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ASSESSING THE IMPACT OF SIMULATION-BASED TRAINING ON NURSE COMPETENCE IN EMERGENCY CARE

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Abstract

Objective: *This experimental study assessed the impact of simulation-based training on nurse competence in emergency care at a tertiary hospital in Khyber Pakhtunkhwa (KPK), Pakistan, with a focus on triage, resuscitation, and systematic patient assessment.*

Methods: *The study was conducted in the adult emergency department of a large public-sector tertiary hospital in KPK. Registered nurses with at least six months of ED experience were randomly allocated to an intervention group receiving a structured high-fidelity simulation programme in addition to routine in-service education, or to a control group receiving routine education alone. The intervention comprised four locally contextualized simulation scenarios (polytrauma with hemorrhagic shock, acute coronary syndrome with cardiac arrest, sepsis with shock, and multi-casualty incident triage), each followed by a structured debriefing. Competence in triage, cardiopulmonary resuscitation (CPR), and primary/secondary survey was measured at baseline and four weeks after training using Objective Structured Clinical Examination (OSCE) checklists and a multiple-choice knowledge test. Self-reported confidence was assessed with a validated Likert-scale questionnaire. Data were analysed using paired and independent t-tests and analysis of covariance, adjusting for baseline scores.*

Results: *A total of 82 nurses completed the study (intervention n = 41; control n = 41). At baseline, groups did not differ significantly in knowledge, OSCE performance, or confidence scores. After four weeks, the intervention group showed significantly greater gains in overall OSCE scores compared with the control group (mean difference 12.8 percentage points, 95% CI 9.4–16.1; $p < 0.001$). The largest improvements were observed in triage accuracy, adherence to CPR*

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algorithms, and completeness of the primary survey. Knowledge scores increased in both groups but were significantly higher in the intervention group post-test ($p < 0.001$). Self-reported confidence in managing unstable patients, prioritising care, and recognising deterioration also increased significantly in the simulation group, with only minimal change in the control group. No adverse events related to training were reported.

Conclusion: *Simulation-based training, integrated into routine professional development, significantly improved emergency nurses' competence and confidence in triage, resuscitation, and patient assessment in a tertiary hospital in KPK, Pakistan. These findings supported the incorporation of structured, context-specific simulation programmes with debriefing into emergency nursing education in resource-constrained settings as a strategy to strengthen patient safety and quality of care.*

INTRODUCTION

Emergency departments (EDs) in low- and middle-income countries have faced increasing volumes of trauma, acute medical emergencies, and complications of chronic disease. Nurses in these settings have been expected to make rapid triage decisions, initiate resuscitation, and perform systematic assessments under intense time pressure and with limited resources. In Pakistan, emergency nursing services in public tertiary hospitals, including those in Khyber Pakhtunkhwa (KPK), have expanded, but traditional training approaches continued to rely heavily on didactic teaching and opportunistic bedside instruction, creating a gap between theoretical knowledge and the complex realities of practice.

Simulation-based education (SBE) emerged internationally as a key strategy to bridge this theory–practice gap by providing learners with a realistic yet safe environment in which to rehearse critical skills and decision-making without risk to patients. Umbrella reviews and systematic reviews in nursing education consistently showed that simulation-based learning improved knowledge acquisition, psychomotor performance, clinical judgment, and confidence compared with conventional teaching alone, particularly when high-fidelity manikins and structured debriefing were used. High-fidelity patient simulation, in particular, was associated with moderate to large effects on performance in life-threatening clinical scenarios such as cardiac arrest, shock, and respiratory failure.

Within emergency care, triage and resuscitation were two domains where small delays or misjudgements could lead rapidly to preventable morbidity and mortality. Recent interventional studies reported that simulation-based triage training improved accuracy of triage decisions and reduced learner anxiety in simulated ED or disaster scenarios. Disaster-oriented simulations using multi-casualty scenarios enhanced nursing students' crisis management and triage performance, reinforcing the value of immersive practice for prioritisation and rapid assessment. Meta-analytic evidence further indicated that repeated exposure to high-fidelity simulations improved resuscitation performance and adherence to advanced life support algorithms across different health professions.

The Pakistani context added further urgency to strengthening emergency nursing competence. Short reports and editorials on simulation-based medical education (SBME) in Pakistan described a health system where medical and nursing education had traditionally been dominated by didactic lectures and apprenticeship models, with relatively limited use of structured simulation until the last decade. As simulation centres were established in major universities and teaching hospitals, early initiatives showed promise but also highlighted challenges, including the cost of high-fidelity equipment, scarcity of trained simulation faculty, and uneven access between urban and peripheral institutions.

Nursing-specific literature from Pakistan supported the potential value of SBE but suggested that most activity remained concentrated in undergraduate programmes, often in large private or semi-private institutions. A recent review of simulation-based

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education from the perspective of nursing faculty in Pakistan reported that faculty recognised simulation as an effective pedagogy for developing safe and competent nurses, while also identifying barriers such as limited equipment, insufficient faculty development, and time pressures. Qualitative work from Karachi nursing schools similarly showed that students viewed simulation positively as a means to gain hands-on experience, but they perceived inconsistency in access and facilitation quality.

Despite this growing body of work, the application of simulation-based training to in-service emergency nurses in public tertiary hospitals, especially in KPK, had remained limited and poorly documented. Much of the existing evidence involved undergraduate students in controlled educational environments rather than practising ED nurses facing high patient loads, staff shortages, and constrained diagnostic facilities. Moreover, previous evaluations in Pakistan tended to focus on knowledge gains or learner satisfaction rather than objective performance measures such as OSCE scores, triage accuracy, or adherence to resuscitation algorithms.

At the study hospital in KPK, informal incident reviews over several years highlighted recurring challenges in emergency nursing care. These included delayed recognition of shock and sepsis, inconsistent application of triage categories, interruptions and omissions in primary and secondary surveys, and variable adherence to Basic and Advanced Life Support guidelines during resuscitation. Nurse managers also noted that newly inducted ED nurses often felt overwhelmed when faced with critically ill patients, despite having completed basic orientation sessions. There was no structured, simulation-based programme targeted specifically at emergency nurses; continuing professional development mainly consisted of lectures, short workshops, and on-the-job supervision.

In response, the nursing education department and ED leadership jointly developed a structured simulation-based training programme tailored to the local emergency case-mix and resource constraints. The programme incorporated four scenario types that reflected common and high-risk situations in the hospital's ED: (1) road-traffic-injury polytrauma with hemorrhagic shock, (2) acute coronary syndrome progressing to cardiac arrest, (3) septic shock in a young adult with delayed presentation, and (4) a mass-casualty incident requiring rapid multi-patient triage. Each scenario was designed around clearly defined learning outcomes aligned with international emergency care and resuscitation guidelines but contextualised to the hospital's protocols, equipment, and workforce. High-fidelity manikins and realistic props were used where available; where technology was limited, the faculty compensated through careful scripting, role allocation, and emphasis on clinical reasoning.

