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Evaluation of the impact of an integrated simulation model in basic life support training on knowledge and practice: A randomized control trial in Jordanian hospitals

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A B S T R A C T

This study aims to evaluate the effectiveness of simulation training (ST) in improving nurses' knowledge and practice, which is essential in the nursing field, particularly among nurses in Jordanian hospitals. ST has the potential to significantly enhance patient care outcomes. A Randomized Control Trial was conducted in five hospitals in Jordan, using three repeated measurement tests: a pre-test, an immediate post-test after the intervention, and a post-test three months later. The nonparametric Mann-Whitney statistical test showed that the control and experimental groups were similar, with no significant differences in the participants' demographic characteristics. The Independent T-test confirmed the similarity of the pre-test results in the control group's knowledge and practice and the intervention group's mean scores. The simulation intervention proved to be highly effective in enhancing Basic Life Support (BLS) knowledge and practice among nurses. It nearly doubled the knowledge pre-test percentage from 40% to 75.35% in the immediate post-test, improving the scores from poor in the pre-test to excellent in the post-test. This significant improvement highlights the importance of simulation training in enhancing nurses' knowledge and practice. Similarly, ST significantly increased the average practice score percentage from 47.5% to 70% after the intervention, demonstrating its substantial impact. In conclusion, BLS simulation is a highly efficient educational method that helps participants acquire knowledge and skills. Simulation training prepares learners to activate cardiopulmonary resuscitation (CPR) quickly and correctly in case of cardiopulmonary arrest. Therefore, simulation in training should be expanded in the nursing curriculum.

1. Introduction

Nursing educators have used simulation since the earliest days of nursing education. The nurses started simulation training (ST) in the 1950s (Span, 2015). The first simulation manikin training was used in a physical assessment course in 1950, and the manikin was named "Mrs. Chase." Then, in 1960, another simulated manikin was formed and named "Harvey," which was used to identify normal and abnormal heart and lung sounds (Lawrence, 2018). The first successful chest compressions were performed in 1903 by a surgeon called Dr. George. Dr. Leonard Scherlis established the American Heart Association (AHA) reanimation committee in 1963, and the first cardiopulmonary resuscitation (CPR) guideline was approved (Sánchez-García et al., 2015). Simulations have become an important learning method in the nursing field (González-Salvado et al., 2020; Handeland et al., 2021). The use of simulation in training has been maximized globally over the last 20 years (Ruslan and Saidi,

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2019). Nassar et al. (2021) mentioned that simulation is an alternative teaching strategy in nursing education. Furthermore, ST took a large place in the nursing education curriculum and training. In addition, ST makes nursing education wider by developing the nurses into more specialties by establishing a higher nursing degree of study, such as a master's degree in acute and intensive nursing care, emergency care, maternity, and pediatrics nursing care (Curl et al., 2016). ST is extensively used in education. Similarly, the nursing profession is highly responsible for using simulation in patient assessment and distinguishing between normal and abnormal health patterns. Besides, educators in nursing and continuing nursing education offices in hospitals should develop new strategies to empower educational processes, especially Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS) (Sé et al., 2019). Using advanced technology in BLS and ACLS increases educational efficiency (Greif et al., 2021).

Simulation manikin is to develop clinical practice (Jung et al., 2017). WHO focused on simulation in medicine and nursing education, enhancing learning by keeping the patient safe (Ekert et al., 2021; Jawabreh et al., 2019). As a result, nurses participating in ST get higher scores than on the written exam. A study by WHO by Martins et al. (2018) mentioned that the simulations positively impact students, teachers, and healthcare providers (HCPs). A study by Britton (2017) marked a significant difference between learning in nursing faculty with ST and learning without simulation; the study found that the score of students trained by simulation was higher than the other groups.

2. Literature review

The healthcare delivery system requires qualified nurses to optimize patient care outcomes (La Cerra et al., 2019). Nurses should continuously develop and update their capabilities in BLS. Nurses should apply BLS quickly and accurately in emergencies (Park and Lee, 2021). Nurses are vital members of the basic life in the resuscitation team (Qalawa et al., 2020). Nurses are the superior target in BLS training (Isa et al., 2022; Partiprajak and Thongpo, 2016). The development of the nursing profession should start in the first year of hiring job to build confidence in knowledge, practice, and decision-making (Ruslan and Saidi, 2019). Most ST is applied to newly employed HCPs (Zavotsky et al., 2016). Wilmoth (2016) expressed that simulation in nursing orientation assists newly employed nurses in gaining insight into complex situations. Simulation effectively absorbs the stress of pre-employed and Post-employed (Alqarni, 2018; Jung et al., 2017; Martins et al., 2018; Ruslan and Saidi, 2019). In addition, the considerable gap between the theory part during the study and the Practice in the workplace for newly employed nurses produces a real shock for these nurses (Jung et al., 2017). Britton (2017) mentioned that only 24-35% of newly employed nurses meet the career expectation.

