RESEARCH PAPER

Check for updates

eISSN 2093-758X
*J Korean Acad Nurs* Vol.51 No.6, 648
https://doi.org/10.4040/jkan.21164

# Effectiveness of the Infectious Disease (COVID-19) Simulation Module Program on Nursing Students: Disaster Nursing Scenarios

Hwang, Won Ju · Lee, Jungyeon

College of Nursing Science, Kyung Hee University, Seoul, Korea

**Purpose:** This study aimed to develop an emerging infectious disease (COVID-19) simulation module for nursing students and verify its effectiveness. **Methods:** A one-group pretest-posttest quasi-experimental study was conducted with 78 under-graduate nursing students. A simulation module was developed based on the Jeffries simulation model. It consisted of pre-simulation lectures on disaster nursing including infectious disease pandemics, practice, and debriefings with serial tests. The scenarios contained pre-hospital settings, home visits, arrival to the emergency department, and follow-up home visits for rehabilitation. **Results:** Disaster preparedness showed a statistically significant improvement, as did competencies in disaster nursing. Confidence in disaster nursing increased, as did willingness to participate in disaster response. However, critical thinking did not show significant differences between time points, and neither did triage scores. **Conclusion:** The developed simulation program targeting an infectious disease disaster positively impacts disaster preparedness, disaster nursing competency, and confidence in disaster nursing, among nursing students. Further studies are required to develop a high-fidelity module for nursing students and medical personnel. Based on the current pandemic, we suggest developing more scenarios with virtual reality simulations, as disaster simulation nursing education is required now more than ever.

**Key words:** Disasters; Global Health; COVID-19; Nursing; Simulation Training

## INTRODUCTION

2020 has been a tough year for global health. As movement between countries has increased and technology has advanced, international cooperation and interdependence have become more important than ever. To manage global health issues such as infectious diseases and disasters and unfair intervention by pharmaceutical companies, we need to be equipped with global health capacities [1]. Coronavirus disease (COVID-19) currently presents the most serious problem for global health, and subsequently global nursing capacity. It threatens not only population health and socio-economic well-being, but also the core concerns of society, including humanitarian issues and human rights. Therefore, we need to develop a curriculum for an outbreak of infectious diseases, which is pandemic, one of social disasters that the world is going through, so that nursing students are equipped with global health competencies to face today's global health issues.

A disaster is an incident that causes widespread human, physical, economic, or environmental disruption and loss, and the resultant stress exceeds the resources of an individual or community and severely harms livelihoods or property [2,3]. Because disasters destroy fundamental local organizations and basic functions, they cannot be easily overcome without external aid. The World Health Organization (WHO) divides

Address reprint requests to : Hwang, Won Ju

College of Nursing Science, Kyung Hee University, 26 Kyungheedae-ro, Dongdaemun-gu, Seoul 02447, Korea

Tel: +82-2-961-0852 Fax: +82-2-961-9398 E-mail: hwangwj@khu.ac.kr

Received: August 6, 2021 Revised: October 20, 2021 Accepted: October 27, 2021 Published online December 31, 2021

disaster management into four stages: prevention, preparation, response, and recovery [4]. Education and training programs to mitigate and prepare for disasters are the most cost-effective methods of disaster management, and are also effective at improving population resilience and speedy recovery after a disaster [5].

Disasters can be classified as natural or social disasters. The COVID-19 pandemic we are currently experiencing is an example of a social disaster [6]. Although medical technology and public health and hygiene have improved, novel infectious diseases capable of causing pandemics have been emerging at a faster rate since the twentieth century. Notable examples include the emergence of the Severe Acute Respiratory Syndrome (SARS) in 2002, the Middle East Respiratory Syndrome (MERS) in 2015, Zika virus, and lastly the Novel Coronavirus, or SARS-Cov2, in 2019. As such, we need to prepare for facing the threat of other infectious diseases disaster in the future [7].

Although awareness of disasters is growing among medical personnel, educational programs to help them prepare for disasters are still limited. One study reported that most clinical nurses believe that they lack experience and education in disasters and disaster nursing, and rate their own disaster preparedness as low [3]. This lack of experience can cause stress and fear regarding disaster management. Believing that one is thoroughly prepared for a disaster can enhance confidence in coping with it. Therefore, prudent systematic education and training are required starting from the undergraduate level to prepare healthcare providers for disasters.

Some studies highlighting the importance of such programs have been conducted after the outbreak of COVID-19. Hamele et al. [8] suggested the 4S pandemic plan—"stuff", "space", "staff", and "systems"—which emphasized the importance of "just in time" regular training in preparation for a pandemic. This raises the question, "How thoroughly were we prepared for the COVID-19 outbreak?" This question applies to the preparedness of all individuals, but particularly those working in healthcare, especially caregiving personnel such as nurses. The preparedness of frontline healthcare workers to respond to epidemic outbreaks is vital. Especially frontline nurses who take a major part in responding to outbreaks, require the awareness and ability to handle an epidemic outbreak from infection control skills to ensuring the safety of population [9]. When asked about the most difficult aspects of coping with COVID-19, nurses stated extended working hours, psychological and physical stress, insufficient education, and lack of personal protective equipment (PPE) [7]. In a cross-sectional study in China, suitable provision and wearing of PPE, improved education for pandemic management, increased staffing, and social and psychological support, were proposed as needs of front-line nurses [10]. Education on wearing PPE especially increased the rate of PPE-wearing by nurses and decreased the rate of COVID-19 infection among medical personnel [11]. In short, the COVID-19 outbreak and emergence of novel infectious diseases over the last several years have taught us the importance of developing a prepared response to infectious disease disasters. However, existing disaster nursing education has mostly focused on mass casualty incidents and natural disasters [12]. There have been some international studies investigating pandemic response training programs for nursing students. However, there has been almost no simulation research modeling the existing response to novel infectious diseases, among undergraduates in South Korea.

