompassing "planning for prevention and preparedness, management of mitigation, early response and rehabilitation, and the implementation of coordinated health system actions to reduce public health impacts." Within this framework, the preparedness and competence of healthcare professionals are widely recognized as critical determinants of community resilience and recovery(3, 4).

Along with this paradigm shift, there is growing recognition of the importance of well-defined, measurable competency frameworks to guide disaster education for healthcare personnel. Competency is the integration of skills, ability, and knowledge to perform a particular role effectively (https://www.merriam-webster.com/dictionary/competency). Teaching competencies are the measurable knowledge, skills, and attitudes targeted through educational interventions to develop disaster preparedness capabilities among undergraduate healthcare students. Foundational frameworks, such as the Core Competencies for Disaster Medicine and Public Health (DMPH), outline preparedness at the personal, interprofessional, and systems levels (5). Similarly, the International Council of Nurses (ICN) Disaster Nursing Competencies define key domains including planning, communication, safety, and ethical practice (6). These frameworks now serve as benchmarks for curriculum development, aligned with standards such as the WHO Emergency Medical Teams framework (7).

1.1. Research problem and rationale

Despite the availability of these frameworks, research consistently shows that both practicing health professionals and students in fields such as medicine, nursing, pharmacy, and public health demonstrate uneven preparedness and low confidence in disaster medicine across regions and disciplines. A study in Pakistan by Gillani et al. among healthcare professionals indicated that the average knowledge (K) score was moderate, the attitude (A) score was low, the readiness to practice (rP) score was moderate, and the overall KArP score was average (8). Genç (2025) conducted a survey of healthcare professionals, which revealed significant gaps in disaster preparedness, with many participants reporting low confidence in their ability to respond effectively (9). Another survey conducted by Ayyad et al. among healthcare professionals in Sudan found low perceived preparedness and limited disaster management skills (10). The findings highlight disparities and the urgent need for standardized training programs. Several studies have examined disaster medicine and preparedness among healthcare professional students (HCPS) in Qatar, Pakistan, China, Yemen, Jordan, and the UAE. Generally, their knowledge, attitude, and preparedness were moderate (8, 11, 12, 13, 14, 15). A review found that preparedness varies widely across disciplines, with most studies focusing on medical and nursing staff while neglecting allied health professionals and support staff. The authors emphasize the need for more inclusive training across the entire healthcare team (16).

After a disaster, the demand for healthcare professionals increases sharply, underscoring the critical link between their preparedness and the effectiveness of disaster response efforts. To address this need, universities and healthcare organizations have been actively developing specialized educational frameworks and programs to enhance healthcare practitioners' disaster preparedness and response competencies (17). A robust body of evidence confirms significant deficits in disaster preparedness across the health professions, spanning both practicing professionals and students. Studies consistently report low to moderate levels of perceived self-efficacy and knowledge among nurses in developing nations, a trend mirrored in high-income countries where surveys reveal a strong demand for more training across all disaster typologies (18, 19, 20). This preparedness gap is not due to a lack of motivation but rather to a systemic deficiency in standardized education, as further evidenced by research among health students, who report a high willingness to engage in disaster response but critically low confidence in their ability to do so (8, 21, 22). This pattern, observed globally from South Korea and Germany to Ethiopia and Latin America, underscores a universal need to move beyond ad-hoc training toward a competency-based educational paradigm (18, 19).

A common theme emerging from all these studies is the critical role of training in addressing the knowledge and readiness gaps among healthcare professionals. While these studies explored various approaches, they consistently emphasized disaster response and preparedness rather than the entire disaster management cycle. Given the vital role of frontline healthcare providers in responding to disasters, their ability and awareness in handling and controlling the situation are essential to ensuring public safety. A successful disaster health response necessitates coordinated efforts from all healthcare workers. Health providers must cultivate

collaborative, interprofessional skills to work effectively together to keep people safe during and after disasters.

Given the consistently low levels of preparedness reported, gaps across geographic, professional, and developmental contexts remain insufficiently addressed, with non-standardized training identified as a key barrier. Therefore, the next critical step is establishing standardized teaching competencies to guide the development of practical, interprofessional educational modules. Such competencies are essential for transforming motivation into operational readiness, ensuring that future healthcare workers are equipped with collaborative skills necessary for a coordinated response throughout the disaster management cycle. By systematically addressing these educational deficiencies, we can cultivate a resilient health workforce capable of mitigating the global challenges posed by disasters. By equipping future doctors, pharmacists, nurses, and other health workers with the necessary competencies, we can better prepare them to address today's global disaster challenges.

1.2. Aims

The specific objectives of this review are as follows:

i) Identify teaching competencies used in disaster preparedness education for healthcare students.

ii) Describe the geographical and disciplinary distribution of studies reporting these competencies.

Unlike prior reviews that primarily assess preparedness levels or evaluate educational interventions, this review provides a competency-oriented synthesis by systematically identifying and mapping disaster preparedness competencies across cognitive, affective, and psychomotor domains for undergraduate healthcare education.

2. Methods

2.1 Research design

This systematic review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Electronic databases were searched in September 2023. The study follows an integrative systematic review approach. In this review, content analysis was used to systematically extract, code, and classify reported disaster preparedness competencies into coherent domains, enabling meaningful comparisons and synthesis across educational interventions and study designs.

2.2 Eligibility, inclusion and exclusion criteria

No restrictions were placed on the design or methodologies of the studies included in this review.