Nurses are the first HCPs who should be trained in BLS (Kose et al., 2020). Why? Nurses are the primary attendants in cardiopulmonary arrest (Bissenbayeva, 2019). Nurses stay with patients for a long time, and they are usually the first healthcare team to recognize the CPA victim (Sachdeva, 2020). The nurse is the first respondent to start BLS resuscitation while waiting for the ACLS team (Aliyari et al., 2019; Asadi et al., 2021; Panday et al., 2019). Healthcare institutions require qualified nurses with sufficient knowledge and Practice to maintain effective patient care (La Cerra et al., 2019). Furthermore, nurses need a unique education to address effective patient care procedures before interacting with real patients. A study conducted in Jordan showed that the Mean of the Post-test equal to 7.5 was higher than that of the Pre-test, equal to 4.7 after BLS training using simulation, and there was a strong correlation between ST scores and nurses' competencies. AHA recommended using simulation in training (Requena-Mullor et al., 2021). Abelsson et al. (2020) considered the ST in BLS training necessary. On the other hand, incident reports and medical errors will increase if there is no connection between the classroom and the clinical area (Tivener and Gloe, 2015). Ultimately, simulation is considered an efficient tool for improving teamwork and nursing practice (Armstrong et al., 2021; Brown and Benson, 2020; Pallas et al., 2021).

Costa et al. (2018) suggested that creating a successful learning strategy for the BLS is also essential, as the trainer needs to use advanced technology simulation in BLS and ACLS. Research published by WHO stated that ST maintains the ethical aspect by permitting the nurses and midwiferies to make mistakes while applying invasive and non-invasive procedures in simulation, not on real patients (Martins et al., 2018).

AHA mentions that the knowledge and Practice of BLS should be updated according to the necessities and new events (Kose et al., 2020). Re-training in BLS using simulation is related to changes in BLS guidelines from international associations like AHA, changing the ABC chain survival in the year 2005 to the CAB in the year 2015, and the new justifications in the AHA BLS 2020 about the chain of survival in 2020 were due to the COVID pandemic effect (Kei and Mebust, 2021; Laco and Stuart, 2022). European Resuscitation Council continuously updated the CPR guidelines according to the new evidence-based Practice or global events from 1992 to 2020 every two years; in 2020, the latest update covered the COVID-19 pandemic (Perkins et al., 2021).

The Jordanian accreditation committee decided to articulate ST in the universities. The major types of simulation start with high-fidelity simulation. These simulations are used in advanced training, such as comprehensive cardiac and respiratory patient care and medication administration (Wilmoth, 2016). Secondly, medium-fidelity simulation is the most common manikin used for

BLS training (Rushton et al., 2020). Finally, low-fidelity simulations, also called partial task trainers (Cura et al., 2020), are the cheapest models (Piryani et al., 2019), suitable and comfortable, and transferred anywhere for BLS training (Ryzner and Kujath, 2018).

BLS Knowledge is the theory principles that reflect applicable concepts in BLS practice (Britton, 2017; Shrestha et al., 2020). BLS knowledge is the major factor in effective resuscitation outcomes (Gutiérrez-Puertas et al., 2021). Sufficient knowledge of BLS is necessary for life-saving among CPA patients (Isa et al., 2022). Likewise, using basic or advanced technological dummies in training provides a high level of knowledge and high-quality care (Sé et al., 2019). ST increases the consolidation of knowledge and skills compared with other traditional methods. Hence, HCP development is achieved through technological interventions and training like simulation; the quality of care will increase, and patient morbidity and mortality will decrease (Sé et al., 2019). Finally, ST is used to acquire the available knowledge but not build new knowledge (Ruslan and Saidi, 2019).