Existing methods of disaster training and education include classical lecture-based teaching, case studies, debates, expert talks, as well as table-top methods and virtual reality simulation [13]. Of these, simulation improves trainees' judgment, adaptability, and coping ability in the field, as well as their knowledge, confidence, practical ability, and skills [14-17]. The urgent and unpredictable circumstances at a disaster site demand rapid decision-making and problem-solving. Because it is difficult to experience real disasters for preparatory training, simulations—based on structured scenarios—allow trainees to experience them indirectly instead. To organize a systematic simulation program, a theoretical framework is necessary. From 1999 to 2015, the most frequently used simulation framework was National League for Nurses (NLN)/Jeffries simulation [18]. In NLN/Jeffries simulation framework, the simulation design includes detailed learning objectives, learner role assignments, systematic strategies for re-debriefing or debriefing, and simu-

lation flow. Also, Jeffries simulation model is based on constructive learning theory, which is a useful theoretical framework for safe and effective simulation-based clinical nursing education [19]. Jeffries simulation model, which comprises five components, teacher, student, educational practice, design characteristics, and evaluation, is used to create positive educational effects through simulation education. Specifically, previous research reported that simulation learning positively influenced students' critical thinking and self-confidence [13,19,20] as well as their disaster response competence. Thus, this model was found to provide an effective theoretical framework for managing and evaluating nursing simulations.

Therefore, this study aimed to design a simulation training program for novel infectious disease disasters based on the simulation model of Jeffries, and to investigate the effects of this training on nursing students.

## METHODS

### 1. Study design

This study used a one-group time series design. The group received pre-training education before the simulation program, and the outcome measures were compared before pre-training (pretest), after pre-training (midtest), and after the simulation program (posttest) (Table 1).

### 2. Participants and data collection

Participants consisted of 78 nursing students from a college of nursing. They were selected by convenience sampling from students in a four-year nursing program during the two semesters, from September 10, 2020 to June 27, 2021. The required sample size was calculated to be 66 persons using $\alpha = 0.05$, a power of 95%, and effect size 0.5 based on a disaster nursing simulation for nursing students developed by Park [13]. To account for a 20% dropout rate, 78 participants were planned to be recruited. No participant dropped out of the study.

**Table 1.** Study Design: One-Group Time Series Design (*N* = 78)

| Group | Pretest | 1st intervention | Midtest | 2nd intervention | Posttest |
|---|---|---|---|---|---|
| Exp. | T1 | X1 | T2 | X2 | T3 |

Exp. = Experimental group; T1~3 = Disaster preparedness, triage, disaster preparation competencies, critical thinking disposition, confidence in disaster nursing, willingness, and knowledge about COVID-19; X1 = Pre-training education; X2 = Simulation program.

Data were collected by researchers after explaining the purpose and process of the study to the participants. All the students in the four-year nursing program were informed that participation was voluntary, and that they would not be penalized in any way if they choose not to participate in this study or to withdraw. Among them only the students who consented to participate were included in the study. Personal information of participants was stored on a password-protected computer system.

### 3. Materials and outcome measures

#### 1) Disaster preparedness

An outbreak of infectious diseases is a disaster situation, which consumes massive resources, exceeding the capacity of healthcare system in community. To maintain the best resiliency of community, disaster preparedness is one of the key capacities. To measure disaster preparedness, we used the instrument of Park [13], who improved a 26-item Disaster Readiness Scale originally developed by Huh and Kang [21] to investigate the effects of a disaster nursing training program for nursing students using small-group case study-based learning. The instrument consists of six items on disaster preparation and eight items on disaster response, assessed on a five-point Likert scale. Cronbach's $\alpha$ was .88 in the study by Park [13] and .91 in this study.

#### 2) Competency in disaster nursing

We used a 26-item Disaster Nursing Ability Instrument developed by Park [13] based on the International Council of Nurses Framework of Disaster Nursing Competencies. This includes ethical and legal practice and responsibility (3 items), communication and information sharing (4 items), education and preparation (4 items), community nursing (4 items), personal and family care (7 items), psychological treatment (3 items), and vulnerable population nursing (1 item). The instrument uses a five-point scale. Content valid-

ity index (CVI) average was .93. Cronbach's α was .95 in the study by Park [13] and .95 in this study.

#### 3) Critical thinking

Critical thinking refers to the personal disposition and cognitive drive to judge personal or professional issues based on a purpose and to use independent decision-making skills. To measure critical thinking, we used Yoon's Critical Thinking Disposition instrument developed by Yoon [22] to measure critical thinking disposition in nursing students. The instrument consists of 27 questions in total, assessed on a five-point Likert scale. Higher total scores indicate better critical thinking ability [22]. Cronbach's α was .84 in the original study and .92 in this study.

#### 4) Confidence in disaster nursing

With reference to the Korean Accreditation Board of Nursing Education's standards for simulation practice, we measured confidence in disaster nursing using a single item, scored out of 10 points, developed by Park [13].

#### 5) Triage

We used disaster triage score developed by Park [13], based on the Simple Triage and Rapid Transport system with reference to the triage scenarios used in the expert track of emergency medicine for international disasters curriculum [23]. Its CVI was 0.96 in a previous study [15].

#### 6) Knowledge of COVID-19

We measured knowledge of COVID-19 using a dichotomous scale with nine items extracted from a WHO question and answer survey [24]. Nine items addressed knowledge of the clinical presentation of COVID-19. Participants could answer "yes" or "no". Correct answers were assigned 1 point.

#### 7) Willingness to participate in the disaster response

We used a dichotomous scale ("yes" or "no") to measure participants' willingness to participate in the disaster response after the infectious disease disaster simulation training.

### 4. Ethical considerations

This study was performed after receiving approval from Kyung Hee University institutional review board (KH-SIRB-20-238). Before participation, the students listened to an explanation of the study and gave their voluntary consent to participate. Participants were informed that they would suffer no disadvantages for participating, refusing to participate, or withdrawing from the study, and that they could leave the study at any time.

### 5. Intervention

#### 1) Development of the scenarios

The Jeffries simulation model was used as the framework for designing, performing, and evaluating a safe and effective simulation for nursing education. The main components of this model are teacher, student, educational practices, simulation design characteristics, and educational evaluation [17]. In this study, instructor and student preparation comprised the program preparation step in the development of the disaster nursing simulation. The infectious disease disaster nursing simulation scenario was designed considering the educational practices of the four fundamental concepts suggested by the Jeffries simulation model. This study evaluated participants' confidence and critical thinking abilities, as well as the effects of disaster preparedness and competency by applying the developed scenario.

