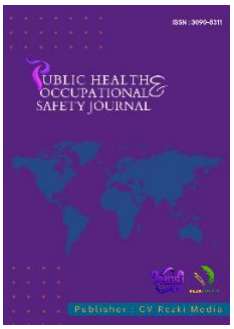

Effects of theory-based education versus simulation-based training on knowledge and skills in managing shortness of breath among university health volunteers

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ABSTRACT

Background: First aid skills for respiratory emergencies, particularly shortness of breath, are crucial for university health volunteers who often serve as the first responders. However, theory-based learning alone is not always adequate for developing practical competencies.

Objectives: This study aims to evaluate the effectiveness of theoretical education compared to the combination of theory and simulation in enhancing the knowledge and skills of university health volunteers in managing cases of shortness of breath.

Methods: A quasi-experimental pre-posttest design was conducted among 40 student volunteers of the Indonesian Red Cross Volunteer Corps (KSR-PMI), aged 18-20 years, who were equally assigned to a theory-only group or a theory-plus-simulation group. The intervention consisted of two 45-minute sessions. Knowledge and skills were assessed before and after the intervention. Data were analyzed using the Wilcoxon Signed Rank Test and the Mann–Whitney U Test with a significance level of $\alpha = 0.05$.

Results: Knowledge significantly improved in both groups ($p < 0.05$), with no significant difference between them ($p = 0.204$). Skill performance improved markedly in the simulation group, increasing from 0% to 100%, compared with only 20% in the theory-only group ($p < 0.001$).

Conclusions: While theoretical education effectively enhances knowledge, it is insufficient for developing practical skills. Integrating simulation-based training significantly improves psychomotor competence and better prepares university health volunteers to manage respiratory emergencies.

Keywords: first aid training, shortness of breath, simulation.

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INTRODUCTION

Medical emergencies in university settings pose significant challenges that require well-prepared first responder teams capable of delivering timely and effective first aid. Academic and non-academic activities, such as sports events, seminars, and student activities, may trigger medical incidents that require immediate first aid (Smith et al., 2020; Taylor et al., 2022). In the global context, respiratory distress has been identified as one of the leading causes of morbidity and mortality, with clinical consequences ranging from severe hypoxia to multi-organ failure when management is delayed (WHO, 2023; Jones et al., 2022). Dyspnea is a complex symptom commonly associated with respiratory, cardiovascular, and metabolic disorders, and it often represents a medical emergency requiring immediate assessment (Parshall et al., 2012; Morris & Adams, 2020). Clinical studies have consistently shown that delayed treatment increases the mortality risk, underscoring the importance of preparedness among trained first responders (Smith et al., 2020; Brill & Wedzicha, 2014). Therefore, the readiness of university health teams to provide timely first aid is a crucial factor in preventing serious complications (Weile et al., 2021).

The literature emphasizes that first aid training plays a critical role in enhancing preparedness for emergencies (Sharma & Gupta, 2019). Theory-based education can improve cognitive understanding; however, its limitation lies in its limited impact on technical skills that require hands-on practice (Alharbi et al., 2024). In contrast, Simulation-based education enables learners to engage in realistic clinical scenarios, promoting the acquisition of psychomotor skills, clinical reasoning, and confidence in emergency response (McGaghie et al., 2014; Cook et al., 2011). Recent evidence from Scopus-indexed studies demonstrates that simulation-based training significantly reduces clinical errors while improving response accuracy, team performance, and decision-making quality in emergency and critical care settings (Cook et al., 2011; McGaghie et al., 2014; Weile et al., 2021). Therefore, the integration of theoretical instruction and simulation-based practice has emerged as a learning strategy that is increasingly recognized in emergency health education.