Training is an effective method to acquire knowledge with hands-on practice BLS on mannequins. BLS must involve skills, not just theoretical ones. ST can allow the participant to perform real-life application of skills and knowledge and produce a safe environment for patients (Laco and Stuart 2022). La Cerra et al. (2019) remarked that ST improves technical skills and performance, strengthens critical thinking, and effectively helps to face emergencies. ST is necessary to help students and nurses gain skills and keep patients from hazards (Hassan et al., 2021; Sherwood and Francis, 2018). Moreover, ST refines the skills in critical situations (Bastin et al., 2017). Nurses' skills in BLS should include assessing the level of consciousness, requesting help, assessing pulse and breathing, understanding the pattern of apnea and gasping breathing, applying chest compression, and maintaining the airway open during ventilation (Wilson et al., 2021). A practical session should assess a C-A-B survey, including performing chest compression appropriately, point of compression, airway opening technique, and non-invasive ventilation (Sé et al., 2019). At the top, repeated BLS training should focus on selecting the correct area of chest compression, airway opening correctly and safely, giving adequate ventilation, and using the AED (Gümüş et al., 2020).

Recertification of BLS and ACLS training is mandatory for all HCPs (Bánfai et al., 2022; Knipe et al., 2020; Wilson et al., 2021). Frequent and refresher BLS training, focusing on skills and self-confidence, should be carried out every three months due to decreased nurses' skills competency (Abelsson et al., 2020). So, updating the knowledge and skills of BLS and ACLS will save the victims' lives (Isa et al., 2022). Similarly, a study by AHA recommended renewing BLS certification every two years, which may be insufficient to deal with CPA victims.

During the COVID-19 pandemic, most nursing students received the training through videos and did not attend on-ground training (Mcdermott and Ludlow, 2022). Graduated nurses in Jordan expressed dissatisfaction due to no more clinical training during the COVID-19 pandemic (Shorey et al., 2022). Admission of patients to the ICU during the COVID-19 pandemic declined by 23% compared with the previous year, and many victims of cardiac arrest and diagnosed with COVID-19 had low survival rates due to low levels of CPR quality (Lauridsen et al., 2021). At the beginning of the COVID-19 pandemic in Paris, the rate of cardiopulmonary arrest doubled from 13.42 to 26.64 per one million persons (Marijon et al., 2020; Perkins and Couper, 2020). In Sweden, cardiopulmonary arrest doubled two or threefold during the COVID-19 pandemic (Holm et al., 2021). The victims with cardiac disease and those diagnosed with COVID-19 have a higher ability to cardiac arrest and increased mortality rate than those without cardiac disease (Bánfai et al., 2022; Manolis et al., 2020). COVID-19 has affected the quality of resuscitation as rescuers are worried about the transmission of the viruses when performing chest compression or ventilation.

This study aims to evaluate the effectiveness of ST in nurses' knowledge and practice among nurses in Jordanian hospitals. The researchers hypothesized there are no significant differences in the participants' characteristics and pre-test results, and there is a significant difference in post-test mean percentage between nurses in the control and experimental group after BLS training using simulation.

3. Method

3.1. Study design

A Randomized Control Trial was conducted in five hospitals in Jordan. Three of the five hospitals were randomized for the control group and two hospitals for the experimental group. The study used three repeated measurement tests: A pre-test, an Immediate post-test after the intervention, and a post-test three months later after the intervention. Furthermore, the list of participants' names was randomized to be assigned to the control and experimental groups.

3.2. Setting and samples

This study ensured homogenous inclusion criteria between the control and experimental groups. The researchers selected nurses with less than two years of experience in nursing, who rarely faced CPR, and who had not attended BLS training in the last two years. Participants with ICU capabilities were excluded. Sample size computation was performed using G*POWER software. This study's sample size was 72 participants; a 30% drop-out rate was added because the final post-test study lasted three months after the intervention. Finally, the sample size was 102 participants divided into two arms; each arm consisted of 51 participants.

3.3. Randomization process

Randomization of the hospitals: Random Allocation Software version 1.0 was utilized for block randomization to distribute hospitals into two groups. Each hospital was assigned a number before using the software. The software output was then automatically distributed to three hospitals in the control group and two hospitals in the interventional group. The researchers ensured that participants for the control and interventional groups were not selected from the same hospitals to avoid data contamination.