To design the simulation scenario program, it was necessary to set clear learning objectives and consider fidelity, complexity, cues, and debriefing. To ensure fidelity to actual experience, the simulated environment was designed to be similar to infectious disease disaster environment. The scenario consisted of three timelines for complexity: immediate response, referral to hospital, and rehabilitation center. In the beginning of practice, information about the background of the module was offered to participants for cues. Researchers informed students about the goal of the scenes in a clear tone prior to each session. After the practice, students were debriefed to reflect on it and share their ideas based on the Jeffries simulation model [17]. Because this practical exercise was conducted in the context of community nursing studies,

it began with the scenario of a family nurse visiting a five-person family. To recreate a vivid family nursing scenario, a practical room was prepared to resemble the setting of a family home. Of the five characters, one person was played by a professionally trained standardized patient, and two roles were fulfilled by patient simulators; a realistic adult simulation manikin and a low fidelity baby doll. As prior researches reported that using students as standardized patients improves overall self-confidence and satisfaction of learners, two people were played by trained student standardized patients, who were recruited from another class [25]. Participants were provided with a bag containing items required for the family nursing practical exercise. Before the start of the program, participants completed their responses to the first round of questionnaires and participated in pre-training about pandemic response and disaster nursing. After pre-training, participants completed their responses to the second round of questionnaires, and the instructor gave the participants a brief explanation of the scenario. The simulation was performed in groups of two to three people and lasted around 40 minutes. There were three scenarios in total, and all participants experienced all three scenarios. After the end of each scenario, participants listened to the instructor's directions and received a brief explanation before moving onto the next stage. After simulation training, there was a 15-minute group debriefing session for the participants to share their opinions on strengths, weaknesses, and opportunities for improvement. Finally, participants completed the third round of questionnaires.

### 2) Program design process: contents of the scenario

The setting for the scenarios was as follows: a family was receiving home care visits because they were economically vulnerable, and their health was at risk. This family had visited relatives living in the "X" region seven days ago, and now the "X" region is experiencing a COVID-19 outbreak. The family had reported that their relatives had presented with coughing and phlegm during their visit (Table 2).

In the first scenario, participants visited the home where the five family members were lying down. Unlike the grandmother/60 and daughter/3, the grandfather/71 and mother/35 both looked acutely ill and showed respiratory distress (Figure 1). Participants, as home visitation nurses, could acquire information about the family's symptoms and basic health (vital signs, oxygen saturation, blood glucose, pain presentation, and so on) on site. Participants could also learn about the family's history of travel to the affected region. The father/40 was lying in the middle of the living room. If participants did not examine the father, the grandmother (standardized patient) provided a hint, saying, "My son has just been sleeping since yesterday evening". Participants who noticed that the father showed impaired consciousness could perform a rapid assessment. Next, participants could recognize that several family members required emergency treatments, and could activate an emergency disaster medicine system by calling 119 (the emergency services number in South Korea) for linkage to a hospital. If participants called 119, the instructor performed the role of a 119 operator. Participants could inform 119 of the family's health informa-

**Table 2.** Program Design and Learning Objectives of the Disaster Simulation Program

| Scenario | Contents of the scenario | Aims of practice |
|---|---|---|
| First | Home visit for five members of family.<br>Students can find out their recent travel history to determine where the emerging infectious disease outbreak happened. | Learning immediate response to emerging infectious diseases<br>Activating disaster system by calling 119 |
| Second | Referring patients to the ER.<br>Students can decide the priority of limited isolation rooms and handover patients to the ER accordingly.<br>Students can explain the situation to the other family members. | Performing triage and isolating patients adequately<br>Handing over patient information to the ER |
| Third | Follow up visit for the family.<br>Students can evaluate the socio-economic status of the subjects.<br>Students perform a psychological assessment of the subjects. | Rehabilitation after self-isolation<br>Knowing how to use social resources |

119 = Emergency call center; ER = Emergency room.