Although numerous studies have highlighted the advantages of simulation in health education, the reported findings are not always consistent. Several studies have demonstrated that knowledge gains between traditional lectures and simulation-based learning do not differ significantly, despite the superior skills observed in simulation groups. Similar results have been reported in other medical fields, such as cardiopulmonary resuscitation training, where technical skills have been shown to improve following simulation; however, knowledge retention often declines without reinforcement (Oermann et al., 2019). In trauma training, some studies have reported significant improvements in psychomotor skills (Tan et al., 2021). In contrast, others have highlighted the weak transfer of training outcomes to real-world practice (Smith et al., 2021). In airway management training, simulation-based education significantly improves technical skills and procedural accuracy; however, its effectiveness depends on the quality of the instructor, structured debriefing, and the availability of sufficient simulation resources (Ardoin et al., 2020). This variability indicates that multiple factors influence the effectiveness of simulation and remain inconsistent across different domains. Amid this heterogeneity of findings, studies focusing specifically on university health teams remain scarce, despite the strategic role and unique characteristics of this group that distinguish them from the general population or school-based learners (Smith et al., 2020).

Based on the problems identified in the preliminary study conducted among 15 members of a university health team between June 17 and 24, 2025, a high demand for training materials related to the management of dyspnea cases was observed (80%). Additionally, there was limited practical experience in oxygenation techniques, utilizing both portable canned oxygen (60%) and portable oxygen cylinders (100%) with standard medical equipment. Low-flow portable oxygen devices may provide limited clinical benefit and should not replace standard medical oxygen delivery systems in cases of acute respiratory distress (O'Driscoll et al., 2017). Data from the World Health Organization (WHO, 2022) indicate that respiratory disorders constitute medical emergencies requiring rapid and appropriate management. In a university context in Iran, Mohammadi et al. (2016) reported a notable prevalence of respiratory symptoms among students within the past 12 months, including wheezing (19.7%) and breathlessness (approximately 10.2%). Dyspnea may indicate failure of the respiratory or cardiovascular system and therefore requires immediate clinical attention.

Delays or errors in providing first aid to individuals experiencing dyspnea may lead to decreased consciousness, pulmonary complications, and even death (Brooks et al., 2018). Such conditions represent a significant barrier to improving emergency response capacity in university settings. Therefore, this study, entitled "Effects of Theory-Based Education Versus Simulation-Based Training on Knowledge and Skills in Managing Shortness of Breath Among University Health Volunteers," is essential to assess the impact of theoretical education on improving knowledge and skills in dyspnea management, to evaluate the effectiveness of combining theoretical education with simulation-based practice, and to compare the effectiveness of these approaches. The novelty of this study lies not only in the application of a combined theory–simulation educational design, whose outcomes remain inconsistent in the existing literature, but also in its specific focus on non-medical university health teams dealing with dyspnea cases—a context that has received limited scholarly attention to date.

METHODS

Study Design and Participants

This study employed a quantitative approach using a quasi-experimental design with pre-test and post-test procedures. The design was selected to determine the effect of educational and simulation interventions on improving knowledge and skills in managing cases of shortness of breath among university health volunteers. The research was conducted at the Faculty of Sports Science from January to September 2025. This location was chosen because it serves as the primary activity center of the Indonesian Red Cross Volunteer Corps (KSR-PMI) at Universitas Negeri Malang, which constituted the study population.

The population consisted of all active members of the KSR-PMI unit in 2025, totaling 40 students, including 9 males and 31 females, aged between 18 and 20 years. A total sampling technique was employed due to the relatively small population size, enabling all eligible members to participate (Etikan et al., 2016). The sample was then divided into two intervention groups, each consisting of 20 participants: (1) the theory-only education group, and (2) the theory+simulation group. The duration of the intervention was minimal, consisting of two 45-minute sessions. Data collection was conducted through pre-tests and post-tests to assess knowledge and through

practical observation checklists to measure skills. Knowledge was assessed using a validated multiple-choice questionnaire with the following scoring categories:

Table 1. Knowledge Level Scale

Score	Category
76-100%	Good
56-75%	Moderate
<56%	Poor

Table 2. Skill Level Scale

Score	Category
8-10	Skilled
4-7	Adequately Skilled
0-3	Poorly Skilled

Ethical approval statement

This study received ethical exemption approval from the Research Ethics Committee of Universitas Negeri Malang (Ethical Exemption No. 05.08.15/UN32.14.2.8/LT/2025) on 5 August 2025.