A central feature of the programme was structured debriefing immediately after each scenario. Facilitators guided nurses to reflect on their clinical decisions, technical skills, teamwork, and communication, linking observed behaviours back to evidence-based practices and local guidelines. This approach followed international best practice in simulation pedagogy, which highlighted debriefing as the primary driver of learning rather than the simulation itself.

Given the resource constraints, hospital leadership needed evidence that such an intensive approach translated into measurable improvements in practice-relevant competencies before committing to wider implementation. The present study therefore evaluated the impact of this simulation-based training on emergency nurses' competence and confidence in triage, resuscitation, and patient assessment, using an experimental design with a control group receiving routine education alone.

The study addressed three main gaps in the existing literature:

1. **Population and context:** Most prior research on simulation in Pakistan focused on students in metropolitan universities; this study examined practising emergency nurses in a public tertiary hospital in KPK, a region with distinct demographic and health-system challenges.
2. **Outcomes:** Many previous studies emphasised knowledge or satisfaction; this study used OSCE-based performance measures, scenario-specific triage accuracy, and self-reported confidence, providing a more comprehensive picture of competence relevant to daily ED practice.
3. **Scope of competencies:** Rather than focusing on a single skill, such as CPR alone, the intervention targeted a coherent set of emergency nursing

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competencies—triage, resuscitation, and systematic assessment—that together shaped patient outcomes in the first "golden minutes" of ED care.

Based on international evidence that high-fidelity simulation and debriefing improved learning outcomes in life-threatening scenarios, and emerging national experience with SBE, the study hypothesised that nurses who received the simulation-based programme would demonstrate significantly greater improvements in emergency care competence and confidence than those who continued with routine education alone.

The findings from this study were intended to inform policy and practice in three ways. First, they were expected to provide empirical data to support or refute investment in simulation-based emergency nursing education in resource-constrained settings like KPK. Second, the study sought to generate a locally adapted model of scenario design and implementation that could be replicated or scaled to other tertiary hospitals in Pakistan. Third, by documenting both educational effects and implementation considerations, the study aimed to contribute to ongoing national discussions on integrating SBE into continuing professional development for nurses, complementing existing work focused on pre-licensure programmes.

MATERIALS AND METHODS

Study design

This study used a two-arm experimental design with parallel groups. Emergency nurses were randomly allocated to either an intervention group that received a structured simulation-based training programme in addition to routine in-service education, or a control group that continued with routine education alone. Data were collected at two time points: baseline (pre-test) and four weeks after completion of the intervention (post-test).

Setting

The study was conducted in the adult emergency department of a large public sector tertiary-care teaching hospital in Khyber Pakhtunkhwa (KPK), Pakistan. The ED operated 24 hours a day and received a mixed case-load of trauma, medical and surgical emergencies from urban and rural catchment areas. At the time of the study, the department had approximately 60–70 nurses working in rotating shifts. Simulation facilities were located within the hospital's nursing education department and comprised a skills lab equipped with one adult high-fidelity manikin, several low-fidelity task trainers, basic monitoring equipment, and audiovisual recording for debriefing.

Participants and eligibility criteria

The target population consisted of registered nurses working in the adult emergency department. Nurses were eligible if they:

- were registered with the Pakistan Nursing Council;
- had at least six months of continuous experience in the ED;
- were working full-time during the data collection period; and
- were willing to participate and provide written informed consent.

Nurses were excluded if they were on extended leave during the study period, were primarily assigned to paediatric or obstetric emergency areas, or had previously completed a formal simulation-based emergency care course within the past year.

Sample size

The sample size was calculated a priori using an online implementation of G*Power for repeated measures (two groups, two measurements). A moderate effect size (Cohen's d = 0.6) on OSCE scores was assumed, based on similar educational interventions reported in the literature. With an alpha level of 0.05, power of 0.80, and an allocation ratio of 1:1, the minimum required sample size was 72 participants (36 per group). To account for an anticipated attrition rate of approximately 20%, the target recruitment was set at 90 nurses.

During the recruitment period, 88 eligible nurses were approached; 86 agreed to participate and completed baseline assessment. Four nurses (two from each group) were unable to attend the post-test due to transfer or extended leave, resulting in 82 participants with complete data (intervention n = 41; control n = 41).

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Recruitment procedure

The researcher met with ED nurse managers and explained the study aims and procedures. Information sessions were organised during shift handovers, where nurses received an information sheet and had an opportunity to ask questions. Those who agreed to participate signed a written informed consent form. Participation was voluntary, and nurses were assured that declining would not affect their employment or performance appraisal.

Randomization and allocation concealment

After baseline assessment, participants were randomly assigned to either the intervention or control group. A computer-generated random sequence with variable block sizes was prepared by a statistician not otherwise involved in the study. Allocation codes were placed in opaque, sequentially numbered sealed envelopes. Once a nurse completed the pre-test, an envelope was opened by a research assistant and the participant was informed of group assignment.

Blinding of participants was not feasible due to the nature of the intervention. However, OSCE examiners and data entry personnel were blinded to group allocation. Nurses were requested not to discuss specific details of the simulation scenarios with colleagues in the control group during the study period.

Intervention: Simulation-based training programme

The intervention consisted of a structured simulation-based training programme focused on triage, resuscitation, and systematic patient assessment. The programme was designed by a multidisciplinary team including emergency physicians, nurse educators, and simulation specialists from the hospital.

Structure and duration

The training programme was delivered over two consecutive weeks. Each participant attended four simulation sessions, each of approximately three hours' duration, for a total of 12 hours of contact time. Sessions were scheduled in small groups of 6–8 nurses to allow active participation and debriefing while minimising disruption to ED staffing.

Each session followed a standard structure:

1. **Pre-briefing (20–30 minutes):**
   - Introduction of learning objectives and ground rules;
   - Orientation to the manikin, equipment, and environment;
   - Emphasis on psychological safety and confidentiality.
2. **Simulation scenario (20–30 minutes):**
   - Participants managed the case as a team, with roles such as team leader, airway nurse, circulation nurse, and recorder rotated across sessions.
3. **Debriefing (40–60 minutes):**
   - Facilitated reflective discussion using a structured model (reaction, analysis, summary);
   - Review of clinical reasoning, technical skills, communication, and teamwork;
   - Linking of observed performance to evidence-based guidelines and local protocols.

Scenario content

Four core scenarios were implemented:

1. **Polytrauma with haemorrhagic shock:**

A young adult male presented after a road traffic collision with hypotension and suspected internal bleeding. The scenario emphasised primary survey (Airway, Breathing, Circulation, Disability, Exposure), rapid identification of shock, fluid resuscitation, and prioritisation for urgent imaging and surgery.