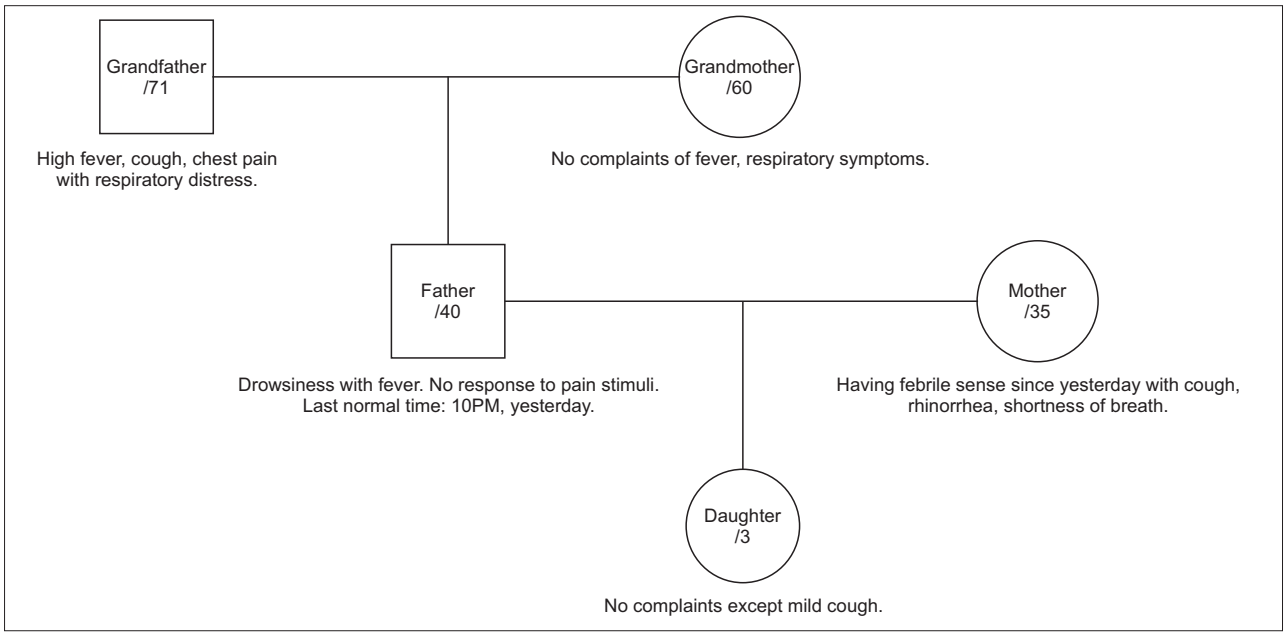


**Figure 1.** A pedigree chart of the subject family.

tion and travel history. Because the family had visited a region affected by an infectious disease and showed respiratory symptoms and fever, participants should suspect a novel infectious disease. Here, participants could recognize the need for isolated transport.

In the second scenario, participants arrived in front of an emergency medical center with the family. Considering the family's respiratory symptoms, fever, and recent travel history, they require admission to the isolation area of the emergency department (ED). Participants could recognize this and hand the relevant facts and patient information to the ED. The ED isolation wards had limited resources due to a lack of beds. Therefore, participants needed to decide which family members were most critical, and relay the same to the ED nurse. After handing father/40, mother/35, and grandfather/71 to the ED, as soon as participants turned around, the daughter/3, who was previously symptomless, would begin coughing. Participants should be able to cope with this sudden turn of events. Since the daughter was not critical, she could be investigated at the screening clinic and discharged. Participants could send grandmother/60 home as well, after explaining that she must self-isolate at home with the daughter until they receive the COVID-19 test results.

In the third scenario, participants performed a follow-up visit three weeks later. The family members (mother/35, grandfather/71, and father/40) would have been confirmed to have contracted COVID-19, and would have received treatment at the hospital. Participants could check their health and verify whether they were experiencing any symptoms, including both representative symptoms of COVID-19, such as respiratory symptoms or fever, as well as other physical or psychological symptoms. In this process, participants could provide emotional support by listening closely and empathizing with the family's statements. If necessary, participants could encourage the family to use mental health facilities to address any psychological trauma after the disease. As misinformation in a disease-disaster situation can impair logical judgement and increase stress, participants could correct any misunderstandings about the infectious disease. Later, the family's socio-economic status and chronic disease management could be examined, since these can be overlooked in a disaster. The participants could then plan linkages with further resources if necessary.

## 6. Data analysis

SPSS 26.0 (IBM Corp., Armonk, NY, USA) was used for

data analysis. Participants' general characteristics were analyzed using percentages and frequency. Disaster preparedness, disaster nursing competencies, critical thinking, confidence in disaster nursing, triage score, and knowledge about COVID-19 were analyzed using a repeated measures ANOVA, and willingness to participate in the disaster response was analyzed using a Cochran's Q test. Additionally, post hoc analysis was performed with Fisher's LSD or McNemar test with adjust $p$-value by Bonferroni- Holm method [26,27].

## RESULTS

### 1. General characteristics

The mean age was 22.2 ± 1.20 years. There were 67 woman students (85.9%) and 11 man students (14.1%). Except two of participants, all the other 76 students (97.4%) were satisfied with their nursing major. Likewise, 97.4% of participants reported that disaster education was needed. 28.2% of participants had had experiences with a disaster. Only 11.5% reported experience with disaster nursing education, and 16.7% reported experience with disaster training. The participants' general characteristics can be found in Table 3.

**Table 3.** General Characteristics of Participants ($N$ = 78)

| Characteristics | M ± SD or n (%) |
|---|---|
| Age (yr) | 22.2 ± 1.20 |
| Gender | |
| Woman | 67 (85.9) |
| Man | 11 (14.1) |
| Grades | |
| > 4.0 | 1 (1.3) |
| 3.5~4.0 | 28 (35.9) |
| 3.0~3.5 | 40 (51.3) |
| < 3.0 | 9 (11.5) |
| Satisfaction of major in nursing | |
| Very satisfied | 42 (53.8) |
| Satisfied | 34 (43.6) |
| Unsatisfied | 2 (2.6) |
| Satisfaction of practice | |
| Very satisfied | 30 (38.5) |
| Satisfied | 44 (56.4) |
| Unsatisfied | 4 (5.1) |
| Needs of disaster education | |
| Yes | 76 (97.4) |
| No | 2 (2.6) |
| Experience of disaster | |
| Yes | 22 (28.2) |
| No | 56 (71.8) |
| Experience of education in disaster nursing in the past | |
| Yes | 9 (11.5) |
| No | 69 (88.5) |
| Experience of disaster drill in the past | |
| Yes | 13 (16.7) |
| No | 65 (83.3) |

M = Mean; SD = Standard deviation.

### 2. Effectiveness of the COVID-19 simulation module

Effectiveness of the COVID-19 simulation module on disaster preparedness, competencies in disaster nursing, confidence in disaster nursing, triage score and critical thinking was assessed by using repeated measured ANOVA. Willingness to participate in disaster response was analysed by using Cochran's Q test (Table 4). Disaster preparedness showed a statistically significant improvement (F = 65.60, $p$ < .001), with significant differences observed between the pretest and midtest ($p$ < .001) and between the midtest and posttest ($p$ < .001). Disaster nursing competencies improved significantly as well (F = 44.09, $p$ < .001), with higher scores in the midtest compared to the pretest ($p$ < .001), and in the posttest compared to the midtest ($p$ < .001). Confidence in disaster nursing also increased (F = 37.80, $p$ < .001), with significantly higher scores in the midtest compared the pretest ($p$ = .024); although the scores in the posttest were not significantly higher than in the midtest, there was a trend-level increase ($p$ = .079).

There was a significant increase in terms of the ratio of participants who reported willingness to participate in disaster response, 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) (Table 4).