Randomization of the participants: The researchers initiated formal, in-person visits to coordinate with the nursing director and the continuous education office at the chosen hospitals. Subsequently, they compiled a comprehensive list of newly employed nurses who fulfilled the eligibility criteria outlined in the study. The randomization is executed through an Excel sheet, utilizing the provided participant lists from each hospital.

3.4. Intervention

The learners in the control group received the AHA-BLS 2020 brochure, and the interventional group received simulation BLS training utilized by expert facilitators in BLS training in 7 hours of lab training. The interventional group participants were divided into 4 groups and received the intervention in 4 days. The intervention was prepared as a PowerPoint presentation and simulation training. The equipment for the intervention was prepared, which included adult and pediatric manikins, a Charlie simulator to relieve choking, bag-valve-mask ventilation, PPE, and a chest compression board. Manikins have chest inflation and deflation characteristics for rescue breathing, a palpable carotid pulse, and a spiral spring inside to allow chest recoil during chest compression.

BLS training requires unique learning theories to integrate Simulation into nursing education (Briese et al., 2020). Miller's (1990) pyramid is the theoretical model that guided this study. WHO recommends using this model for BLS training with Simulation to maximize nurses' knowledge and practice levels (Martins et al., 2018). Miller's pyramid encourages trainers to conduct the training using simulation because ST is a non-critical and non-threatening training environment that keeps patients safe and away from any harm (Nash, 2019). Shrestha et al. (2020) justified using safe environment training like simulation because no trainer is allowed to conduct BLS training on actual patients, and patients hardly ever permit trainers to perform invasive or non-invasive procedures on their bodies. According to a WHO study on ST in nursing and midwifery education, it is highly recommended to use this model to maintain safety and reduce medical errors by HCPs (Martins et al., 2018). Miller's pyramid (Fig. 1) emphasizes the importance of "knowing" before practice and suggests that knowledge training is the foundation of healthcare education. Clinical practice training follows knowledge preparation (Nash, 2019).

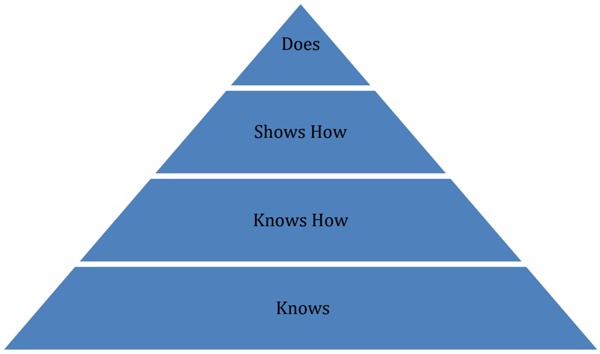

Fig. 1: Miller's pyramid

Depending on Miller's framework, it is more than just focusing on knowing something. It also includes Practice and training to apply care to patients. Miller (1990) formulated a conceptual framework called Miller's pyramid. This pyramid helps the learner form a matrix between the knowledge and practice parts and what the learner wants to achieve in the outcomes. This pyramid describes the progression of learner practice and competency, depending on four levels, as shown in Fig. 1.

Level (1): Know: The pyramid base gives the learners knowledge related to the subject, which is the competency's foundation and building block. Researchers at this level give the participants a PowerPoint presentation and discuss all concepts and information relevant to the BLS (Chowdhary et al., 2020). Level (2): Know-how: At this level, the trainer shows the trainees how to apply the knowledge; the researchers start ST practice in BLS. Kose et al. (2020) stated that after the trainer demonstration, the participants would apply all BLS training. Level (3): Show-how: The trainees demonstrate what they learned in the previous levels; in the BLS, the participants should start to apply both knowledge and Practice and repeat the training until mistakes are eliminated. After the trainer demonstration and all participants complete the first training trial, the trainees repeat all BLS steps until they eliminate all mistakes and perfectly do all BLS steps (Kose et al., 2020). Level (4): Does: At the apex and top of the pyramid, focusing on learner behaviors, the trainer decides that the learner can apply BLS independently. Therefore, at this level, the trainers ensure that the learner can handle actual patients and use BLS. Participants can gain certification in BLS training. They deeply understand BLS and become primary persons in CPR situations.

3.5. Measurement and data collection

Standardized Questionnaires "AHA's BLS test" comprises 23 questions related to knowledge and psychomotor domain. Adopted from Yunus et al. (2015) to ensure the questionnaires' reliability, a pilot study was conducted on 20 nurses. Cronbach's alpha is 0.748, attesting to the appropriateness of this tool. Participants are awarded one mark for every correct answer and zero for each incorrect response.