2. **Acute coronary syndrome with cardiac arrest:**

A middle-aged patient initially presented with chest pain and evolving ST-segment elevation, progressing to ventricular fibrillation. Nurses were expected to recognise early warning signs, prepare for defibrillation, deliver high-quality CPR, and coordinate resuscitation according to current life support guidelines.

3. **Sepsis with shock:**

A young adult with fever, tachycardia, and hypotension presenting from a peripheral facility. The focus was on early sepsis recognition, rapid assessment, administration of oxygen and fluids, blood culture preparation, and communication with the medical team.

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4. **Mass-casualty triage:**

Multiple simulated victims arrived following an explosion-type incident. Nurses were required to perform rapid triage using a standardised triage tool, assign categories, and allocate resources appropriately in a crowded environment.

Scenarios were tailored to locally available resources (e.g., drug formulary, monitoring capability, staffing patterns). Facilitators adjusted complexity according to the group's experience while maintaining core learning objectives.

Control condition

Participants in the control group continued to receive the department's usual in-service education, which consisted mainly of monthly lecture-based sessions on emergency topics, ad hoc case discussions, and routine bedside supervision. No structured simulation-based sessions were introduced for this group during the study period. After completion of data collection, nurses in the control group were offered the same simulation programme as an educational benefit.

Outcome measures

Three main outcome domains were assessed:

1. **Knowledge of emergency care**
2. **Observed clinical competence (OSCE performance)**
3. **Self-reported confidence in emergency care**

All instruments were administered at baseline and four weeks after the intervention.

Knowledge test

Knowledge was assessed using a 30-item multiple-choice questionnaire developed by the research team based on current emergency nursing and resuscitation guidelines and local protocols. Items covered triage principles, recognition of shock and sepsis, key steps in basic and advanced life support, and components of the primary and secondary survey. Each item had four options with one correct answer. Correct responses were scored as 1 and incorrect or blank responses as 0, giving a total possible score from 0 to 30.

The initial item pool was reviewed by an expert panel of three emergency physicians and three senior nurse educators for content relevance and clarity. Based on their feedback, several items were rewritten or removed. The final version was piloted with 15 ED nurses from another hospital in the same city; items with poor discrimination indices were revised. Cronbach's alpha for internal consistency in the pilot sample was 0.78 and in the main sample at baseline was 0.81.

OSCE-based competence assessment

Clinical competence in triage, resuscitation, and assessment was evaluated through an Objective Structured Clinical Examination (OSCE). The OSCE consisted of three stations, each representing one of the target domains:

1. **Triage station:**
   - Nurses were asked to triage a set of written and role-played cases using the same triage tool applied in the ED.
   - A structured checklist captured accuracy of triage category assignment and justification.
2. **Resuscitation station:**
   - A simulated adult cardiac arrest scenario using a manikin.
   - The checklist included key steps such as activation of help, assessment of responsiveness and breathing, initiation and quality of chest compressions, airway management, ventilation, rhythm recognition (where applicable), and adherence to resuscitation algorithms.
3. **Assessment station:**
   - A scenario requiring a primary and focused secondary survey in a trauma or medical emergency case.
   - The checklist covered the sequence and completeness of the primary survey (ABCDE), vital sign assessment, pain assessment, and identification of red flags requiring urgent intervention.

Each item on the checklists was scored as 0 (not done or incorrect), 1 (partially correct or incomplete), or 2 (done correctly and completely). Scores were summed for each station and then converted to a percentage for ease of interpretation. An overall OSCE score was calculated as the mean of the three station percentages.

The checklists were adapted from existing validated tools and then modified for local protocols. Content validity was assessed by the same expert panel as for the knowledge test. Two experienced nurse educators

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who were not involved in delivering the intervention were trained as OSCE examiners. Inter-rater reliability was tested during a pilot OSCE with 10 nurses, where both examiners independently rated performance; intraclass correlation coefficients for the station scores ranged from 0.82 to 0.88, indicating good agreement.

Self-reported confidence

Self-reported confidence was measured using a 20-item questionnaire developed for this study. Items asked participants to rate their confidence in specific tasks such as "recognising a patient in shock", "leading a resuscitation team", "performing high-quality chest compressions", "assigning triage categories", and "conducting a primary survey". Each item was scored on a 5-point Likert scale from 1 ("not confident at all") to 5 ("very confident"). Total scores ranged from 20 to 100, with higher scores indicating greater confidence.

The draft instrument was reviewed by the expert panel for relevance and clarity and piloted with 15 ED nurses from another hospital. Minor wording changes were made based on participant feedback. Cronbach's alpha in the main sample at baseline was 0.90, indicating excellent internal consistency.

Data collection procedure

Baseline data were collected during scheduled sessions in the skills lab before randomization. Participants first completed a brief demographic form, the knowledge test, and the confidence questionnaire. They then rotated through the three OSCE stations. Each station had a fixed time limit, and examiners followed the standardised checklist and scoring guidelines.

Four weeks after completion of the intervention, all participants were invited for post-test assessment using the same procedures and instruments. The post-test OSCE used parallel scenarios with similar difficulty but different clinical details to minimise recall while maintaining content equivalence. Participants were reminded not to discuss specific OSCE content with colleagues who had not yet been assessed.

Data management and statistical analysis

Data from paper forms and OSCE checklists were double entered into a password-protected database by two independent data entry clerks who were blinded to group allocation. Discrepancies were resolved by checking against the original forms.

Descriptive statistics were used to summarise demographic characteristics and baseline outcome measures. Continuous variables were presented as means and standard deviations or medians and interquartile ranges, depending on distribution, while categorical variables were summarised as frequencies and percentages.

For each outcome (knowledge, OSCE scores, confidence), within-group changes from baseline to post-test were examined using paired t-tests when data were normally distributed or Wilcoxon signed-rank tests otherwise. Between-group differences in post-test scores were assessed using independent-samples t-tests. To adjust for any small baseline imbalances, analysis of covariance (ANCOVA) was used with post-test scores as the dependent variable, group as the fixed factor, and baseline scores as covariates. Effect sizes were calculated as Cohen's d for between-group comparisons.

All analyses were conducted using a standard statistical software package (e.g., SPSS). A two-sided p value < 0.05 was considered statistically significant.

RESULTS

Participant flow and retention

Of the 88 eligible emergency nurses who were approached, 86 consented to participate and completed baseline assessment. After randomization (43 per group), four nurses did not complete the post-test (two from the intervention group and two from the control group) due to transfer to other departments or extended leave. Data from 82 nurses (intervention n = 41; control n = 41) were included in the final analysis (Figure 1). No participant withdrew because of dissatisfaction with the training or study procedures.