Critical thinking did not show any significant differences

 https://doi.org/10.4040/jkan.21164

**Table 4.** Evaluation of the Educational Program Application for Simulation Practice

| Outcomes | T1 | T2 | T3 | F or $\chi^2$ | *p* | T3-T2 | T2-T1 |
|---|---|---|---|---|---|---|---|
| | M ± SD or n (%) | M ± SD or n (%) | M ± SD or n (%) | | | MD or $\chi^2$ | MD or $\chi^2$ |
| Disaster preparedness | 38.44 ± 8.46[a] | 47.04 ± 7.47[b] | 52.19 ± 7.10[c] | 65.60 | < .001 | 5.15* | 8.60** |
| Competency in disaster nursing | 79.35 ± 15.46[a] | 90.60 ± 13.99[b] | 100.55 ± 13.06[c] | 44.09 | < .001 | 9.95** | 11.26** |
| Confidence in disaster nursing | 3.79 ± 1.83[a] | 6.04 ± 8.34[b] | 6.29 ± 1.75[b] | 37.80 | < .001 | 0.26 | 2.24* |
| Critical thinking | 79.35 ± 15.46[a] | 90.60 ± 13.99[a] | 100.55 ± 13.06[a] | 0.25 | .777 | 1.42 | - 0.65 |
| Triage score | 2.51 ± 1.14[a] | 2.62 ± 1.12[a] | 2.58 ± 1.28[a] | 0.14 | .868 | – 0.04 | 0.10 |
| Knowledge of COVID-19 | 8.51 ± 0.70[a] | 8.41 ± 1.26[a] | 8.44 ± 0.75[a] | 0.33 | .719 | 0.03 | – 0.10 |
| Willingness to participate in disaster nursing† | | | | | | | |
| Yes | 46 (59.0)[a] | 56 (71.8)[ab] | 69 (88.5)[b] | 15.35†† | < .001 | 5.33 | 2.03 |
| No | 32 (41.0) | 22 (28.2) | 9 (11.5) | | | | |

M = Mean; MD = Mean difference; T1 = Pretest; T2 = Midtest; T3 = Posttest; SD =Standard deviation.
*$p$ < .05, **$p$ < .001.
†$p$-value was calculated by Cochran Q test. Post hoc was performed with Fisher's Least Significant Difference (LSD) and McNemar's test; ††Subgroup analysis was performed for "willingness to participate in disaster nursing" using a $\chi^2$ test.

between time points (F = 0.25, $p$ = .777). Triage scores (F = 0.14, $p$ = .868) and knowledge of COVID-19 (F = 0.33, $p$ = .719) showed no significant differences between time points. All data with disaster preparedness, disaster nursing competencies, critical thinking conformed to a normal distribution. Triage score, confidence in disaster nursing, willingness to participate in disaster didn't conform to a normal distribution [28].

## DISCUSSION

This study aimed to develop and test the effectiveness of a novel infectious disease disaster simulation module to train nursing students to better prepare for such occurrences in the future. In Jeffries simulation model, they suggest to evaluate knowledge, skill performance, learner satisfaction, critical thinking and self-confidence as outcomes [17]. To this end, we analyzed the effects of the simulation model on nursing students' critical thinking disposition, disaster preparedness, triage, disaster nursing competencies, confidence in disaster nursing, willingness to participate in the disaster response, and knowledge about COVID-19.

Disaster preparedness showed significant improvements after pre-training and after simulation training in this study. This supports the results of several prior studies that reported increased confidence and disaster preparedness among nurses following disaster preparation training. In one study that implemented a disaster preparation simulation for 90 nursing college students, 95% of participants reported an improvement in their ability to cope with a disaster [12]. In another study of nursing college students in Indonesia, improved disaster preparedness, triage, and initial disaster response competency were reported after a disaster simulation program [29].

Competency in disaster nursing also showed a significant increase at each time point (F = 44.09, $p$ < .001). According to a previous study, disaster nursing competency is positively affected by actual disaster experience. Satoh et al. [30] reported that nursing students with experience of a disaster nursing program showed significantly better disaster nursing competency, disaster nursing knowledge, understanding of their role in the disaster response, and teamwork, compared to those without this experience, at the site of the Fukamoto earthquake in Japan in 2016.

Confidence in disaster nursing improved significantly after the program, especially after pre-training. The improvement after simulation training compared to after pre-training was not statistically significant, but there was a trend-level improvement. This is consistent with a study by Jung et al. [3], in which confidence in disaster nursing improved after nurses participated in a disaster nursing convergence program. Cant and Cooper [31] reviewed 12 studies on simula-

tion-based learning in nursing, and found that it improved learners' confidence, critical thinking ability, and knowledge in six of these studies, which corroborates our findings.

In the present study, the ratio of participants who reported willingness to participate in the disaster response increased significantly, from 46 persons (59.0%) before pre-training, to 56 persons (71.8%) after pre-training, and 69 persons (88.5%) after simulation training. This is in agreement with previous studies, including one study by Jeffries [17] in which students participated in a disaster simulation based on a simulation model; in a subsequent in-depth interview, the students reported a desire to participate in disaster rescue activities [32]. Another previous study had found that experience with disaster preparation training or disaster education not only significantly improved willingness to participate in disaster response, but also fostered the will of healthcare workers to protect civilians from the hazardous circumstances of a disaster [33].

Even among clinical nurses, willingness to participate in disaster response has been reported to increase with experience. This is consistent with previous results showing that increased experience of disasters or disaster training is associated with increased confidence and willingness to participate in disaster response [34]. One study also reported that trained medical personnel experience less fear about exposure to hazards in disaster situations [35]. These results demonstrate that disaster nursing simulation improves competency in disaster nursing and disaster preparedness, leading to improvements in confidence in disaster nursing and willingness to participate in the disaster response [12,29,36]. Therefore, high-fidelity simulation-based programs for nursing students can help nurses who can lead the field response to disasters—a frontline role that demands diverse competencies.

On the other hand, even after the intervention, this study did not show any significant changes in the participants' critical thinking ability, which matches findings from some earlier studies. In a study by Chae and Choi [37], no differences in critical thinking disposition were observed even after administering a simulation program, which the authors attributed to lack of implementation time studies using multimode simulation [38], high-fidelity simulation [39], and simulation convergence programs [3] which have likewise reported no significant effects on critical thinking.

