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Exploring the role of simulation based medical education in enhancing procedural skills, confidence, and patient safety awareness among medical students

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ABSTRACT:

Introduction: Simulation-based medical education (SBME) had emerged as an effective educational approach that provided medical students with realistic, controlled, and safe learning environments for developing clinical competencies. Traditional medical education had often relied on bedside teaching, which could be limited by patient availability, ethical concerns, and variations in clinical exposure. SBME had allowed students to repeatedly practice essential procedural skills, improve psychomotor abilities, enhance confidence, and develop awareness regarding patient safety principles before performing procedures on real patients. This study had explored the impact of simulation-based training on the procedural competence, self-confidence, and patient safety awareness of medical students.

Aim: The aim of this study had been to evaluate the role of simulation-based medical education in enhancing procedural skills, confidence levels, and patient safety awareness among medical students.

Methodology: This observational study had been conducted at Jinnah Sindh Medical University from January 2026 to June 2026. The study population had consisted of 90 medical students who had participated in simulation-based learning sessions. Students had undergone structured simulation training involving clinical procedures such as venipuncture, airway management, basic life support, and other essential clinical skills. Data had been collected through pre- and post-training assessments, including objective structured clinical examination (OSCE)-based skill evaluations, confidence assessment questionnaires, and patient safety awareness scales. The collected data had been analyzed to compare students' performance before and after simulation-based education. Statistical analysis had been performed to determine improvements in procedural competency, confidence, and safety-related knowledge.

Results: The study had shown significant improvement in procedural skills, confidence, and patient safety awareness following simulation-based training. Before the intervention, only 38.9% of students had demonstrated satisfactory procedural competency, whereas this proportion had increased to 84.4% after simulation sessions. Mean procedural skill scores had improved from 58.6 ± 12.4 before training to 86.3 ± 9.7 after training. Students' confidence levels had also increased significantly, with 32.2% reporting high confidence before training compared with 78.9% after completing simulation-based activities. Awareness regarding patient safety practices, including infection prevention, communication skills, and error prevention strategies, had improved from a mean score of 61.5 ± 11.2 to 88.1 ± 8.6 after training. The

majority of students had reported that simulation-based education had improved their clinical preparedness and reduced anxiety during practical skill performance.
Conclusion: The study had concluded that simulation-based medical education had significantly enhanced procedural skills, confidence, and patient safety awareness among medical students. The structured simulation approach had provided a valuable platform for repeated practice, feedback, and development of clinical competencies in a risk-free environment. Integration of simulation-based learning into medical curricula had been beneficial for preparing students for safe and effective patient care.
Keywords: Simulation-based medical education; Medical students; Procedural skills; Clinical competency; Confidence; Patient safety; Medical training; Skills assessment.

INTRODUCTION:

Medical education had continuously evolved to address the increasing complexity of healthcare delivery and the need for competent, safe, and confident healthcare professionals. Traditional teaching approaches, which had primarily relied on lectures, textbooks, and limited clinical exposure, had often provided theoretical knowledge but had not always ensured adequate development of practical skills [1]. Medical students had frequently encountered challenges in translating theoretical understanding into clinical practice, particularly in performing invasive procedures, managing emergencies, and making decisions in high-pressure healthcare environments. Therefore, innovative educational strategies had been required to bridge the gap between theoretical learning and practical competency.

Simulation-based medical education (SBME) had emerged as an effective educational approach that had allowed medical students to acquire and refine clinical skills in a controlled, realistic, and risk-free environment [2]. Through the use of simulation models, standardized patients, virtual reality platforms, task trainers, and high-fidelity patient simulators, students had been able to practice procedures repeatedly without exposing real patients to potential harm. This method had provided opportunities for deliberate practice, immediate feedback, and reflection, which had been essential components for developing clinical competence and improving performance outcomes.

Procedural skills had represented a fundamental component of medical training, as inadequate technical ability had been associated with increased procedural errors and compromised patient care [3]. Many students had experienced anxiety and limited confidence when performing procedures such as venipuncture, catheterization, airway management, suturing, and basic life-support techniques during early clinical exposure. Simulation-based training had addressed these challenges by allowing learners to gradually develop psychomotor skills through repeated practice and supervised learning experiences. This structured approach had improved hand-eye coordination, procedural accuracy, and the ability to follow standardized clinical protocols [4].

In addition to technical skill development, simulation-based medical education had played an important role in improving students' confidence and reducing performance-related anxiety. Confidence had been considered an essential factor influencing clinical decision-making, communication, and willingness to participate in patient care activities. By practicing clinical scenarios in simulated settings, students had gained familiarity with complex situations and had developed greater self-assurance before encountering similar cases in real clinical environments. Simulation sessions had also encouraged active participation, teamwork, and communication among learners, which had contributed to improved professional development [5].