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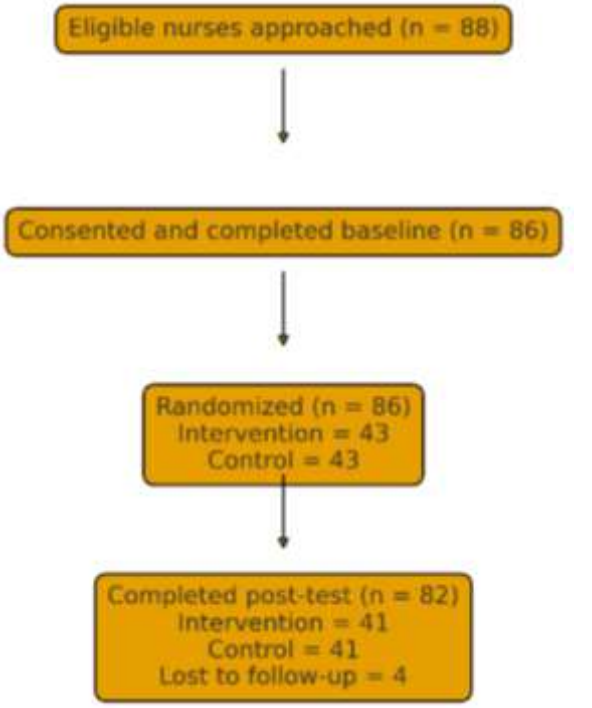

Figure 1. Participant flow diagram

Baseline characteristics

Demographic and professional characteristics of participants are shown in **Table 1**. The two groups were comparable at baseline in terms of age, gender distribution, years of nursing and ED experience, educational level, and previous exposure to basic life support (BLS) or advanced cardiovascular life support (ACLS) courses.

Table 1. Baseline demographic and professional characteristics of participants (n = 82)

Characteristic	Intervention (n = 41)	Control (n = 41)	p value[1]
Age (years), mean ± SD	29.7 ± 4.2	30.1 ± 4.5	0.64
Female, n (%)	24 (58.5)	25 (61.0)	0.82
Years as registered nurse, mean ± SD	5.1 ± 3.0	5.3 ± 3.2	0.78
Years in ED, mean ± SD	2.8 ± 1.5	2.9 ± 1.6	0.79
Bachelor's degree in nursing, n (%)	30 (73.2)	28 (68.3)	0.64
Post-basic emergency course, n (%)	6 (14.6)	5 (12.2)	0.75
Prior BLS certification (ever), n (%)	36 (87.8)	35 (85.4)	0.74
Prior ACLS certification (ever), n (%)	9 (22.0)	8 (19.5)	0.78

[1]Independent-samples t-test for continuous variables, chi-square test for categorical variables.

Baseline outcome measures

At baseline, there were no statistically significant differences between the intervention and control groups in knowledge, OSCE-based competence, or self-reported confidence (Table 2). Overall OSCE scores were modest in both groups, with particular

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weaknesses in triage accuracy and completeness of the primary survey.

Table 2. Baseline knowledge, competence (OSCE), and confidence scores

Outcome measure	Intervention (n = 41) mean ± SD	Control (n = 41) mean ± SD	p value
Knowledge score (0–30)	18.2 ± 3.1	18.0 ± 3.3	0.82
OSCE triage score (%)	55.2 ± 10.7	54.7 ± 11.2	0.84
OSCE resuscitation score (%)	59.8 ± 9.6	60.2 ± 9.9	0.86
OSCE assessment (primary survey) score (%)	60.7 ± 9.1	58.8 ± 8.7	0.34
Overall OSCE score (%)	58.6 ± 8.9	57.9 ± 9.1	0.74
Confidence score (20–100)	62.3 ± 8.7	61.9 ± 9.0	0.85

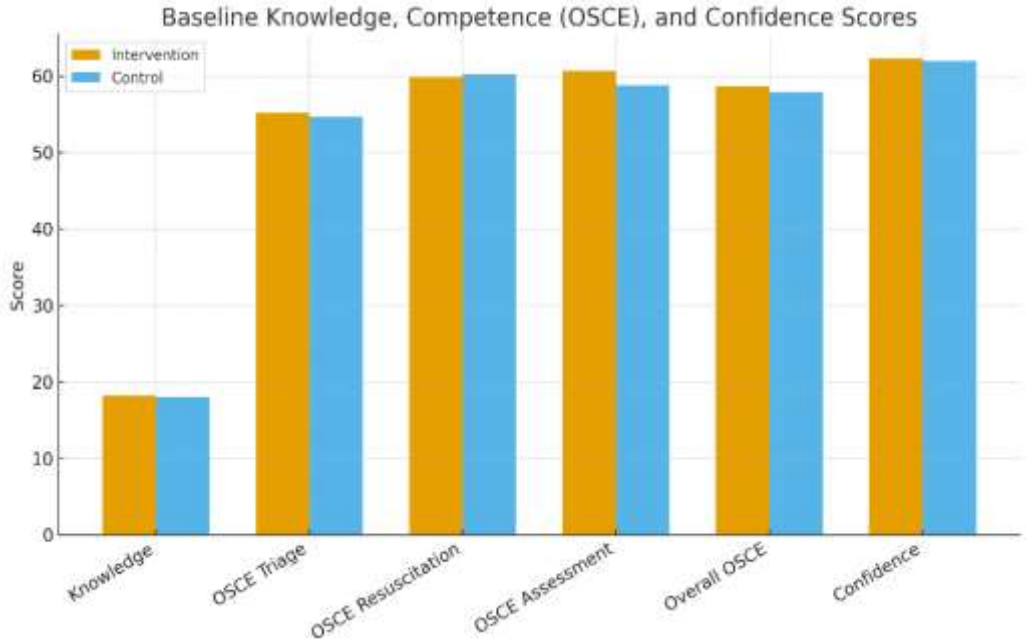

Figure 2. Mean overall OSCE scores at baseline and post-test

Primary outcome: Overall clinical competence (OSCE)

Four weeks after the intervention, overall OSCE scores improved in both groups, but the gain was markedly greater in the intervention group (Table 3 and Figure 2).

- In the **intervention group**, mean overall OSCE score increased from 58.6% (SD 8.9) to 81.4% (SD 7.2), a mean change of +22.8 percentage points (SD 7.5; $p < 0.001$).
- In the **control group**, mean overall OSCE score increased from 57.9% (SD 9.1) to 66.3% (SD 8.8), a mean change of +8.4 percentage points (SD 6.9; $p < 0.001$).

The between-group difference in change scores was 14.4 percentage points (95% CI 10.5–18.3; $p < 0.001$). ANCOVA adjusting for baseline OSCE scores confirmed a statistically significant effect of the intervention on post-test overall competence (adjusted mean difference 13.6 percentage points; 95% CI 9.7–17.5; $p < 0.001$), with a large effect size (Cohen's $d \approx 1.6$).