Contrastingly, other studies have reported that simulation programs have had positive effects on critical thinking [16,40-42]. In particular, Al Gharibi and Arulappan [43] reported that students who experienced three simulation sessions showed better critical thinking disposition than students who experienced only one simulation session. As explained by Brown and Chronister [44]—whose study reported no significant change in critical thinking after only 30 minutes of high-fidelity simulation—critical thinking is determined by an individual's learning habits, motivation, basic knowledge, logical ability, and social characteristics. It is a unique trait of individuals that is not easily changed [45]. These observations support the claims of Chae and Choi [37] and Al Gharibi and Arulappan [43] that a curriculum of simulation with sufficient duration is required to significantly improve critical thinking. Thus, when interpreting the results of the present study, it is important to consider that only a single three-hour session of the intervention was administered.

In terms of triage, most studies on disaster response and preparation training had earlier reported that disaster nursing simulation programs have a significant effect on triage scores. However, because triage requires the ability to make rapid judgments in a short time, it is closely related to clinical experience and therefore can be difficult to improve in subjects lacking clinical experience. For example, when one week of pediatric disaster simulation training was given to residents, triage accuracy improved significantly [46]. However, when Kim and Lee [36] applied disaster simulation training for undergraduate students, the triage accuracy was 26%, which can be considered similar to the present study. Moreover, previous studies on triage in simulation training focused on multiple casualty incidents, earthquakes, or biochemical terror scenarios, there have been no studies focusing only on disaster pandemics. As such, the lack of effect on triage scores in this study are thought to be due to the program being limited to the specific disaster of a novel infectious disease and pandemic. Finally, the questionnaire on knowledge about COVID-19 was intended to spark partici-

 https://doi.org/10.4040/jkan.21164

pants' interests and spread awareness of COVID-19, which was newly emerging when we began the development of this program in early 2020, but no significant difference in students' knowledge before and after simulation training has been found. Nevertheless, if a more structured questionnaire were developed based on the knowledge about COVID-19 that has been accumulated in the last year, it could be used as an introduction to transfer the appropriate knowledge and capture students' attention.

Although this is a valuable study, it still has some limitations. First, because this program was administered to a single group of nursing students, there may be difficulties in generalizing the program to more participants in the future. The study used a one-group pretest and posttest design and quasi experimental study. The participants were recruited from a university, which making it difficult to completely eliminate selection bias. It is also difficult to eliminate the maturation effect due to pre-training. As it is difficult to rule out effects of history, maturation, and statistical regression, nonequivalent control group can be added to improve the research design. Also, by adding serial time series design, we can confirm if the testing effects have affected on the results. Unfortunately, the ongoing COVID-19 pandemic made it difficult to recruit a more diverse sample and control group due to the constantly changing conditions for practicum training in nursing. Thus, further studies are required to develop with control group design. Second, wearing PPE was not included in the module for following reasons. Wearing PPE was already included as a part of regular courses for students not only for participants but all. We thought it was not strongly needed to include wearing PPE in the module due to time limitations. The scenario was based on a real-live situation which can happen at the very front line in the pandemic era. In most disaster situations, responders can't be fully equipped as needed before they seize the scene. Finally, the novel infectious disease simulation module for disaster nursing used in this study consisted of pre-training, followed by a single simulation session lasting around three hours. Previous studies on simulation interventions have involved at least three to four sessions and have been up to six to eight weeks long or as long as one semester [43]. As mentioned above, critical thinking didn't show a significant improvement. Several studies reported that simulation programs didn't significantly affect on critical thinking skills [3,37-39,44]. To make a meaningful change of critical thinking, it requires a long period of time and education [47]. Based on all, we suggest to develop an authentic simulation module with enough periods of sessions. We need to develop sufficient disaster competencies and coping abilities among nurses to deal with disasters that could occur at any time in the future. We need education that accounts for the unique nature of infectious disease disasters, in which medical services plays an even more urgent role compared to other types of disaster.

The COVID-19 pandemic has made clear the urgent need for an information technology environment in the event of persistent infectious disease outbreaks. If these types of simulation scenarios were developed and provided in virtual reality, we expect that it would be an even more effective educational tool, given the nature of infectious disease disasters [48]. On the other hand, in-depth interviews revealed that these simulations induced strong interest and engagement in learning for students. In addition, future research on developing disaster nursing simulation education is needed.

## CONCLUSION

This study showed that a simulation training program for the emerging pandemic crisis (COVID-19) positive affected nursing students' disaster preparedness, disaster nursing competency, and confidence in disaster nursing. In a disaster, which is an urgent, critical situation demanding complex competencies, nurses are the ideal group to lead on the frontline with diverse competencies, confidence, and willingness to participate in disaster response. Simulation programs can help nursing students to improve their disaster competencies to prevent issues in providing healthcare in low-resources settings, combating the global burden of disease, considering the health implications of migration and displacement, and advocating for human rights. Based on our findings, we make the following suggestions. Future studies should develop a high-fidelity program and administer it to a

larger group of nursing students and medical personnel to extend the study implication. As such, we hope that this study will help nursing students and medical personnel deal with infectious disease disasters that they face in community nursing practice in the future.

## CONFLICTS OF INTEREST

The authors declared no conflict of interest.

## ACKNOWLEDGEMENTS

None.

## FUNDING

This work was supported by internal funding for the customized study by Kyung Hee University (No. 20201219).

## DATA SHARING STATEMENT

Please contact the corresponding author for data availability.

## AUTHOR CONTRIBUTIONS

Conceptualization or/and Methodology: Hwang WJ.
Data curation or/and Analysis: Lee J.
Funding acquisition: Hwang WJ.
Investigation: Hwang WJ & Lee J.
Project administration or/and Supervision: Hwang WJ & Lee J.
Resources or/and Software: Hwang WJ.
Validation: Hwang WJ & Lee J.
Visualization: Hwang WJ.
Writing original draft or/and Review & Editing: Hwang WJ & Lee J.