The inclusion criteria encompassed educational programs in medicine, nursing, pharmacy, and public health, regardless of academic level, age, or gender. Both natural (e.g., earthquakes, floods) and man-made (e.g., wars, pandemics) disasters were considered. Studies were included if they were published in the English language between 2013 and 2023. Studies were excluded if the population was not composed of healthcare professional students (e.g., psychology, allied health, EMS), did not address disaster preparedness, or did not discuss educational modules or programs related to disaster preparedness.

2.3 Search strategy

A comprehensive and systematic literature search was conducted across five electronic databases: Embase, Scopus, Cochrane Library, PubMed, and ERIC. Additionally, ProQuest and ResearchGate were searched as supplementary sources to capture relevant grey literature.ResearchGate was used as a supplementary source to capture grey literature and non-indexed studies using a structured keyword search consistent with the main strategy. All retrieved records were screened, deduplicated, and appraised using the same procedures as database-derived studies.. Database-specific search strategies were developed for each source, incorporating controlled vocabulary terms (e.g., MeSH and Emtree, where applicable) and free-text keywords related to healthcare students, disaster preparedness, disaster medicine, education, and competencies. The full search strategies for all databases are provided in Table 1 to ensure transparency and reproducibility.

Although the syntax and indexing varied across databases, comparable core search concepts and Boolean operators (“AND”, “OR”) were applied consistently. The search was limited to peer-reviewed publications reflecting contemporary educational practices and frameworks in disaster preparedness. All retrieved records were exported into EndNote 20 for reference management, and duplicate citations were removed. The remaining records were then uploaded to Rayyan® QCRI (https://www.rayyan.ai/) to facilitate independent screening of titles and abstracts against the predefined eligibility criteria.

Table 1: Searched terms using ‘OR’

Search terms:
Health Students, OR Health care professional students, OR student*
Disaster* OR Disaster preparedness, OR Disaster Management, OR disaster readiness.
Interprofessional education, OR Education Curriculum OR Training program OR disaster curriculum OR Teaching

2.4 Study selection

Two primary researchers (MAA, YA) initially screened the retrieved titles and abstracts in Rayyan® to identify potentially relevant studies in line with the review objectives and inclusion/exclusion criteria. In the second round, each reviewer independently evaluated the full text of the selected articles to determine eligibility. A third researcher (MIMI) validated the process and outputs. Any disagreements were resolved through discussion among all reviewers. Once the final set of eligible papers was agreed upon, they were requested through the university library website. Additionally, the reference lists of the included papers were searched for potentially relevant studies.

2.5 Quality and risk bias assessment

This systematic review of the disaster readiness literature identified various study designs and methodologies used to prepare health college students for disasters. It employed appropriate appraisal tools tailored to each article's specific design. The mixed-method design was assessed using the MMAT version 2018. Before-and-after studies without a control group were evaluated using the NIH quality assessment tool, a 12-question checklist. Responses to each question were categorized as "NR" (not reported), "NA" (not applicable), "CD" (cannot determine), "Y" (yes), or "N" (no). The final score was calculated by summing the "Y" responses and dividing by 12. The NIH tool also assessed the risk of bias as Low (75-100%), Moderate (25-75%), or High (0-25%). Quasi-experimental studies were appraised using the JBI critical appraisal checklist, which comprises 9 questions with responses of "Yes," "No," "Unclear," or "Not applicable."

2.6 Data extraction and analysis

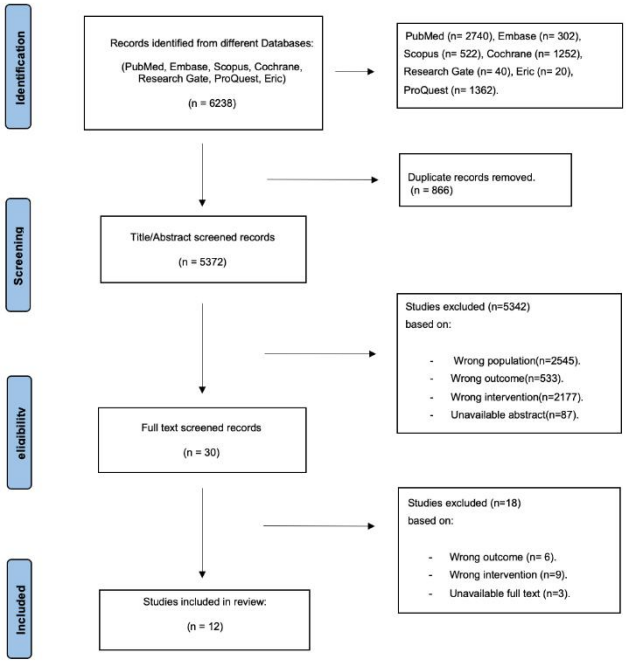
Data extraction was conducted independently by the primary , researchers (MAA, YA), and confirmed by the third researcher (MIMI). The following information was extracted from each reviewed article: Authors, Year of publication, Country or nation, Study design, Sample size, Type of participants, Research instrument, Competencies, Results, and Conclusion.

3. Results

3.1 Study selection and screening

The selection of studies was conducted using the PRISMA flow chart shown in Figure 1. The literature search identified a total of 6,238 papers across seven databases. 866 duplicated articles were found. Additionally, 5342 records were discarded based on titles and abstracts due to incorrect population (2545), intervention (2177), outcome (533), and unavailable abstracts (87). Thirty studies were screened for full text, and 18 were excluded: 3 were unavailable, 9 focused on preparedness levels rather than preparedness competencies, and 6 had unrelated outcomes. Twelve papers were selected for final review by all authors and appraised for quality and risk of bias.