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Table 3. Within-group pre–post changes in outcomes

Outcome measure	Group	Pre-test mean ± SD	Post-test mean ± SD	Mean change ± SD	p value (within-group)
Overall OSCE score (%)	Intervention	58.6 ± 8.9	81.4 ± 7.2	+22.8 ± 7.5	< 0.001
	Control	57.9 ± 9.1	66.3 ± 8.8	+8.4 ± 6.9	< 0.001
Knowledge (0–30)	Intervention	18.2 ± 3.1	25.1 ± 2.4	+6.9 ± 3.0	< 0.001
	Control	18.0 ± 3.3	21.3 ± 3.0	+3.3 ± 2.5	< 0.001
Confidence (20–100)	Intervention	62.3 ± 8.7	81.2 ± 7.9	+18.9 ± 9.2	< 0.001
	Control	61.9 ± 9.0	67.4 ± 8.5	+5.5 ± 7.3	< 0.001

Paired t-tests within each group.

Domain-specific OSCE performance

When individual domains were analysed, the intervention group showed significant improvements in triage, resuscitation, and assessment performance, all of which were greater than in the control group (Table 4 and Figure 3).

ANCOVA adjusting for baseline scores showed that, at post-test, the intervention group had significantly higher scores than the control group for all three domains ($p < 0.001$ for each).

Table 4. Domain-specific OSCE scores at baseline and post-test

Domain	Group	Pre-test mean ± SD	Post-test mean ± SD	Between-group difference in post-test (ANCOVA-adjusted)[1]
Triage score (%)	Intervention	55.2 ± 10.7	80.3 ± 8.9	+15.9 percentage points (95% CI 11.4–20.4; p < 0.001)
	Control	54.7 ± 11.2	63.5 ± 10.8	
Resuscitation score (%)	Intervention	59.8 ± 9.6	82.6 ± 7.5	+14.8 percentage points (95% CI 10.6–19.0; p < 0.001)
	Control	60.2 ± 9.9	68.5 ± 8.9	
Assessment score (%)	Intervention	60.7 ± 9.1	81.4 ± 7.9	+13.7 percentage points (95% CI 9.3–18.1; p < 0.001)
	Control	58.8 ± 8.7	66.9 ± 8.4	

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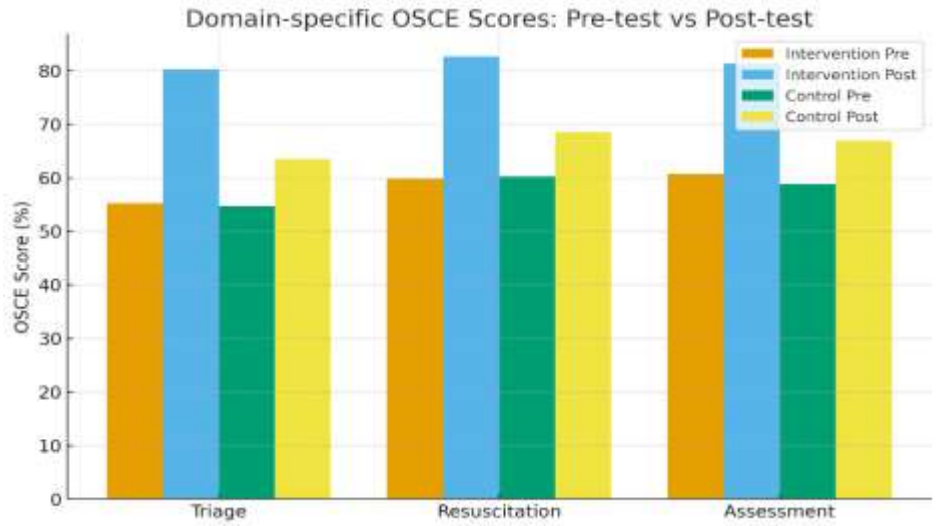

Figure 3. Changes in domain-specific OSCE scores

Knowledge outcomes

Knowledge scores increased significantly in both groups, but the improvement was greater in the intervention group (Table 3 and Figure 4).

- Intervention group: mean knowledge score increased from 18.2 ± 3.1 to 25.1 ± 2.4 (mean change +6.9 ± 3.0; $p < 0.001$).
- Control group: mean knowledge score increased from 18.0 ± 3.3 to 21.3 ± 3.0 (mean change +3.3 ± 2.5; $p < 0.001$).

ANCOVA indicated a significant effect of the intervention on post-test knowledge after adjustment for baseline scores (adjusted mean difference 3.4 points on a 30-point scale; 95% CI 2.3–4.4; $p < 0.001$).

Self-reported confidence

Self-reported confidence in managing emergency situations also improved significantly in both groups, but the magnitude of change was substantially higher in the intervention group.

- Intervention group: confidence increased from 62.3 ± 8.7 to 81.2 ± 7.9 (mean change +18.9 ± 9.2; $p < 0.001$).
- Control group: confidence increased from 61.9 ± 9.0 to 67.4 ± 8.5 (mean change +5.5 ± 7.3; $p < 0.001$).

ANCOVA showed that, following adjustment for baseline confidence, the intervention group had a significantly higher post-test confidence score than the control group (adjusted mean difference 11.4 points; 95% CI 7.8–15.0; $p < 0.001$).

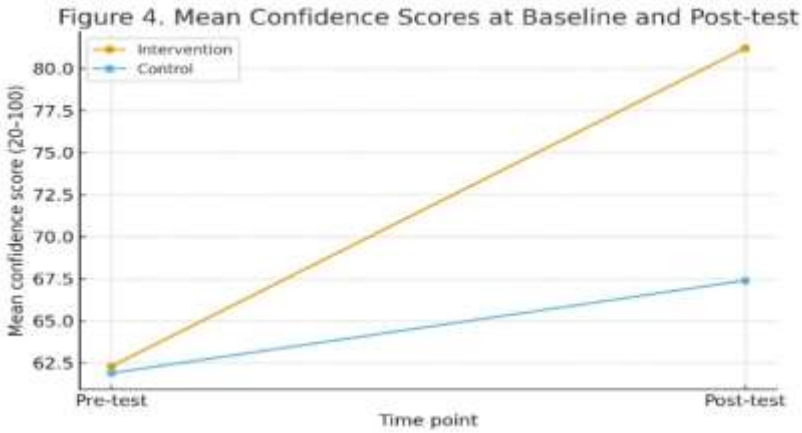

Figure 4. Mean confidence scores at baseline and post-test

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Additional observations

No adverse events or injuries occurred during simulation sessions. A few participants reported initial anxiety when being observed during OSCEs and simulations, but this usually decreased after the first scenario and debriefing. Attendance at simulation sessions in the intervention group was high (over 95% of scheduled sessions were attended), and no sessions had to be cancelled due to staffing shortages.