Research Instruments

The data collection procedure began with administering a pre-test to both groups. Afterward, both groups received theoretical education, whereas only the second group received additional simulation-based practical training. Following the interventions, a post-test was administered to assess changes in both knowledge and skills. Measurement instruments consisted of: An 18-item true–false multiple-choice knowledge questionnaire, and A 10-step observation checklist assessing performance (performed/not performed). Both instruments were administered before and after the interventions. The knowledge questionnaire was validated through expert judgment by public health and medical professionals at Universitas Negeri Malang using Aiken's V formula, yielding a coefficient of 0.825 (indicating very high validity). Further validation through Pearson's product–moment correlation yielded values above the critical threshold (0.733–0.784), and reliability testing produced a Cronbach's alpha of 0.900, indicating high consistency. The skills observation checklist was also validated through expert judgment, resulting in an Aiken's V value of 0.75 (high validity). The assessment of respondents' skills was conducted directly by the researcher using an expert-validated assessment instrument (DeVellis, 2017).

Data Analysis

Data analysis was conducted after performing normality testing using the Shapiro–Wilk test, which is suitable for small sample sizes. The data were found to be non-normally distributed and ordinal in scale; therefore, nonparametric tests were applied. The Wilcoxon Signed-Rank Test was used to analyze pre–post differences within groups, and the Mann–Whitney U Test was used for between-group comparisons. A significance level of $p < 0.05$ was applied to determine the effectiveness of the interventions.

RESULTS

Based on Table 3, the respondents were predominantly female (78%), totaling 31 out of 40 participants. Most respondents were aged 19–20 years, with the most

significant proportion being 19-year-olds (50%). The majority came from the Faculty of Sports Science (33%). Although faculty background was not examined as a differentiating variable, these findings highlight the potential of university-based volunteer teams to function as adaptive and effective multidisciplinary emergency responders.

Table 3. Frequency Distribution of Respondent Characteristics

Intervention Group 1			Intervention Group 2		
Respondent Characteristics	Frequency (n=20)	Percentage (%)	Respondent Characteristics	Frequency (n=20)	Percentage (%)
Gender					
Male	5	25	Male	4	20
Female	15	75	Female	16	80
Total	20	100	Total	20	100
Age					
18 years	0	0	18 years	3	15
19 years	11	55	19 years	9	45
20 years	9	45	20 years	8	40
Total	20	100	Total	20	100
Faculty					
Mathematics and Natural Sciences	4	20	Mathematics and Natural Sciences	3	15
Educational Science	2	10	Educational Science	2	10
Literature	2	10	Literature	1	5
Sports Science	6	30	Sports Science	7	35
Social Sciences	2	10	Social Sciences	1	5
Psychology	2	10	Psychology	1	5
Engineering	2	10	Engineering	2	10
Total	20	100	Total	20	100

Intervention group 1 is the group that only received education on handling shortness of breath cases. Before the intervention, 40% of respondents fell into the moderate or poor knowledge categories. After receiving theoretical education, 90% of participants achieved a "good" knowledge category. The improvement was statistically significant ($p = 0.000$), indicating that theoretical instruction effectively enhanced cognitive understanding (Table 4). Reported that lectures and instructional discussions remain effective methods for improving cognitive learning outcomes, even though they do not significantly influence psychomotor skills.

Prior to the intervention, 90% of respondents were categorized as "poorly skilled." After theoretical education, only 20% achieved the "skilled" category. Although the improvement was statistically significant ($p = 0.000$), the magnitude of change was relatively small compared to cognitive gains (Table 5).