The knowledge and practice grade level ranges from excellent (75% and above), very good (65%–74%), good (55%–64%), average (45%–54%), and poor (less than 45%). Participants receive one mark for each correct answer and zero for each incorrect response. Approval was obtained for the use of the AHA's BLS test questionnaires.

- Pre-test: The baseline data: A pre-test is a primary step before the intervention to assess the level of participants who fulfilled the eligibility conditions for the control and experimental groups. It is required 30 minutes after participants sign the informed consent form and fill out the demographic data.
- Post-tests: BLS acquisition and BLS retaining: The Immediate post-test and Post-test after three months were conducted to compare them with pre-tests and to compare post-tests between interventional and control groups. The response rate of the pre-test and immediate post-test was 100%, while the response rate of the participants in the experimental group was 94% and 88% in the control group.

3.6. Data analysis

Quantitative data was analyzed using IBM SPSS version 27, and the researchers also utilized descriptive statistics to compute the average percentage of knowledge and practice level at all measurement times. Mann-Witney statistical analysis was used to identify the homogeneity between the characteristics of the participants in the two groups. An Independent T-test was used to identify the homogeneity in the pre-test results between groups.

4. Result and discussion

Both the experimental and control groups had homogenous inclusion criteria after random assignment (Table 1). All participants had a bachelor's degree in nursing, 89.2% had experienced less than one year in a nursing career, and the remaining had experienced between one and two years; moreover, no participants had exposure to CPR and did not attend BLS training. The age of participants was narrowed between 20 and 24 years old; only 9.8% of participants were between 25 and 29; additionally, the data presented a relatively equal distribution of gender, where 48 were women and 54 were men.

Table 1: Demographical features of participants

Demographical data	Category	Number (n=102)	Percent (%)
Age (year)	20-24	92	90.2%
	25-29	10	9.8%
Gender	Men	54	52.9%
	Women	48	47.1%
Education level	Bachelor degree	102	100%
Experience in nursing	Less than one year	91	89.2%
	From 1 to 2 years	11	10.8%
Did you receive any BLS training in your health institutions?	Yes	0	0
	No	102	100%

4.1. Baseline demographical characteristics of the participants

The ordinal normality assumption was checked for age, experience, and educational level, and it was found that it was not fulfilled. The nonparametric Mann-Witney statistical test identified that the interventional group's median differed from the control groups. Table 2 shows the median and interquartile range (IQ) results of the year's participants' age, education level, and experience. [Interventional Median Age (IQ)=2(0)], [Control Median Age (IQ)=2(0)] and p-value>0.05. Moreover, [Interventional Median Work Experience (IQ)=1(0)], [Control Median Work Experience (IQ)=1(0)] and p-value>0.05. Finally, [Interventional Median Educational Level (IQ)=1(0)], [Control Median Educational Level (IQ)=1(0)] and p-value>0.05. These results presented that the control and experimental groups were identical, with no significant differences in the demographical characteristics of the participants.

4.2. Pre-test comparison between the control and interventional groups

Pre-test results (Table 2) presented firstly the knowledge domain Levene's Test for the equality of variance; since the F-statistic=0.271, (p=0.604), the null hypothesis of equal variance was not rejected, then the assumption of equal variance was assumed between the pre-test of the control group and the Pre-test in the interventional group. The t-statistics (df) result was 0.991 (100), (p=0.324). Secondly, the practice domain Levene's Test for the equality of variance; since the F-statistic=0.015, (p=0.904), the null hypothesis of equal variance was not rejected, then the assumption of equal variance was assumed between the Pre-test of the control group and the Pre-test in the interventional group. The t-statistics (df) result was -0.143 (100), with (p=0.887). The data analysis of the Pre-test highlighted a significant homogeneity in the control group knowledge and practice Mean (SD): 5.61 (1.686) and 4.67 (1.337), respectively, and intervention group Mean (SD): 5.27 (1.710) and 4.71 (1.432) respectively.