Informal feedback collected during debriefings and at the end of the course suggested that nurses perceived simulation as highly relevant to their daily ED practice. Many reported feeling more prepared to lead resuscitation efforts, prioritise patients during busy shifts, and recognise early signs of deterioration. These perceptions were consistent

with the quantitative improvements observed in OSCE and confidence scores.

DISCUSSION

This study evaluated the impact of a structured simulation-based training programme on emergency nurses' competence and confidence in a tertiary-care hospital in Khyber Pakhtunkhwa, Pakistan. The results showed that nurses who took part in the simulation programme achieved substantially greater improvements in OSCE performance, knowledge scores, and self-reported confidence than colleagues who continued with routine in-service education alone. The effect was consistent across the three core domains that the intervention targeted—triage, resuscitation, and systematic patient assessment—suggesting that the programme did not simply boost test-taking skills but supported broader clinical performance in time-critical situations.

Interpretation of key findings

The primary outcome—overall OSCE performance—improved markedly in the intervention group, with an average gain of almost 23 percentage points, compared with an 8-point gain in the control group. This difference remained large and statistically significant even after adjustment for baseline scores. Clinically, this meant that nurses who underwent simulation training were more likely to follow structured assessment frameworks, identify unstable patients early, and implement the correct sequence of life-saving interventions.

The domain-level results helped to clarify where simulation had the greatest impact. Triage performance improved the most in relative terms, with large gains in accuracy and prioritisation. This was not surprising. Triage is a cognitive task that relies heavily on pattern recognition and decision-making under pressure. The mass-casualty and rapid triage scenarios gave nurses repeated exposure to realistic but risk-free situations in which they had to make fast decisions and then immediately reflect on those choices during debriefing. Over time, this appeared to sharpen their judgement and reduce hesitation.

Resuscitation scores also improved substantially. After the training, nurses were more likely to initiate CPR promptly, maintain better compression quality, apply defibrillation in a timely manner, and coordinate team roles effectively. These improvements were likely driven by the opportunity to practise hands-on skills on a manikin, use actual equipment from the ED, and experience realistic urgency without the fear of harming a real patient. The debriefing sessions allowed facilitators to correct subtle errors—such as suboptimal compression depth or delays in rhythm checks—that might not be obvious in normal ward teaching.

The gains in primary survey and systematic assessment suggested that simulation helped nurses to internalise structured assessment frameworks such as ABCDE, rather than relying on unstructured "head-to-toe" habits. During scenarios, facilitators repeatedly brought the discussion back to "What did you check first? What did you miss? What could have happened if this was a real patient?" This repetition, combined with immediate feedback, probably strengthened mental checklists and made them more automatic in subsequent OSCEs.

Knowledge scores improved in both groups, but the greater gain in the simulation group indicated that practical, scenario-based learning reinforced theoretical content more effectively than lectures alone. Simulation sessions started with short pre-briefings and ended with debriefings that linked observed actions back to guidelines and local protocols. This repeated integration of "why" (guideline recommendations) and "how" (practical

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implementation) likely enhanced understanding and retention.

The increase in self-reported confidence in the intervention group was also notable. While confidence alone does not guarantee competence, nurses who feel more assured are often better able to take initiative, speak up during emergencies, and assume leadership roles when needed. Many participants reported during informal feedback that they felt more comfortable leading resuscitation efforts and making triage decisions after having "already seen" similar situations in the simulation lab. In contrast, the control group showed only modest gains, consistent with gradual learning from routine exposure but without the concentrated practice that simulation provided.

Comparison with previous research

Although most high-quality trials of simulation-based education have been conducted among nursing students or in high-income settings, their overall pattern of results was broadly consistent with the current study. Previous work has shown that simulation-based training improves triage decision-making, disaster response skills, and anxiety management among nursing students in emergency internships. Similarly, simulation-based programmes have been associated with better performance in resuscitation and recognition of clinical deterioration, as well as higher levels of learner satisfaction and self-confidence.

What distinguished the present study was its focus on practising emergency nurses in a busy public-sector hospital in Pakistan. Much of the existing Pakistani literature on simulation has centred on undergraduate education, specialty residents, or small pilot initiatives within well-resourced private institutions. By showing that a relatively compact, locally designed programme improved measurable clinical performance among staff nurses, this study strengthened the argument that simulation is not only a "nice-to-have" academic tool but a practical strategy to upgrade frontline clinical practice in resource-constrained environments.

The magnitude of improvement observed here, especially in OSCE performance, was comparable to or slightly higher than effect sizes reported in some student studies. This might reflect the fact that participants already had clinical experience and could immediately situate new learning within their daily practice. It may also indicate that the simulation scenarios were closely aligned with the real case-mix in the study ED, enhancing relevance and transferability.

Possible mechanisms

Several mechanisms may explain why simulation-based training produced such strong effects in this context:

1. **Safe rehearsal of rare or high-stakes events:** Some critical emergencies—mass-casualty incidents, cardiac arrest in younger patients, sudden airway compromise—are relatively infrequent but require flawless performance when they occur. Simulation allowed nurses to rehearse these scenarios multiple times without risk to patients, reducing the "shock factor" when similar events occur in reality.

2. **Deliberate practice with immediate feedback:** In routine clinical work, nurses may not receive detailed, structured feedback on their performance during an emergency, especially when the team is under pressure. In simulation, facilitators could pause, replay, and unpack events, enabling participants to refine specific actions, such as the sequence of the primary survey or coordination of roles during CPR.

3. **Integration of teamwork and communication skills:** Emergencies are inherently team-based. Simulation sessions required nurses to negotiate roles, call for help, hand over information, and challenge each other when necessary. These relational skills are difficult to teach in a classroom but become very visible in a simulation scenario and can be addressed constructively during debriefing.

4. **Alignment with local protocols and constraints:** Because scenarios were designed around the hospital's own equipment and staffing patterns, learners did not have to mentally translate between an idealised high-income environment and their own

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reality. This "fit" likely made it easier to transfer learning back to the ED.

Implications for emergency nursing in KPK and similar settings

The study findings had important implications for nursing education and service delivery in KPK and other provinces with similar health-system challenges. First, they provided empirical support for investing in simulation facilities and faculty development within public-sector institutions, not just private universities. Even a single high-fidelity manikin, combined with thoughtful scenario design and trained facilitators, was able to deliver meaningful gains in competence.

Second, the results suggested that simulation-based training could be integrated into routine continuing professional development for ED nurses. The intervention in this study required four half-day sessions spread over two weeks—a level of time commitment that, while not negligible, was feasible within the staffing constraints of the department. Hospitals could consider offering such programmes periodically, for example as part of induction for new ED nurses or as mandatory refresher courses every few years.