Figure 1: Study selection flow chart based on (PRISMA) flow chart.



3.2 Quality assessment

Three articles by Phan et al. (22), Hung et al. (23), and Grandhi et al. (24), which used a mixed-methods study design, were appraised using the MMAT version 2018. Six studies by Castor Delgado et al. (25), Saiboon et al. (26), Alim et. al. (27), Xia et. al. (28), Digregorio et. al. (29), and Glauberman et al. (30) used the NIH quality assessment tool. JBI critical appraisal checklist was used for studies by Hwang & Lee (31), and Huh and Kang et al. (32). Finally, for the study by Shujuan et al. (33), Cochrane's risk-of-bias tool was used for quality assessment. Generally, most studies raise concerns about bias. The quality appraisal scores for the studies are shown in Table 2 below.

Table 2: Quality assessment of twelve articles

Authors	QA Tool	Results
Phan et. al. (22)	MMAT	Both S1 and S2 and all mixed-method criteria are met
Gandhi et. al. (24)	MMAT	Both S1 and S2 and all mixed-method criteria are met
Hung et. al. (23)	MMAT	Both S1 and S2 and all mixed-method criteria are met
Castor Delgado et. al. (25)	NIH Tool	Moderate risk of bias (58%)
Saiboon et. al. (26)	NIH Tool	Moderate risk of bias (58%)
Alim et. al. (27)	NIH tool	Moderate risk of bias (66%)
Xia et. al. (28)	NIH tool	Moderate risk of bias (75%)
Digregorio et. al. (29)	NIH tool	Moderate risk of bias (66%)
Glauberman et al. (30)	NIH tool	Moderate risk of bias (33%)
Huh and Kang et al. (32)	JBI Critical Appraisal Checklist Tool	Included
Hwang and Lee (31)	JBI Critical Appraisal Checklist Tool	Included
Shujuan et al. (33)	Cochrane risk-of-bias tool	Some concerns of bias

3.3 Studies' characteristics and outcomes of interventions

Table 3 shows the general characteristics of the twelve studies. Most of the studies were from Asia regions, such as Saiboon et al. (26), Hwang & Lee (31), Hung et al. (23), Xia et al. (28), Huh and Kang et al. (32), Shujuan et al. (33) and Alim et. al. (27). While studies by Phan et. al. (22), Gandhi et. al. (24) Glauberman et. al. (30) and Digregorio et. al. (29) were conducted in the USA i.e. North America and only the study by Castor Delgado et. al (25) was done in Spain i.e. Europe. Almost all study participants were nursing students; studies by Gandhi et al. (24) and Glauberman et al. (30) included both nursing and public health students. Except for studies by Castor Delgado et al. (25) and Saiboon et al. (26), the participants were only medical students.

The authors used different instruments or designs for disaster preparedness to identify improvements in specific competencies among students and to measure effectiveness. Three studies—Phan et al. (22), Hung et al. (23), and Gandhi et al. (24) — used a mixed-methods design. Casto Delgado et al. (25), Glauberman et al. (30), Xia et al. (28), Digregorio et al. (29), Shujuan et al. (33) and Alim et al. (27) used an experimental design. Two studies by Hwang & Lee (31) and Hung and Kang (32) employed a quasi-experimental design, whereas Saiboon et al. (26) used a pre-post questionnaire or survey.

Table 3: Characteristic features of the included studies

Author	Year of publication	Country, Region	Research design	Study Sample size	Participant Type	Research instruments
Phan et. al.(22)	2023	United States (U.S.), North America	Mixed-method design	104	Nursing students	The 75-min simulation consisted of 3 parts: a 15-minute prebrief, a 15-minute disaster simulation, and a 45-min debrief.
Castor Delgado et. al.(25)	2022	Spain, Europe	Experimental study (pre-test and post-test)	135	Medical student	A simulation exercise is the "table-top" exercise. First session 1) Presentation and exam (15 min), (2) Theoretical explanation (45 min) , (3) Table-top exercise (90 min), (4) debriefing (30min), (5) self-perception questionnaire (15min) after the exercise. After

						one month, an exam was given to the students.
Hwang & Lee.(31)	2021	South Korea, Asia	A quasi-experimental study of one group (pre-test and post-test)	78	Nursing students	The first round of questionnaires about pandemic response and disaster nursing (pre-training). Then, the second round of questionnaires. The 40-minute Stimulation module consisted of pre-simulation lectures on disaster nursing, including infectious disease pandemics, practice, and debriefings with serial tests. The three scenarios contained pre-hospital settings, home visits, arrival to the emergency department, and follow-up home visits for rehabilitation. Third round of questionnaires (post-training).
Hung et. al.(23)	2021	Hong Kong; Asia	Mixed-method design	157	Nursing students	Disaster preparedness and management course Theoretical and practical inputs (45h). Pre- and post-intervention questionnaires.
Gandhi et. al.(24)	2021	United States (U.S.), North America	Mixed-method design	89	Public health and Nursing Students	-Stimulation exercise presented a pandemic-spreading scenario (4hrs). -Tabletop exercise about preparedness for response to pandemic influenza (2hrs). -Pre- and Post-intervention survey.
Saiboon et. al.(26)	2021	Malaysia, Asia	Prospective, cross-sectional, pre-post interventional study	168	Pre-clinical year medical students, from the first and second year of the program.	-Three self-learning video lectures of 8-10 mins duration, covering disaster risk management principles and medical management. -A self-administered questionnaire assessing the participants' knowledge of the 2 principles that were covered through the video lectures.
Glauberman et. al. (30)	2020	United States (U.S.), North America	Experimental study (pre-test and post-test)	10 and 60	Public health and Nursing Students	All students were given the same prework assignments to prepare them for the DAIS. In addition, they received disaster. triage training, either online or in the classroom. After each session, all students completed a faculty-created retrospective pre- and post-questionnaire based.