Table 4. Pre- and post-intervention knowledge levels in Intervention Group 1 (theory-based education)

Category	**Pre-Intervention**		**Post-Intervention**		**p-value**
	N (20)	**%**	**N (20)**	**%**	
Good	12	60%	18	90%	
Moderate	6	30%	1	5%	0,000
Poor	2	10%	1	5%	

Table 5. Pre- and post-intervention skill levels in Intervention Group 1 (theory-based education)

Category	Pre-Intervention		Post-Intervention		p-value
	N	%	N	%	
Skilled	0	0%	4	20%	0,000
Adequately Skilled	2	10%	7	35%	
Poorly Skilled	18	90%	9	45%	

Group 2 received both theoretical education and practical simulation of shortness of breath management. The proportion of respondents achieving "good" knowledge increased from 35% before intervention to 80% afterward. The improvement was statistically significant (p = 0.000), demonstrating that combining theory and simulation enhanced cognitive learning similarly to the theory-only approach (Table 6).

Table 6. Pre- and post-intervention knowledge levels in Intervention Group 2 (theory-based education combined with simulation)

Category	Pre-Intervention		Post-Intervention		p-value
	N	%	N	%	
Good	7	35%	16	80%	0,000
Moderate	9	45%	4	20%	
Poor	4	20%	0	0%	

Table 7. Pre- and post-intervention skill levels in Intervention Group 2 (theory-based education combined with simulation)

Category	Pre-Intervention		Post-Intervention		p-value
	N	%	N	%	
Skilled	0	0%	20	100%	0,000
Adequately Skilled	1	5%	0	0%	
Poorly Skilled	19	95%	0	0%	

Before intervention, 95% of respondents were categorized as "poorly skilled." After simulation practice, all respondents (100%) achieved "skilled" status. This dramatic improvement was statistically significant (p = 0.000), showing the strong effectiveness of simulation in developing psychomotor competencies (Table 7).

Table 8. Between-group comparison of post-intervention knowledge and skill outcomes

Variables	Group 1	Group 2	p-value
	Mean Rank	Mean Rank	
Knowledge	18,18	22,83	0,204
Skill	11,98	29,03	0,00

Knowledge Comparison The knowledge improvement between the two groups did not differ significantly (p = 0.204) (Table 8). Although the theory+simulation group showed a slightly higher increase, the difference was not statistically significant. Cognitive learning may reach a plateau with brief interventions, especially with small sample sizes (Polit & Beck, 2017). Skill Comparison Skill improvement showed a highly significant difference (p = 0.000). Group 1 (Theory Only): mean rank = 11.98 Group 2 (Theory + Simulation): mean rank = 29.03 This confirms that simulation training had a substantial impact on psychomotor skill development.

DISCUSSION

The demographic characteristics of respondents provide important contextual insights for interpreting the study findings. The predominance of female participants aligns with previous evidence indicating that female university students tend to

exhibit higher levels of prosocial behavior, social empathy, and a greater willingness to engage in volunteer activities compared to their male counterparts (Clary et al., 2021). This tendency may explain the greater representation of female students within campus health volunteer organizations.

The age distribution of respondents, predominantly 19–20 years, corresponds to late adolescence and early adulthood—a critical developmental phase characterized by optimal cognitive capacity and psychomotor maturation (Santrock, 2019). International studies have reported similar findings, indicating that individuals in early adulthood tend to acquire clinical and procedural skills more effectively when exposed to simulation-based learning environments (Kim et al., 2021). Accordingly, the age characteristics of respondents in this study likely supported the effectiveness of educational interventions, particularly those combining theoretical instruction with practical simulation.

Another important implication relates to the diverse academic backgrounds of the respondents. Participants were drawn not only from health-related faculties but also from non-health disciplines, highlighting that emergency preparedness within university settings is inherently multidisciplinary. Previous studies have shown that first aid teams composed of individuals from diverse academic and professional backgrounds tend to demonstrate broader situational awareness, stronger coordination, and more comprehensive emergency responses (Smith et al., 2020). Although faculty background was not examined as a differentiating variable in this study, these findings suggest that university health volunteers represent a promising multidisciplinary workforce capable of adapting to various emergency scenarios.

The significant improvement in knowledge observed in the theory-only group confirms that lecture-based education remains an effective means of transferring information and strengthening cognitive understanding. This finding is consistent with previous studies, which have demonstrated that didactic instruction and structured discussions significantly enhance knowledge acquisition among health-related learners (Oermann et al., 2019; Alharbi et al., 2024). However, although theoretical education successfully strengthened conceptual understanding, its impact on psychomotor skill development was limited. This discrepancy highlights the inherent limitations of theory-only approaches, as practical competencies cannot be adequately developed through passive learning alone and require active engagement and repeated hands-on practice (Cook et al., 2011).