## REFERENCES

1. Brown G. Aspects of global health issues: Diseases, natural disasters, and pharmaceutical corporations and medical research. The ABNF Journal. 2016;27(3):53-57.
2. Yamamoto A. Development of disaster nursing in Japan, and trends of disaster nursing in the world. Japan Journal of Nursing Science. 2013;10(2):162-169. https://doi.org/10.1111/jjns.12042
3. Jung HM, Kim NH, Lee YH, Kim MS, Kim MJ. The effect of a disaster nursing convergence education program on disaster nursing knowledge, preparedness and self-confidence of nursing students. Journal of the Korea Convergence Society. 2018;9(1):377-386. https://doi.org/10.15207/JKCS.2018.9.1.377
4. Moore S, Mawji A, Shiell A, Noseworthy T. Public health preparedness: A systems-level approach. Journal of Epidemiology and Community Health. 2007;61(4):282-286. https://doi.org/10.1136/jech.2004.030783
5. Torani S, Majd PM, Maroufi SS, Dowlati M, Sheikhi RA. The importance of education on disasters and emergencies: A review article. Journal of Education and Health Promotion. 2019;8:85. https://doi.org/10.4103/jehp.jehp_262_18
6. Freitas CMd, Silva IVdMe, Cidade NdC. COVID-19 as a global disaster: Challenges to risk governance and social vulnerability in Brazil. Ambiente & Sociedade. 2020. doi: 10.1590/1809-4422asoc20200115vu2020L3ID.
7. Calò F, Russo A, Camaioni C, De Pascalis S, Coppola N. Burden, risk assessment, surveillance and management of SARS-CoV-2 infection in health workers: A scoping review. Infectious Diseases of Poverty. 2020;9(1):139. https://doi.org/10.1186/s40249-020-00756-6
8. Hamele M, Neumayer K, Sweney J, Poss WB. Always ready, always prepared-preparing for the next pandemic. Translational Pediatrics. 2018;7(4):344-355. https://doi.org/10.21037/tp.2018.09.06
9. Lam SKK, Kwong EWY, Hung MSY, Pang SMC, Chiang VCL. Nurses' preparedness for infectious disease outbreaks: A literature review and narrative synthesis of qualitative evidence. Journal of Clinical Nursing. 2018;27(7-8):e1244-e1255. https://doi.org/10.1111/jocn.14210
10. Hu D, Kong Y, Li W, Han Q, Zhang X, Zhu LX, et al. Frontline nurses' burnout, anxiety, depression, and fear statuses and their associated factors during the COVID-19 outbreak in Wuhan, China: A large-scale cross-sectional study. EClinicalMedicine. 2020;24:100424. https://doi.org/10.1016/j.eclinm.2020.100424
11. Quigley AL, Stone H, Nguyen PY, Chughtai AA, MacIntyre CR. Estimating the burden of COVID-19 on the Australian healthcare workers and health system during the first six months of the pandemic. International Journal of Nursing Studies. 2021;114:103811. https://doi.org/10.1016/j.ijnurstu.2020.103811
12. Kaplan BG, Connor A, Ferranti EP, Holmes L, Spencer L.

Use of an emergency preparedness disaster simulation with undergraduate nursing students. Public Health Nursing (Boston, Mass.). 2012;29(1):44-51. https://doi.org/10.1111/j.1525-1446.2011.00960.x
13. Park YM. The development and effects of a simulation-based disaster nursing education program for nursing students using standardized patients [dissertation]. Seoul: Kyung Hee University; 2020. p. 1-162.
14. Comer SK. Patient care simulations: Role playing to enhance clinical understanding. Nursing Education Perspectives. 2005;26(6):357-361.
15. Bearnson CS, Wiker KM. Human patient simulators: A new face in baccalaureate nursing education at Brigham Young University. The Journal of Nursing Education. 2005;44(9):421-425. https://doi.org/10.3928/01484834-20050901-07
16. Ahn JH, Kim JY, Hwang ES. The effect of simulation-based education on critical thinking disposition, problem solving skills and nursing process confidence in college nursing students. Asia-pacific Journal of Multimedia Services Convergent with Art, Humanities, and Sociology. 2019;9(7):187-197. https://doi.org/10.35873/ajmahs.2019.9.7.017
17. Jeffries PR. A framework for designing, implementing, and evaluating simulations used as teaching strategies in nursing. Nursing Education Perspectives. 2005;26(2):96-103.
18. Hong S, Park B, Lee H, Lee JH. Analysis and evaluation of the National League for Nursing/Jeffries Simulation Theory. Journal of Korean Society for Simulation in Nursing. 2019;7(2):27-44. https://doi.org/10.17333/JKSSN.2019.7.2.27
19. Hwang WJ, Kim JA. Development and evaluation of a home-visit simulation scenario for elderly people with diabetes mellitus who live alone. Journal of Community Health Nursing. 2020;37(2):89-102. https://doi.org/10.1080/07370016.2020.1736399
20. Jeffries PR, Bigley MB, McNelis AM, Cartier JM, Pintz C, Slaven-Lee PW, et al. A call to action: Building evidence for use of simulation in nurse practitioner education. Journal of the American Association of Nurse Practitioners. 2019;31(11):627-632. https://doi.org/10.1097/JXX.0000000000000335
21. Huh SS, Kang HY. Effects of an educational program on disaster nursing competency. Public Health Nursing (Boston, Mass.). 2019;36(1):28-35. https://doi.org/10.1111/phn.12557
22. Yoon J. Development of an instrument for the measurement of critical thinking disposition: In nursing [dissertation]. Seoul: The Catholic University of Korea; 2004. p. 1-64.
23. Park J, Choi S. A study on the triage performance of military nurses and its related factors using a mass casualty scenario, paper exercise. Korean Journal of Military Nursing Research. 2012;30(1):128-142.
24. World Health Organization (WHO). COVID-19 strategic preparedness and response plan: Operational planning guideline. Geneva: WHO; 2021. p. 3-7.
25. Keiser MM, Turkelson C. Using students as standardized patients: Development, implementation, and evaluation of a standardized patient training program. Clinical Simulation in Nursing. 2017;13(7):321-330. https://doi.org/10.1016/j.ecns.2017.05.008
26. McCrum-Gardner E. Which is the correct statistical test to use? British Journal of Oral and Maxillofacial Surgery. 2008;46(1):38-41. https://doi.org/10.1016/j.bjoms.2007.09.002
27. Westfall PH, Troendle JF, Pennello G. Multiple McNemar tests. Biometrics. 2010;66(4):1185-1191. https://doi.org/10.1111/j.1541-0420.2010.01408.x
28. Krithikadatta J. Normal distribution. Journal of Conservative Dentistry. 2014;17(1):96-97. https://doi.org/10.4103/0972-0707.124171
29. Alim S, Kawabata M, Nakazawa M. Evaluation of disaster preparedness training and disaster drill for nursing students. Nurse Education Today. 2015;35(1):25-31. https://doi.org/10.1016/j.nedt.2014.04.016
30. Satoh M, Iwamitsu H, Yamada E, Kuribayashi Y, Yamagami-Matsuyama T, Yamada Y. Disaster nursing knowledge and competencies among nursing university students participated in relief activities following the 2016 Kumamoto earthquakes. SAGE Open Nursing. 2018;4:2377960818804918. https://doi.org/10.1177/2377960818804918
31. Cant RP, Cooper SJ. Simulation-based learning in nurse education: Systematic review. Journal of Advanced Nursing. 2010;66(1):3-15. https://doi.org/10.1111/j.1365-2648.2009.05240.x
32. Xia S, Yang B, Chen X, Petrini MA, Schory SA, Liu Q. Application and effects of a disaster nursing simulation training for Chinese undergraduates. Journal of Nursing Education and Practice. 2016;6(10):8-15. https://doi.org/10.5430/jnep.v6n10p8
33. Arbon P, Ranse J, Cusack L, Considine J, Shaban RZ, Woodman RJ, et al. Australasian emergency nurses' willingness to attend work in a disaster: A survey. Australasian Emergency Nursing Journal. 2013;16(2):52-57. https://doi.org/10.1016/j.aenj.2013.05.003
34. Jang I, Kim JS, Lee J, Seo Y. Educational needs and disaster response readiness: A cross-sectional study of clinical nurses. Journal of Advanced Nursing. 2021;77(1):189-197. https://doi.org/10.1111/jan.14570
35. Shi M, Xu W, Gao L, Kang Z, Ning N, Liu C, et al. Emergency volunteering willingness and participation: A cross-sectional survey of residents in northern China. BMJ Open. 2018;8(7):e020218.