						on the four core IPE competencies
Xia et. al. (28)	2019	China, Asia	Experimental study using a pretest and post- test control group design.	63	3rd and 4th year nursing students.	- Disaster nursing preparedness training program containing 3 topics; disaster fundamentals, disaster triage, and family preparedness. (6 hrs and 20 mins) -Pre-post questionnaire at three time points; before intervention, right after intervention, and 1 month after intervention. (40min)
Digregorio et. al. (29)	2019	United States (U.S.), North America	Experimental pre-test, post-test descriptive research design	109	Nursing student	A one-hour simulated disaster drill was conducted. The Interprofessional Collaborator Assessment Rubric (ICAR) was used as the pre-test and post-test instrument for all participants.
Shujuan, et. al. (33)	2019	China, Asia	Two-arm randomized controlled trial	106	2nd year nursing students.	-Control group: Usual disaster nursing course; including 24 lectures and four skills laboratory manikin simulation sessions. -Intervention group: Besides the usual disaster nursing course, they received VR training scenarios; a total of 12 scenarios including two disaster scenes (fire and earthquake). (10-25 min for each scenario). -A pre-post questionnaire was provided for all participants.
Huh and Kang. (32)	2018	South Korea, Asia	A quasi-experimental design with a nonequivalent control group	60	Nursing students	- Disaster nursing education program using case-based small group learning method based on the disaster nursing competencies that were set by the International Council for Nurses (460 mins per week over a total of 4 weeks). - Pre-post content validity index questionnaire.
Alim et al. (27)	2015	Indonesia, Asia	Experimental pre-post-test	309 in the training progra	Undergraduate and diploma nursing students.	- Disaster preparedness training consists of 4 topics: introduction to disaster preparedness, command and management for healthcare, and 2 parts of basic

				m, 225 in the drill.		life support treatment in disaster (8hrs). - Disaster drill by responding to disaster situation through small groups. -The observational evaluation was measured by instructors during the drill.

Table 4: Outcomes of disaster medicine educational program interventions in the included studies

Author	Competencies	Results	Conclusion
Phan et. al.(22)	1- Knowledge	74% of nursing students agreed that their level of knowledge was enhanced after the simulation.	Concluded that nursing faculty can best provide the balance between the use of available material and personnel resources and an adequate level of realism.
	2-Self-confidence	Mean scores increased from 2.78 pre-simulation to 4.14 post-simulation on a 0-5 scale.	
Castor Delgado et. al.(25)	1-Knowledge	Median = 9 (IQR = 2) better acquisition of knowledge related to MCI roles (P = 0.048) .	Table-top exercises increase students' motivation, their theoretical knowledge, and the perception of their skills to respond to MCI, with a high degree of retention of knowledge
	2-Skills acquisition perception: - Leadership skills - Multidisciplinary coordination team. - Scene safety assessment. - Scene sectorization skills. - Triage skills.	There was a better perception of multidisciplinary team coordination skills (P = 0.014), but no statistical differences were found in the other perceived skills analyzed.	
Hwang and Lee (31)	1- Disaster preparedness	Showed a statistically significant improvement ($F = 65.60$, $p < .001$), with significant differences observed between the pre-test and mid-test ($p < .001$) and between the mid-test and post-test ($p < .001$).	A simulation program targeting an infectious disease disaster positively impacts disaster preparedness, disaster nursing competency, and confidence in disaster nursing among nursing students.
	2- Ethical and legal practice 2- Responsibility 3- Communication 4- Information sharing.	All were improved significantly ($F = 44.09$, $p < .001$), with higher scores in the mid-test compared to the pre-test ($p < .001$), and in the post-test compared to the mid-test ($p < .001$).	
	3- Critical thinking.	No significant differences were shown between time points ($F = 0.25$, $p = .777$).	

	4- Confidence	It increased (F = 37.80, p < .001), with significantly higher scores on the mid-test than on the pre-test (p = .024). However, the post-test scores were not significantly higher than the mid-test scores; there was a trend-level increase (p = .079).	
	5- Knowledge	No significant differences were obtained between time points (F = 0.33, p = .719).	
	6- Triage	No significant results were shown. (F = 0.14, p = .868)	
	7- Willingness to participate	significant increase in terms of the ratio of participants with 46 persons (59.0%) responding positively in the pretest, 56 persons (71.8%) responding positively in the midtest, and 69 persons (88.5%) responding positively in the posttest ($\chi 2 = 15.35$, p < .001). There was no significant difference between the posttest and the midtest ($\chi 2 = 5.33$ p = .057), the midtest and the pretest ($\chi 2 = 2.03$, p = .462)	
Hung et. al.(23)	1- Knowledge.	Significant positive results were found for disaster knowledge (t(156) = −8.12, $p < 0.01$, d = −0.84).	It reflected that an appropriate course design with interactive, simulation-based, and learner-centered nursing education programs could positively influence participants' knowledge and self-confidence.
	2- Perceived ability in terms of confidence.	Perceived ability (t(156) = −7.95, $p < 0.01$, d = −0.72).	
	3- Willingness to offer help.	There was no significant improvement in willingness.	
Gandhi et. al.(24)	1- Situational awareness.	The mean difference of Pre-post survey score = 0.511, with a P-value < 0.001 (Statistically significant)	The study findings showed the effectiveness of simulation-based teaching strategies in improving future healthcare professionals' responses to pandemics.
	2- Effective communication.	The mean difference of pre-post survey score= 0.533, with a P-value < 0.001 (Statistically significant)	
	3- Public health knowledge.	The mean difference of pre-post survey score= 0.803, with a P-value < 0.001 (Statistically significant)	