Table 2: Demographical characteristics of the participants

Score	Median (IQ)		Z-statistic	Mann-Whitney U	p-value
	Control group	Intervention group			
Age	2(0)	2(0)	-.663	1249.500	0.508
Experience in years	1(0)	1(0)	-.318	1275.000	0.751
Educational level	1(0)	1(0)	.000	1300.500	1.000

4.3. Post-test-2 comparison between the control and interventional groups

Post-test-2 analysis results (Table 3), including firstly, Levene's test for the knowledge domain equality of variance, whereas the (F-statistic=0.135), (p=0.714), the null hypothesis of equal variance was assumed between the Post-test-2 of the control group and experimental group. The t-statistics (df) was -5.520(91) and (p<0.001). Secondly, Levene's test for the practice domain equality of variance, whereas the (F-statistic=0.501), (p=0.481), the null hypothesis of equal variance was assumed between the Post-test-2 of the control group and experimental group. The t-statistics (df) result was -3.176(91) and (p=0.002). The data analysis highlighted that the experimental and control groups' Post-test-2 Mean±SD were heterogeneous and significant differences in knowledge and practice. The control group's knowledge and practice Mean±SD were 5.93±2.049 and 4.80±1.727, respectively, and the experimental groups' Mean±SD were 8.33±2.137 and 5.90±1.601, respectively.

Table 3: Independent T-test

Dependent variables	Mean±SD		Levene's test		T-statistic (pdf)	p
Pre-test comparison between control (n=51) and experimental (n=51) groups						
	Control group	Experimental group	F test	p		
Knowledge	5.61±1.686	5.27±1.710	0.271	0.604	0.991 (100)	0.324
Practice	4.67±1.337	4.71±1.432	0.015	0.904	-0.143 (100)	0.887
Post-test-2 comparison between control (n=45) and experimental (n=48) groups						
Dependent variables	Mean±SD		Levene's test		T-statistic (pdf)	p
	Control group	Experimental group	F test	p		
Knowledge	5.93±2.049	8.33±2.137	0.135	0.714	-5.520 (91)	< 0.001
Practice	4.80±1.727	5.90±1.601	0.501	0.481	-3.176 (91)	0.002

Using Crosstab and Explorer analysis on the SPSS, the researchers present the average percentage and number of participants in the knowledge and practice domain in all test points (Table 4). Table 4 shows what was mentioned earlier in this research; the participants' knowledge and practice scores in percentage (%) varied from excellent if the participant got 75% and above to "very good" if the score was from 65%—74%, "good" if the score was between 55% and 64%, "average" if the score was 45%—54% and poor if the score was less than 45%. Table 4 represented many considerations; one of these considerations was that the ST intervention was effective in increasing BLS knowledge and practice among newly employed nurses because it doubled the percentage of the knowledge Pre-test from 40% to the Post-test 75.35% and moved the percentage from poor to excellent in Post-test-1, too; increased the average percentage of the practice score in the Pre-test percentage from 47.5 to 70% in the Post-test-1. Secondly, Table 4 presented the number of excellent participants in the pre-test knowledge group, which was zero in the intervention group and one in the control group. There were 31 participants in the intervention group versus nine in the control group in the post-test-1. Furthermore, 28 participants in the intervention group got poor scores on the pre-test in the knowledge domain, and one participant became a participant in post-test-1. Finally, Table 4 presented the number of excellent participants in the pre-test practice score, which was one participant in the intervention group and zero in the control group. In the post-test-1, 20 participants got excellent in the intervention group versus 5 participants in the control group. Furthermore, the number of participants who got poor Pre-test practice scores in the intervention group was minimized from 21 to five participants in Post-test-1. The objective of this study was to evaluate the effectiveness of the ST module intervention on the knowledge and practice level of nurses in Jordanian Hospital. ST in this study improved BLS knowledge and practice when comparing pre-test assessments and post-test scores, as well as the mean percentage. The ST has a crucial role in facilitating nurses' knowledge and practice development, leading to a significant difference in the Mean±SD of the intervention group compared to the control group during the post-test follow-up. The good knowledge and practice score in this study is in line with other studies that used simulations to teach new nurses, healthcare professionals, and school of health sciences students more about BLS (Irfan et al., 2019; Jawabreh et al., 2019; Kose et al., 2020; Méndez-Martínez et al., 2019; Ounprasertsuk and Wongthong, 2020; Piryani et al., 2019; Sé et al., 2019; Umuhoza et al., 2021).