https://doi.org/10.1136/bmjopen-2017-020218
36. Kim J, Lee O. Effects of a simulation-based education program for nursing students responding to mass casualty incidents: A pre-post intervention study. Nurse Education Today. 2020;85:104297. https://doi.org/10.1016/j.nedt.2019.104297
37. Chae MJ, Choi SH. Effectiveness of student learning with a simulation program focusing on cardiac arrest in knowledge, self-confidence, critical thinking, and clinical performance ability. Korean Journal of Adult Nursing. 2016;28(4):447-458. https://doi.org/10.7475/kjan.2016.28.4.447
38. Ko E, Kim HY. Effects of multi-mode simulation learning on nursing students' critical thinking disposition, problem solving process, and clinical competence. Korean Journal of Adult Nursing. 2014;26(1):107-116. https://doi.org/10.7475/kjan.2014.26.1.107
39. Shinnick MA, Woo MA. The effect of human patient simulation on critical thinking and its predictors in prelicensure nursing students. Nurse Education Today. 2013;33(9):1062-1067. https://doi.org/10.1016/j.nedt.2012.04.004
40. Song YA. Effects of integrative simulation practice on nursing knowledge, critical thinking, problem-solving ability, and immersion in problem-based learning among nursing students. Korean Journal of Women Health Nursing. 2020;26(1):61-71. https://doi.org/10.4069/kjwhn.2020.03.15.1
41. Park JA, Hong JY. The effect of simulation education on critical thinking disposition, problem solving process, communication skills, and clinical competence of nursing students. Journal of Learner-Centered Curriculum and Instruction. 2017;17(19):769-786. https://doi.org/10.22251/jlcci.2017.17.19.769
42. Cho GY. Effects of a simulation-based education on cardiopulmonary emergency care knowledge, critical thinking and problem solving ability in nursing students. Journal of Fisheries and Marine Sciences Education. 2016;28(2):439-449. https://doi.org/10.13000/JFMSE.2016.28.2.439
43. Al Gharibi KA, Arulappan J. Repeated simulation experience on self-confidence, critical thinking, and competence of nurses and nursing students-an integrative review. SAGE Open Nursing. 2020;6:2377960820927377. https://doi.org/10.1177/2377960820927377
44. Brown D, Chronister C. The effect of simulation learning on critical thinking and self-confidence when incorporated into an electrocardiogram nursing course. Clinical Simulation in Nursing. 2009;5(1):e45-e52. https://doi.org/10.1016/j.ecns.2008.11.001
45. Ravert P. Patient simulator sessions and critical thinking. The Journal of Nursing Education. 2008;47(12):557-562. https://doi.org/10.3928/01484834-20081201-06
46. Cicero MX, Auerbach MA, Zigmont J, Riera A, Ching K, Baum CR. Simulation training with structured debriefing improves residents' pediatric disaster triage performance. Prehospital and Disaster Medicine. 2012;27(3):239-244. https://doi.org/10.1017/S1049023X12000775
47. Zarifsanaiey N, Amini M, Saadat F. A comparison of educational strategies for the acquisition of nursing student's performance and critical thinking: Simulation-based training vs. integrated training (simulation and critical thinking strategies). BMC Medical Education. 2016;16(1):294. https://doi.org/10.1186/s12909-016-0812-0
48. Farra S, Miller E, Timm N, Schafer J. Improved training for disasters using 3-D virtual reality simulation. Western Journal of Nursing Research. 2013;35(5):655-671. https://doi.org/10.1177/0193945912471735