Saiboon et. al.(26)	1- Knowledge on Principles of Disaster Response: - Definition - Classification - Phases - Stage - Activation - Command and control - Safety		For all of them, the mean score on the pre-post test showed a significant difference (P-value <0,001)	The study found that a novel e-learning platform is effective in improving disaster risk management in undergraduate medical students. Although it showed efficacy in teaching/learning basic decision-making knowledge, this was not the case for complex decision-making knowledge 'such as treatment and transport decisions.'
	2- Knowledge on Medical Management of Disaster Response: - Decontamination - Triage - Treatment - Transport		Only decontamination and triage competencies showed significant differences in the mean scores of the pre-posttest (P-value <0.001). However, treatment and transport competencies did not show any significant differences (P-value= 0.029 and 0.18, respectively)	
Glauberman et. al. (30)	1- Values and ethics		Pre- and post-questionnaires significantly improved scores on all four IPE core competencies.	The study found that adapting the DAIS activity from a resource-intensive exercise to a streamlined tabletop format offered several advantages.
	2- Roles and responsibilities			
	3- Teamwork			
	4- Communication			
Xia et. al. (28)	In disaster fundamentals topic:	Knowledge Skill Attitude	- Before the intervention, there were no significant differences in the scores of knowledge, skill, and attitude between the 2 groups. - Right after the intervention, significant differences were shown only in knowledge between both groups (P-value =0.003), but not in terms of skill and attitude. - One month after intervention, no significant differences were found between the groups' three competencies.	This disaster education program is highly effective in enhancing nursing students' knowledge and skills for disaster response. However, no improvement was found in attitude competency for disaster response. Further development of disaster training programs is needed for nursing students.
	In disaster triage topic:	Knowledge Skill Attitude	- Before intervention, there were no significant differences in the scores of knowledge, skill, and attitude between the 2 groups. Right after the intervention, knowledge and skill scores were found to have significant differences between the two groups (P-value = .002, .024, respectively), but that was not the case for attitude competency.	

			- One month after the intervention, same as disaster fundamentals results, no significant differences were obtained in all competencies between the groups.	
	In family preparedness topic:	Knowledge Skill Attitude	-Before the intervention, the result is the same as in the previous topics. -right after the intervention, significant differences were found in knowledge and skill competencies between the two cohorts, but not in attitude. (P-value= 0 for both knowledge and skill scores) -one month after the intervention, unlike the previous topics, significant differences were found to be in knowledge and skill competencies but not in attitude among both groups. (P-value= 0 , .002 respectively)	
Digregorio et. al. (29)	1- Communication 2- Collaboration 3- Roles and responsibilities 4- Collaborative patient/client-family centred approach. 5- Team functioning		All the sections of the ICAR had a lower mean score on the ICAR post-test than the pre-test.	The assessment identified the need to integrate inter-professional competencies in disaster preparedness education.
	6- Conflict management and resolution		Statistically significant ($Z = -3.153$, $p = .002$, $r = -0.30$).	
Shujuan, et. al. (33)	1- Disaster preparedness. 2- Confidence. 3- Performance.		After adjusting for all covariant imbalances, significant differences between the 2 groups were shown in the effect of VR on disaster preparedness, confidence, and performance. (P-value = 0.001, 0.069, and 0.044 respectively)	The VR intervention effectively improved nursing students' disaster preparedness, confidence, and performance.
Huh and Kang. (32)	1- Disaster nursing knowledge.		The mean difference of the pre-post questionnaire for the intervention group = 8.90, with a P-value < 0.001 (Statistically significant).	Significant improvements were demonstrated in disaster nursing competencies

		While for the control group, MD = -1.33	among nursing students after receiving the disaster education program. Thus, a future disaster nursing curriculum could be developed based on this program.
	2- Disaster triage.	The mean difference of the pre-post questionnaire for the intervention group = 1.50, with a P-value of 0.002 (Statistically significant). While for the control group, MD = -0.73	
	3- Disaster readiness.	The mean difference of the pre-post questionnaire for the intervention group = 45.70, with a P-value < 0.001 (Statistically significant). While for the control group, MD = 10.16	
Alim et. al. (27)	1- The ability to triage and identify health problems.	Among all participants in the drill (225), on a 5-point Likert scale, with a 5 score of very proficient, a mean of 3.7 with an SD of 0.71 was measured.	The training and drill showed effective results regarding disaster knowledge and preparedness for undergraduate and diploma nursing students.
	2- The ability to do initial treatment.	Among all participants in the drill (225), on a 5-point Likert scale, with a 5 score of very proficient, a mean of 4.05 with an SD of 0.51 was measured.	
	3- The ability to transport survivors safely to the nearest health facility.	Among all participants in the drill (225), on a 5-point Likert scale, where a 5 score means very proficient, a mean of 4.10 with an SD of 0.43 was measured.	
	4- The ability to work with other team members.	Among all participants in the drill (225), on a 5-point Likert scale, where a 5 score means very proficient, a mean of 4.39 with an SD of 0.82 was measured.	