Table 4: Crosstab and explorer analysis

Mean percentage of knowledge and practice score						
Dependent variables	Knowledge score			Practice score		
Group/type of test	Pre-test	Post-test-1	Post-test-2	Pre-test	Post-test-1	Post-test-2
Control group	42%	59.02%	45%	46.22%	53.11%	48.09%
Interventional group	40%	75.35%	64%	47.50%	70%	58.96%

Number of participants according to knowledge percentage											
	Excellent (N)		Very good (N)		Good (N)		Average (N)		Poor (N)		Total
Group/type of test	PRE	POST-1	PRE	POST-1	PRE	POST-1	PRE	POST-1	PRE	POST-1	
Control group	1	9	1	7	6	13	15	14	28	8	102
Experimental group	0	31	2	10	2	4	19	5	28	1	102

Number of participants according to practice percentage											
	Excellent (N)		Very good (N)		Good (N)		Average (N)		Poor (N)		Total
Group/type of test	PRE	POST1	PRE	POST1	PRE	POST1	PRE	POST1	PRE	POST-1	
Control group	0	5	3	6	12	15	16	12	20	13	102
Experimental group	1	20	3	11	11	9	15	6	21	5	102

The simulation in the BLS training in this study was vital to increase the significant differences in increase BLS knowledge and competencies among newly employed nurses in post-test-2. This result is in line with many previous studies (Alexander, 2020; Hassan et al., 2021; Laco and Stuart, 2022; Rushton et al., 2020; Ryan et al., 2019; Sé et al., 2019; Sherwood and Francis, 2018). Many studies showed that improving nurses' knowledge and skills in BLS can enhance positive patient care outcomes (Knipe et al., 2020; Sherwood and Francis, 2018) and cost-effectiveness. The healthcare system requires expert nurses with high levels of knowledge and practice to maximize the effectiveness of patient care (La Cerra et al., 2019). The ST intervention effectively doubled the participants' average knowledge score from 40% in the pre-test to 80% in the immediate test (post-test-1). Also, more participants achieved an excellent level of knowledge after the intervention than before. Very few studies used the mean average percentage to describe the effectiveness of BLS ST as educational material on knowledge and practice levels (Isa et al., 2022).

The study used an Independent-sample T-test to compare the performance of the intervention and control groups on post-test-2, which assessed their BLS knowledge and practice. The p-value and mean results showed significant differences between the two groups. The intervention group had higher average scores in both knowledge and practice compared to the control group. In conclusion, the findings suggest that BLS training using simulation was more effective than the standard intervention. These results support the initial hypothesis that "there was a significant difference in post-test scores of newly employed nurses between the intervention and control groups across all measured variables." Another study also supported these findings, showing significant differences in knowledge and practice between the two groups in their post-tests.

The significant improvements in knowledge and practice scores among participants in the intervention group may be due to several factors, including the use of a simulation manikin as a unique method in clinical training, the incorporation of Miller's pyramid in BLS training, and the facilitator's experience as a clinical instructor and trainer. In this study, ST motivated the participants. It also encouraged them to continue and repeat BLS training, allowing them to perform chest compressions and all CPR scenarios without the fear of harming real patients. As a result, ST is a valuable strategy that should be used in nursing and other healthcare fields. The study's findings about the use of simulation to increase learner motivation align with a previous WHO study, which highlighted that simulation training improves nurses' motivation to enhance their knowledge and practice skills (Martins et al., 2018). Furthermore, the current study supports previous research that focused on increasing learner motivation for BLS training through simulation (Ruslan and Saidi, 2019).

Furthermore, no trainer can apply BLS training to real patients. Patients rarely consent to the trainees applying any non-invasive, non-risky procedure to their bodies, and if they approve, they do so only once (Shrestha et al., 2020). Many previous studies supported the researchers' present study findings and considered ST an active method that positively affects BLS training in nursing, permits nurses to gain knowledge, makes the training process more dynamic, and maximizes practice. Furthermore, they recommended that health institutions implement ST in all healthcare sectors (Kose et al., 2020; Lee et al., 2021; Oermann et al., 2020; Ounprasertsuk and Wongthong, 2020; Panday et al., 2019; Piryani et al., 2019). Another explanation for participants' positive results in the practice domain in the current study is the integration of Miller's pyramid in ST. Earlier studies indicated that nursing education and training require specific learning theories to integrate simulation into nursing education (Briese et al., 2020). WHO suggested using Miller's pyramid in critical care procedures among nurses and midwives. They mentioned that this model would help nursing students learn more and practice what they've learned (Martins et al., 2018).