Third, improvements in triage accuracy, resuscitation performance, and assessment completeness were likely to translate into better patient outcomes, although this study did not directly measure clinical endpoints. Earlier recognition of shock, more consistent resuscitation quality, and better prioritisation of high-risk patients could reduce delays to critical interventions, particularly in crowded EDs serving rural and peri-urban populations.

Strengths of the study

Several features strengthened the credibility of the findings. The study used an experimental design with random allocation and a control group, which reduced the risk of selection bias. Outcome assessors were blinded to group assignment, limiting the possibility of scoring bias. Competence was measured using OSCEs with structured checklists, rather than relying solely on written tests or self-report, and the instruments underwent pilot testing and reliability assessment before use.

The intervention itself was clearly defined, reproducible, and grounded in recognised frameworks for simulation-based education. Scenario content aligned with local case-mix and protocols, improving ecological validity. Finally, attrition was low and balanced between groups, and analyses were adjusted for baseline values using appropriate statistical methods.

Limitations

At the same time, the study had several limitations that should be considered when interpreting the results. First, it was conducted in a single tertiary hospital in KPK, which may limit generalisability to other hospitals with different staffing models, patient populations, or resource levels. Multi-centre studies across diverse settings would help to confirm the wider applicability of these findings.

Second, the follow-up period was relatively short. Outcomes were measured four weeks after the intervention, so the study could not assess how long improvements were sustained or whether periodic refreshers would be required. Longitudinal follow-up of competence and confidence over six or twelve months would provide more insight into skill retention.

Third, competence was assessed in simulated OSCE environments rather than in real clinical practice. While OSCEs approximated key tasks and allowed standardised assessment, they could not fully reproduce the complexity, distractions, and emotional pressures of an actual emergency shift. Future work could incorporate observational audits or chart reviews to explore whether improvements in simulated performance translate into observable changes in patient care.

Fourth, the study did not measure patient-level outcomes such as time to first shock, time to antibiotics in sepsis, or mortality. Direct links between simulation training and patient outcomes are difficult to establish and would require larger samples and robust clinical data systems. Nevertheless, the observed improvements in process measures were consistent with key steps known to influence outcomes in emergency care.

Finally, participation was voluntary, which may have introduced some degree of self-selection. Nurses who were more motivated or more interested in professional development might have been over-represented among participants. However,

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randomisation ensured that such characteristics were distributed between groups, and baseline scores were similar.

Recommendations for practice and future research

Based on these findings, several practical recommendations emerge. Hospital administrators and nursing leaders in KPK and similar settings should consider:

- integrating simulation-based programmes into standard orientation and continuing education for ED nurses;
- prioritising scenarios that reflect local patterns of trauma, sepsis, and cardiovascular disease;
- investing in faculty development so that nurse educators and clinicians are confident in scenario facilitation and debriefing; and
- using OSCEs or similar tools as part of routine competence assessment to identify ongoing training needs.

Future research should build on this work by exploring:

- long-term retention of skills and confidence after simulation-based training;
- the cost-effectiveness of simulation programmes compared with traditional education approaches;
- the impact of repeated or refresher simulations over time;
- multi-centre trials involving multiple hospitals in different provinces; and
- links between simulation-enhanced competence and patient-level outcomes such as mortality, length of stay, or complication rates.

Exploring alternative or complementary modes of simulation, such as low-cost task trainers, virtual reality, or blended e-learning plus in-person scenarios, may also be valuable, particularly for institutions with limited resources.

Summary

In summary, this study showed that a structured, context-specific simulation-based training programme substantially improved emergency nurses' competence and confidence in triage, resuscitation, and patient assessment in a tertiary hospital in KPK, Pakistan. The improvements were large, consistent across domains, and achieved with a manageable investment of staff time and resources. These findings supported the wider adoption of simulation-based approaches in emergency nursing education as a practical strategy to strengthen patient safety and quality of care in resource-constrained health systems.

CONCLUSION

This experimental study demonstrated that a structured simulation-based training programme significantly enhanced emergency nurses' competence and confidence in a tertiary-care hospital in Khyber Pakhtunkhwa, Pakistan. Nurses who participated in the simulation sessions achieved markedly higher gains in OSCE performance, triage accuracy, resuscitation skills, and systematic patient assessment than colleagues who continued with routine in-service education alone. Knowledge and self-reported confidence also improved in both groups, but the magnitude of change was consistently greater in the intervention group, indicating that simulation added clear value beyond standard teaching methods.

The findings suggested that realistic, scenario-based training with facilitated debriefing helped nurses to consolidate theoretical knowledge, practise time-critical skills, and refine clinical decision-making in a safe environment. By repeatedly managing simulated cases of trauma, shock, cardiac arrest, and mass-casualty triage, participants were able to internalise structured assessment frameworks, strengthen teamwork and communication, and gain assurance in leading or contributing to resuscitation efforts. These changes were particularly important in a high-pressure, resource-constrained emergency department where small delays or omissions could have serious consequences for patient outcomes.

Although the study did not directly examine patient-level indicators, the improvements observed in key process measures—such as triage decisions, adherence to resuscitation algorithms, and completeness of the primary survey—were closely aligned with recognised determinants of safe and effective emergency care. The results therefore supported the view that simulation-based education was not merely an academic exercise but a practical tool to strengthen frontline emergency nursing practice. At the same time, the single-centre design and relatively short follow-up period underscored the need for further multi-site and longitudinal research to explore skill

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retention, cost-effectiveness, and potential impact on clinical outcomes.

Overall, this study concluded that integrating structured simulation-based training into continuing professional development for emergency nurses was both feasible and beneficial in a public-sector tertiary hospital in KPK. Hospital leaders and nursing educators were encouraged to invest in simulation infrastructure, faculty development, and locally relevant scenario design as part of broader efforts to improve the quality and safety of emergency care. With appropriate support and scaling, similar programmes could contribute to a more competent, confident, and resilient emergency nursing workforce across Pakistan and comparable low- and middle-income settings.