As illustrated in Table 4, competencies were measured as an outcome of the interventions used in each study. There are between 2 and 10 competencies in each study. A total of 24 unique competencies were identified from the 12 studies. A content analysis showed that the most frequently cited competencies are knowledge, then confidence, communication, triage-related competency, and skills. These competencies were further classified into the following domains: cognitive (knowledge-based), affective (attitude/confidence), and psychomotor (skills-based). In addition, most study participants showed an increase in knowledge after the intervention; for instance, in Hung et al. (23), knowledge improved significantly ($p < 0.01$). In contrast, only one study by Hwang and Lee (31) found no significant difference in the students' knowledge before and after the intervention. This study was also the only one to find no significant differences in most measurement outcomes, except for ethical and legal practice, responsibility, communication, and information sharing (26). Overall, most studies reported positive responses across most competencies.

4. Discussion

This study aims to identify teaching competencies used in disaster preparedness education for undergraduate healthcare students. It also describes the geographical and disciplinary distribution of studies reporting these competencies. Twenty-four key competencies were identified to prepare future healthcare providers to effectively manage and respond to disasters. Findings from 12 studies indicated that knowledge was the most frequently emphasized competency. Drawing on established disaster risk reduction and health emergency frameworks, disaster preparedness in the context of healthcare education refers to the development of knowledge, skills, attitudes, and system-based competencies that enable healthcare students to

anticipate, respond to, and recover from disasters through effective decision-making, communication, coordination, and professional practice within complex emergency environments.

4.1 Characteristics profiles

This systematic review found that most studies assessing the effectiveness of disaster education programs in terms of competencies were conducted in East Asian countries, including Hong Kong, South Korea, China, and Malaysia (Table 2). This trend aligns with the heightened focus on disaster preparedness in the Asia-Pacific region, considered the world's most disaster-prone region, according to the UNFPA (34). The region's high exposure to natural disasters likely drives researchers to prioritize disaster preparedness strategies more actively than in areas with lower disaster risks. Similarly, four studies were conducted in North America, a region also highly susceptible to natural disasters (35). In contrast, only one study was conducted in Europe (Spain), and no studies were identified from the Middle East. However, the Middle East has experienced numerous disasters, both natural and man-made, such as earthquakes in Turkey, Syria, and Morocco, as well as ongoing conflicts in Syria, Palestine, and Sudan. Despite this, several studies in the Middle East indicate that disaster preparedness among healthcare providers and students is low to moderate. For instance, according to Shanableh et al., healthcare workers in the UAE demonstrated moderate knowledge and attitudes toward disaster response, highlighting the need for disaster-related training and education (36). In Yemen, Naser and Saleem found that healthcare providers had an inadequate understanding of disaster preparedness, underscoring the importance of integrating emergency preparedness into core medical curricula (37). Similarly, during the COVID-19 pandemic in Libya, frontline healthcare workers, including doctors and nurses, demonstrated limited awareness and preparedness to manage the crisis (38). Overall, the lack of disaster preparedness in the Middle East is concerning and requires prompt action from health colleges and facilities to enhance training and readiness. The geographic distribution of included studies also raises concerns regarding global equity and generalizability. The underrepresentation of low- and middle-income countries (LMICs) and the Middle East highlights a critical disconnect between the global disaster burden and the generation of educational evidence. Regions disproportionately affected by natural disasters, conflict, and public health emergencies remain underrepresented in disaster education research, reflecting broader educational inequities and limitations in research capacity. This imbalance limits the global relevance of existing competency frameworks and underscores the need for context-sensitive research and capacity-building initiatives to inform disaster preparedness education in high-risk settings.

The findings of this study highlight significant professional disparities in disaster preparedness education. While most existing studies have focused on nursing students, only two have included medical students, and two others have included both nursing and public health students. Notably, no studies have addressed other healthcare disciplines such as pharmacy, physiotherapy, or dental medicine, despite growing evidence of inadequate disaster preparedness among students in these fields. A pilot study conducted in India assessed dental graduates' knowledge, attitudes, and behaviors regarding disaster preparedness. The results underscored a critical need to enhance their competencies in this area (39). Similarly, a systematic review by McCourt et al. examined the disaster preparedness of pharmacists and pharmacy students, revealing that fewer than 18% of registered pharmacists felt adequately prepared to respond to a disaster (40). Pharmacy students demonstrated comparably low levels of preparedness.

A key gap in the literature is the limited research on disaster preparedness among pharmacy students and other health professional students beyond medicine and nursing. Pharmacists have played a pivotal role in disaster response, as evidenced by their work during the COVID-19 pandemic (41). For instance, a study assessing the availability of essential medicines in 14 health facilities in Gaza found that, among 25 essential medicines, only four were available in public facilities, four in humanitarian centers, and just one in private pharmacies—falling short of the WHO benchmark of 80% availability (42). Several critical medicines for chronic illnesses were entirely unavailable. In conflict-affected regions, the availability and quality of medicines are of paramount importance. Despite their essential role as frontline healthcare providers, there is a pressing need for further research to better understand and address the disaster preparedness needs of pharmacy and other health professional students.