A comparative analysis between the two intervention groups further revealed that, while knowledge gains were relatively comparable, skill acquisition differed markedly ($p < 0.001$). The theory-plus-simulation group achieved a substantially higher mean rank than the theory-only group, underscoring the critical role of simulation in translating cognitive understanding into actionable skills. This finding is particularly relevant in the management of dyspnea, where rapid, accurate, and confident responses are essential to prevent clinical deterioration.

The dramatic improvement in skill performance observed in the theory-plus-simulation group reinforces the effectiveness of simulation-based education in developing psychomotor competencies. Simulation provides direct experiential learning opportunities that allow participants to practice procedures, receive immediate feedback, correct errors, and build confidence within a controlled and safe environment. These findings support experiential learning theory, which emphasizes that meaningful skill acquisition occurs through direct experience rather than through cognitive exposure alone, and are consistent with previous evidence showing that

simulation-based training enhances procedural accuracy, confidence, and clinical decision-making while reducing errors in emergency care settings (Cook et al., 2011; Tawfik et al., 2020; Alharbi et al., 2024).

Limitations of the study

Despite its strengths, this study has several limitations. First, the sample size was relatively small and drawn from a single university, limiting the generalizability of the findings. Second, skill assessments were conducted immediately after the intervention, which prevented the evaluation of long-term knowledge and skill retention. Third, the study focused exclusively on one type of emergency condition—dyspnea—thereby excluding other potential emergencies commonly encountered in university environments.

Future research should therefore involve larger, multi-center samples, incorporate longitudinal follow-up to assess skill retention, and examine a broader range of emergency scenarios. Such approaches would provide a more comprehensive understanding of the effectiveness of combined theory and simulation-based training in enhancing emergency preparedness among university health teams.

CONCLUSIONS

This study confirms that theoretical education effectively improves knowledge regarding the management of shortness of breath among university health volunteers; however, theory alone is insufficient for developing practical first aid skills. The integration of theoretical instruction with simulation practice resulted in markedly greater improvements, particularly in skill acquisition, with all participants in the simulation group reaching the "skilled" category. These findings demonstrate that practical respiratory emergency skills can be developed even among non-medical volunteers when training incorporates both cognitive and experiential components.

The results highlight the strategic potential of university health volunteers as competent first-line responders in campus emergencies. By adopting training models that combine theory and simulation, universities can strengthen emergency preparedness and enhance the functional role of student volunteers within the campus health system. This study also supports global evidence emphasizing experience-based learning as an effective approach for improving confidence, decision-making, and practical competence in emergency care, extending its applicability to non-medical student populations in developing country settings.

Despite these contributions, the findings are limited by the small sample size, single-institution setting, immediate post-intervention assessment, and focus on a single emergency condition. Future research is recommended to involve larger and more diverse samples, multi-center designs, and long-term follow-up to assess skill retention, as well as training programs that cover a broader range of emergency scenarios. Such studies would provide more substantial evidence to inform sustainable and scalable emergency training models in university settings.

AI DISCLOSURE STATEMENT

Artificial intelligence tools were used solely to assist with language refinement and manuscript editing. The authors take full responsibility for the content and integrity of the study.

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DATA AVAILABILITY

The data supporting the results of this study were gathered through field-based observations and have been recorded by the researcher. Although the dataset is not openly accessible, it can be shared by the corresponding author upon reasonable and well-justified request.

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This study did not receive any funding.

CONFLICT OF INTEREST

The author affirms that this research was conducted with complete independence and integrity and is free from any conflicts of interest with any organization, institution, or individual. No financial, professional, or personal affiliations could have influenced the study's design, data collection, analysis, or interpretation. This declaration ensures the objectivity and credibility of the research findings, thereby reinforcing its contribution to the safety of artisanal and small-scale miners.

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