REFERENCES

Miller B. The effectiveness of simulation-based learning (SBL) on students' knowledge and skill acquisition and retention: a systematic review. BMC Med Educ. 2024;24:1099. doi:10.1186/s12909-024-06080-z

Ratish S. Effectiveness of simulation among nursing students: a systematic review. Int J Adv Res Nurs. 2025;8(1):202-206. doi:10.33545/nursing.2025.v8.i1.C.464

La Cerra C, Dante A, Caponnetto V, et al. Effects of high-fidelity simulation based on life-threatening clinical scenarios on learning outcomes of undergraduate and postgraduate nursing students: a systematic review and meta-analysis. BMJ Open. 2019;9(2):e025306. doi:10.1136/bmjopen-2018-025306

Zeng Q, Wang K, Liu WX, et al. Efficacy of high-fidelity simulation in advanced life support training: a systematic review and meta-analysis of randomized controlled trials. BMC Med Educ. 2023;23:664. doi:10.1186/s12909-023-04654-x

Herrero-Izquierdo L, et al. Effectiveness of high-fidelity clinical simulation in cardiopulmonary resuscitation training: a systematic review and meta-analysis of controlled trials. Clin Simul Nurs. 2025;80:101665. doi:10.1016/j.ecns.2024.101665

Kassabry MF. The effect of simulation-based advanced cardiac life support training on nursing students' self-efficacy, attitudes, and anxiety in Palestine: a quasi-experimental study. BMC Nurs. 2023;22:420. doi:10.1186/s12912-023-01588-z

Masoumian Hosseini M, Masoumian Hosseini ST, Qayumi K, Hosseinzadeh S, Ahmady S. Crossover design in triage education: the effectiveness of simulated interactive vs routine training on student nurses' performance in a disaster situation. BMC Res Notes. 2023;16:313. doi:10.1186/s13104-023-06596-5

Kim KJ, Choi MJ, Kim M. Effects of virtual reality-based disaster simulation education on nursing students. PLoS One. 2025;20(10):e0329563. doi:10.1371/journal.pone.0329563

Cho MK, Kim MY. Effectiveness of simulation-based interventions on empathy enhancement among nursing students: a systematic literature review and meta-analysis. BMC Nurs. 2024;23:319. doi:10.1186/s12912-024-01944-7

Mahou FZ, Decormeille G, Changuiti O, Mouhaoui M, Khattabi A. The effects of screen-based simulation on nursing students' acquisition of medication administration and dosage calculation skills: a randomized controlled trial. BMC Nurs. 2024;23:777. doi:10.1186/s12912-024-02436-4

Herrero-Izquierdo L, et al. Effectiveness of using high-fidelity simulation on learning outcomes in nursing education: a systematic review and meta-analysis. Eur Rev Med Pharmacol Sci. 2024;28(1):444–458. doi:10.26355/eurrev_202401_34567

Cant RP, Cooper SJ. Simulation-based learning in nurse education: systematic review. J Adv Nurs. 2010;66(1):3-15. doi:10.1111/j.1365-2648.2009.05240.x

Ahn H, Kim Y. Effectiveness of simulation-based nursing education depending on fidelity: a meta-analysis. BMC Med Educ. 2015;15:27. doi:10.1186/s12909-015-0286-1

Cant R, Levett-Jones T, James A, et al. High-fidelity simulation in undergraduate nursing education: a meta-analysis. Nurse Educ Today.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

2022;109:105183. doi:10.1016/j.nedt.2021.105183

Jeffries PR, Rodgers B, Adamson K. The evidence in simulation-based learning experiences in nursing education and practice: an umbrella review. Clin Simul Nurs. 2015;11(6):293-302. doi:10.1016/j.ecns.2015.02.004

Krumwiede K. The use of simulation in nursing education: enhancing clinical skills and confidence. J Adv Pract Nurs. 2024;9(3):1-2. doi:10.37421/2573-0347.2024.9.378

Saleem M, Khan Z. Healthcare simulation: an effective way of learning in health care. Pak J Med Sci. 2023;39(4):1185-1190. doi:10.12669/pjms.39.4.7145

Fayyaz J. Simulation in health profession education in Pakistan: bridging gaps, building futures. J Shalamar Med Dent Coll. 2024;5(2):55-57. doi:10.53685/jshmdc.v5i2.293

Farooq Z, Sheraz S, Muntaha ST, Fatima S, Ghulam A. Effect of simulation-based learning on clinical performance of nursing interns at a private hospital, Lahore, Pakistan. Pak BioMed J. 2023;6(12):1-5. doi:10.54393/pbmj.v6i12.976

Siddiqui F, Ali S, Bibi A, et al. Simulation-based learning in nursing education: students' perception at a tertiary care hospital in Pakistan. Pak J Med Health Sci. 2023;17(3):896-900. doi:10.53350/pjmhs202317896

Mallick SA, Hasan S. The past, present and future of simulation-based medical education in Pakistan: a short report. J Pak Med Assoc. 2025;75(1):108-110. doi:10.47391/JPMA.9221

Elendu C, Amaechi DC, Okatta AU, et al. The impact of simulation-based training in medical education: a review. Medicine (Baltimore). 2024;103(27):e38813. doi:10.1097/MD.0000000000038813

Osborne C, Brown C, Mostafa A. Effectiveness of high- and low-fidelity simulation-based medical education in teaching cardiac auscultation: a systematic review and meta-analysis. J Healthc Simul. 2023;2(2):75-84. doi:10.54531/NZWS5167

Cho Y, Kim J, Park S. Learning with simulation: the experience of nursing students. Clin Simul Nurs. 2021;50:1-7. doi:10.1016/j.ecns.2020.08.006

Cant R, Levett-Jones T, McKenna L, et al. Exploring the extent to which simulation-based education addresses contemporary patient safety priorities: a scoping review. Collegian. 2019;26(1):194-203. doi:10.1016/j.colegn.2018.04.006

Saleem A, Moazzam Z, Dogar SA, Qazi SH. Simulation-based training in the paediatric surgery population: a review of current trends and future direction. J Pak Med Assoc. 2021;71(Suppl 1):S38-S41. PMID:33582721

Gillani AH, Ibrahim MI, Akbar J, Fang Y. Evaluation of disaster medicine preparedness among healthcare profession students: a cross-sectional study in Pakistan. Int J Environ Res Public Health. 2020;17(6):2027. doi:10.3390/ijerph17062027

Faizatiwahida N, Setiyarini S, Alim S. An education and training program on disaster triage for nurses and nursing students: literature review. Berita Ilmu Keperawatan. 2024;17(1):1-12. doi:10.23917/bik.v17i1.3882

Dubovsky SL, et al. Virtual reality and screen-based simulation learner outcomes using high-fidelity technology in emergency department triage training. Clin Simul Nurs. 2023;70:1-8. doi:10.1016/j.ecns.2022.11.007

Seaton P, Levett-Jones T, Cant R, et al. Exploring the extent to which simulation-based education addresses contemporary patient safety priorities: a scoping review. Collegian. 2019;26(1):194-203. doi:10.1016/j.colegn.2018.04.006

Hosseini MM, Hosseini STM, Qayumi K, et al. Nursing student satisfaction with a crisis management game-based training: a quasi-experimental study. Iran J Emerg Med. 2023;10(1):e22. (focuses on emergency and crisis management simulation).

Ismail FW, Ajani K, Baqir SM, et al. Challenges and opportunities in the uptake of simulation in healthcare education in the developing world: a scoping review. MedEdPublish. 2024;14:38. doi:10.12688/mep.20271.1