These findings have important implications for curriculum transferability and interprofessional disaster education. The predominance of discipline-specific and nursing-focused studies raises important concerns regarding curriculum transferability and interprofessional education. Disaster response is inherently collaborative, yet the limited inclusion of multiple health professions constrains the applicability of identified competencies across diverse curricula and undermines interprofessional readiness. This gap suggests that current disaster education models may insufficiently prepare healthcare students for team-based decision-making and coordinated response in real-world disaster settings.

4.2 Teaching competencies on disaster medicine and preparedness

The primary objective of this review was to determine the core competencies for disaster preparedness, as

detailed in Table 3. The study generated several noteworthy findings. Firstly, knowledge emerged as the most frequently studied competency across nine studies (22, 23, 24, 25, 26, 28, 30, 31, 32), underscoring its critical role in preparing students to respond effectively to disasters. Some studies further differentiated between various types of knowledge. For example, Saiboon et al. (26) assessed students' understanding of disaster principles and disaster management response. Similarly, Xia et al. (28) evaluated knowledge of disaster fundamentals, triage, and family preparedness. However, while knowledge is undeniably necessary, it is insufficient unless it can be applied in real-world practice to benefit society. From this perspective, other competencies are equally essential and should not be considered inferior to knowledge. All extracted competencies must be considered holistically.

In addition to knowledge, the next most commonly identified competencies across the 12 studies were confidence (22, 23, 31, 33), communication (24, 29, 30, 31), triage-related skills (25, 26, 31, 32), and general skills (25, 26, 28). Weaving these competencies together, the first thing students will need is a solid foundation in the required knowledge. This includes knowledge of triage protocols and disaster medicine, which directly fosters confidence in making rapid, decisive decisions under pressure and provides a cognitive foundation for subsequent actions (43). Then the students will apply this knowledge during low-fidelity triage drills, which are critical first operational decision-making tasks in a disaster. Triage is not a solo, silent activity; it necessitates immediate communication, which defines the initial workflow for the entire team (44). Hence, it sets priorities and allocates the team's resources and manpower, making it the first significant act of team leadership and coordination. Effective communication is the driving force behind teamwork and collaboration. Assertiveness and respectful communication are essential for effective collaboration when addressing ethical dilemmas or complex cases. Clear communication will provide seamless teamwork (43, 44). Nevertheless, functioning cohesively will create a psychological safety and trust within the team. This will foster collective and individual confidence. In turn, this confidence will empower the entire cycle, since a confident student is more likely to apply their knowledge under extreme pressure, make resilient triage calls, communicate actively, and collaborate proactively with the team. These competencies are vital in ensuring a comprehensive and practical approach to disaster preparedness among healthcare students.

On the other hand, some variations were observed among the included studies. To illustrate further, a few studies have listed competencies in detail, including Hwang and Lee (31), Castor Delgado et al. (25), and Digregorio et al. (29). While others examined a limited number of competencies, besides being so general in choosing the competencies to be studied, Phan et. al. (22), Gandhi et al. (24), Hung et. al. (23), Huh and Kang (32), and Shunjan et. al. (33) studies could be examples of this. However, in the Hwang and Lee study (31), unique competencies examined only in this study, such as critical thinking, information sharing, and ethical and legal practice, besides leadership, were not only studied in the Hwang and Lee study (31) but also in the Castor Delgado et al. study (25). In their study, Castor Delgado et al. also examined other competencies, including multidisciplinary team coordination, safety, and sectorization (25). Furthermore, the willingness to offer help or practice was examined as a competency in only two studies: Hwang and Lee (31) and Hung et al. (23). Nonetheless, even though Gandhi et al. (24) did not examine many competencies, they chose a rare competency not mentioned by any of the other studies: situational awareness. To add to the list of rare competencies, conflict management and resolution have been studied only by Digregorio et al. (29), an essential competency for health care providers managing a disaster. That is due to the nature of the work in complex situations, such as disasters, where many conflicts and struggles must be addressed wisely. When discussing conflicts, resolving them requires that the healthcare provider have well-established values, ethics, and a legal background, as found in Hwang and Lee's study (31) and Glauberman et al.'s study (30). Last but not least, the collaborative patient/client-family approach is a significant and critical competency, as studied by Digregorio et al. (29). It highlights the importance of the basics in health care, so even if there is a terrible disaster and the whole system is missing, the first and most important goal for health care providers is to have a collaborative approach with the patient or the family while setting up the health care plan.

In this review, disaster preparedness competencies are clustered into three educational domains: cognitive, affective, and psychomotor, highlighting important imbalances in current educational approaches. Cognitive competencies—primarily disaster-related knowledge, situational awareness, and conceptual preparedness—were most consistently addressed across studies, reflecting a predominant emphasis on knowledge transmission (22, 23, 24, 26, 28, 32). Affective competencies, including confidence, willingness to participate, and professional values, were frequently reported but often as secondary outcomes, suggesting that attitudinal development is acknowledged but not systematically targeted (22, 23, 30, 31, 33). In contrast, psychomotor competencies, such as triage performance, teamwork, communication, and coordination, were largely confined to simulation- or drill-based interventions, indicating limited integration of skills-based training within routine curricula (25, 29, 30, 27, 28, 33). This pattern suggests that disaster education for healthcare students remains heavily knowledge-oriented, with insufficient attention to affective engagement and hands-on skill

development, despite their critical role in real-world disaster response. Collectively, these competencies foster a well-rounded preparedness in health students, equipping them to become effective and responsive healthcare providers in future practice. Establishing standardized teaching competencies and standards for disaster preparedness among healthcare students will provide a foundation for future researchers and policymakers to develop comprehensive educational programs. Equipping students with these essential skills will better prepare them to address disaster management challenges.