The facilitator has many educational and training certifications that make him unique in facilitating the BLS intervention, including a master's degree in critical care nursing, more than ten years of experience in critical care units, a critical care subject lecturer (theory and practice) for bachelor students, and a valid BLS and ACLS training certification from an international organization (AHA). Moreover, the facilitator has certification as a trainer in nursing education. Many previous studies are consistent with this study about the facilitator eligibility criteria mentioned earlier in this research

(Abelsson et al., 2020; Etlidawati and Milinia, 2021; Greif et al., 2021; Lee et al., 2021).

The findings reflect that the ST intervention was more effective in gaining practice than the standard intervention. On the other hand, the post-test-2 mean decreased in the standard intervention of the control group to reach near the pre-test result, reflecting that the standard intervention was ineffective. Many previous studies stated that CPR competency deteriorated after three to six months (Laco and Stuart, 2022; Méndez-Martínez et al., 2019; Partiprajak and Thongpo, 2016; Umuhoza et al., 2021).

4.4. Nursing and healthcare delivery system implication

Simulation has become an essential part of nursing education over the past two decades (Nassar et al., 2021; Umuhoza et al., 2021). Simulations play a crucial role in the training of medical professionals (González-Salvado et al., 2020; Handeland et al., 2021) and have expanded the nursing curriculum to include advanced degree programs such as critical care, emergency care, maternity care, and pediatric care (Curl et al., 2016). In conclusion, the integration of simulation into nursing education brings significant advancements to the nursing profession. It has the potential to boost clinical skills, elevate patient safety, foster teamwork, enhance professional growth, offer valuable experience in a risk-free setting, and create more opportunities for research. Ultimately, the incorporation of simulation into nursing education will enhance nurses' knowledge, abilities, and confidence, particularly in critical care procedures.

5. Limitation of the study

One limitation of this study is that the sample only included newly employed nurses from five hospitals in two cities in Jordan. As a result, the findings may not apply to other populations. The researchers suggest expanding data collection in future studies to better assess the intervention's effectiveness. The results reflect the largely homogenous population of nurses in Amman and Al-Zarqa and should not be considered representative of nurses in other cities. However, the inclusion criteria and measurement tools could be used in other national or international settings. Therefore, replicating this research method is strongly recommended for future studies.

6. Strength of study

The study used a randomized control trial to assess the effectiveness of the ST module on knowledge and practice. The randomized control trial is widely regarded as the most reliable research design for testing the effectiveness of interventions. One key advantage of this design is its ability to rigorously test hypotheses, making it the standard for intervention studies (Polit and Beck, 2014). This approach was used to ensure the comparability of the groups and to minimize bias. Additionally, the study followed a detailed methodology based on the Consort 2010 guidelines to ensure the research was conducted in a comprehensive and standardized way. The researchers used a systematic computerized sampling method for selecting both hospitals and participants, ensuring representation from different healthcare settings and newly employed nurses to improve the generalizability of the results. Various data collection tools were used, including pre-test, post-test-1, and post-test-2, to gather comprehensive information on knowledge and practice levels. The study also adhered to ethical standards, obtaining approval from relevant ethics committees, including the IRB in Jordan and the IRB at USM University.

7. Conclusion

The study shows that simulation-based learning with a focus on BLS training can significantly improve nurses' knowledge and practice scores. The use of a simulation manikin and the integration of Miller's pyramid in BLS training were found to be effective strategies for nursing education. Additionally, the facilitator's experience and qualifications were important factors in the success of the intervention. The study recommends the implementation of ST in healthcare institutions to improve BLS training and competencies among nurses and healthcare professionals. The findings of this study can help inform future research and development of effective educational strategies and interventions in nursing education.

Compliance with ethical standards

Ethical considerations

The Universiti Sains Malaysia Human Research Ethics Committee authorized ethical approval under the study protocol code USM/JEPeM/22110681, which complies with the Helsinki Declaration. The researchers discussed the study's objectives and risks before the participants voluntarily signed a hard copy of the consent and became a part of this study. Participants' data was kept in a safe and confidential area. This study is free from hazards and medicine use and is not applicable in emergencies. This study was registered with the ClinicalTrials.gov Protocol Registration and Results System (PRS), with registration ID number NCT06001879, on August 16, 2023.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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