4.3 Study recommendations

Based on the findings of this integrative systematic review, several directions for future research in disaster preparedness education for healthcare students are recommended. First, given the predominance of cognitive outcomes, future studies should move beyond knowledge acquisition alone and adopt balanced, competency-based educational designs that intentionally integrate cognitive, affective, and psychomotor learning domains. While innovative approaches such as simulations, case-based learning, and problem-based learning have demonstrated effectiveness in enhancing disaster-related knowledge, their impact on confidence, attitudes, teamwork, and hands-on performance requires more systematic evaluation with robust, standardized outcome measures.

Second, future research should explicitly address interprofessional education (IPE) in disaster preparedness. Disaster response is inherently collaborative; however, the limited integration of multiple health professions constrains the curriculum's transferability and real-world applicability. Studies should therefore design and evaluate interprofessional disaster education interventions involving students from medicine, nursing, pharmacy, public health, and allied health, with particular attention to communication, role clarity, coordination, and team performance across professional boundaries.

Third, the marked geographic imbalance in the existing literature highlights an urgent need for research from low- and middle-income countries (LMICs) and the Middle East, regions that experience a disproportionate share of natural disasters, conflicts, and public health emergencies. Future studies should prioritize context-sensitive disaster education research that accounts for local hazard profiles, resource constraints, cultural factors, and health system capacities. Strengthening research capacity and fostering international collaborations in these settings are essential to reducing educational inequities and developing globally relevant competency frameworks.

Finally, as most included studies focused on undergraduate healthcare students, future research should extend to postgraduate trainees, residents, and practicing healthcare professionals, and examine the effectiveness of continuing professional development programs in sustaining disaster preparedness competencies over time. Longitudinal and implementation-focused studies are particularly needed to assess whether educational gains translate into improved performance during real-world disaster response.

4.4 Study strengths and limitations

This integrative systematic review has several notable strengths. To the best of the authors' knowledge, it is among the first evidence-based reviews to systematically identify and synthesize disaster preparedness competencies in undergraduate healthcare education, drawing on diverse study designs and educational contexts. By adopting an integrative review approach, the study incorporated experimental, quasi-experimental, and mixed-methods research, providing a comprehensive and conceptually rich overview of disaster preparedness competencies that would not be achievable through design-restricted reviews. The inclusion of a large initial yield (6,238 records) and the final synthesis of 12 eligible studies reflects a rigorous and transparent screening process appropriate for a focused educational review. In addition, searching multiple databases ($n = 7$) and including both peer-reviewed and selected grey literature increased the breadth of coverage and reduced the likelihood of omitting relevant educational interventions.

Despite these strengths, several limitations should be acknowledged. First, although extensive efforts were made to retrieve full texts, some potentially relevant studies were unavailable, which may have resulted in unintentional exclusions. Second, restricting the search to English-language publications may have introduced language and regional bias, limiting the representation of disaster education research from non-English-speaking regions and constraining global generalizability. Third, the exclusion of related terminology, such as emergency management, may have led to the omission of studies addressing overlapping competency domains, reflecting the conceptual fluidity within disaster-related education literature. Fourth, while grey literature was included, reliance primarily on ProQuest and ResearchGate may not have captured proprietary, practice-based, or short-course disaster training programs, which are common in disaster medicine education but underreported in academic databases. Fifth, this review was not registered in PROSPERO.

Methodological heterogeneity across included studies precluded quantitative synthesis or meta-analysis, necessitating reliance on qualitative content analysis. While appropriate for an integrative review, this approach limits the ability to estimate effect sizes or directly compare intervention effectiveness. Finally, the predominance of nursing-focused studies and the

underrepresentation of interprofessional cohorts, low- and middle-income countries, and the Middle East highlight important gaps in the existing evidence base, which should be considered when interpreting and applying the findings.

Overall, these strengths and limitations underscore both the contribution and boundaries of this review and point to critical areas for future research to strengthen the evidence base for disaster preparedness education.

5. Conclusions

This systematic review presents a relevant and useful review of disaster preparedness competencies in undergraduate healthcare education. Its main contribution lies in identifying and organizing competencies across educational domains and highlighting important gaps in current disaster education research, including overemphasis on cognitive outcomes, limited interprofessional education, and underrepresentation of high-risk regions. It further examines these competencies across different geographical regions and types of educational institutions. Across the 12 included studies, 24 unique competencies were identified. Content analysis indicated that the most frequently reported competencies were knowledge, confidence, communication, triage-related skills, and general skills. Most participants were nursing students, and most studies were conducted in Asian countries. These competencies are essential for ensuring a comprehensive and practical approach to disaster preparedness education among healthcare students.

Declarations

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- Contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work – MAA, YA, MIMI
- Drafting the work or reviewing it critically for important intellectual content – MAA, YA, MIMI, BM
- Final approval of the version to be published – MAA, YA, MIMI, BM
- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved - MAA, YA, MIMI, BM
- All authors read and approved the final manuscript.

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