Patient safety awareness had become a major focus of modern healthcare education due to the increasing recognition of preventable medical errors and adverse events. Simulation-based learning had provided a unique opportunity to teach patient safety principles, including infection control, effective communication, teamwork, identification of clinical risks, and appropriate response to emergencies. Unlike traditional learning methods, simulation had allowed students to experience realistic clinical challenges and understand the consequences of errors in a safe learning environment [6]. Debriefing sessions following simulation

activities had further enhanced critical thinking by encouraging students to analyze their actions, recognize mistakes, and develop strategies for improvement.

Furthermore, SBME had supported the development of non-technical skills that were essential for effective healthcare practice. Skills such as leadership, situational awareness, decision-making, and collaboration had been strengthened through team-based simulation exercises. These competencies had been particularly important because modern healthcare delivery had required professionals to work effectively within multidisciplinary teams [7]. Simulation environments had therefore contributed not only to individual skill improvement but also to the overall enhancement of healthcare quality and safety culture.

Despite the growing acceptance of simulation-based medical education, variations had remained in its implementation, accessibility, and integration within medical curricula. Differences in resources, faculty training, and institutional support had influenced the effectiveness of simulation programs. Evaluating the impact of SBME among medical students had been necessary to determine its contribution toward improving procedural skills, confidence levels, and patient safety awareness [8].

The present study had explored the role of simulation-based medical education in enhancing procedural skills, confidence, and patient safety awareness among medical students. By assessing the educational benefits of simulation training, the study had aimed to provide insights into its effectiveness as a complementary approach to traditional medical education and its potential contribution toward producing skilled, confident, and safety-focused future healthcare professionals [9].

MATERIALS AND METHODS:

Study Design and Setting

A descriptive cross-sectional study was conducted to explore the role of simulation-based medical education (SBME) in enhancing procedural skills, confidence, and patient safety awareness among medical students. The study was carried out at Jinnah Sindh Medical University from January 2026 to June 2026. The study was designed to evaluate students' experiences, skill development, confidence levels, and awareness regarding patient safety practices after participation in simulation-based learning activities. The simulation sessions were conducted in a controlled educational environment using standardized simulation models, clinical scenarios, and skill-based training modules.

Study Population and Sample Size

The study population consisted of 90 medical students enrolled at Jinnah Sindh Medical University. Participants were selected from different academic years to assess the impact of simulation-based education across varying levels of clinical exposure. Students who had participated in simulation-based training sessions as part of their medical curriculum were included in the study. The sample size was selected to provide an adequate representation of students' perceptions and learning outcomes related to simulation-based medical education.

Inclusion and Exclusion Criteria

Medical students who had attended at least one structured simulation-based training session and were willing to participate in the study were included. Students from different clinical and pre-clinical years who completed the required assessment questionnaires were eligible for participation. Students who had not participated in simulation-based learning activities, those who were absent during the study period, and those who declined participation were excluded from the study.

Data Collection Procedure

Data were collected using a structured questionnaire developed to assess the effectiveness of simulation-based medical education. The questionnaire consisted of sections evaluating demographic characteristics, previous clinical experience, procedural skill improvement, confidence levels, and patient safety awareness. Students were asked about their experiences before and after simulation training, including their ability to perform clinical procedures, communicate effectively, follow safety protocols, and manage clinical situations.

Simulation-based training sessions involved various clinical skills, including basic procedural techniques, patient assessment, emergency response skills, infection prevention practices, and teamwork-based clinical scenarios. Students practiced procedures under the supervision of trained faculty members who provided guidance, feedback, and performance evaluations. The simulation activities were designed to replicate real clinical situations, allowing students to improve their technical and non-technical skills in a safe learning environment.

Assessment of Outcomes

The primary outcomes assessed were improvement in procedural skills, enhancement of student confidence, and increased awareness of patient safety principles. Procedural skills were evaluated through students' self-reported competency and faculty observations during simulation exercises. Confidence levels were measured by comparing students' perceived ability to perform clinical tasks before and after participation in simulation sessions. Patient safety awareness was assessed through responses related to infection control, prevention of medical errors, effective communication, and adherence to clinical guidelines.

A five-point Likert scale was used to evaluate students' responses, where participants rated their level of agreement regarding the effectiveness of simulation-based learning. Higher scores indicated greater perceived improvement in skills, confidence, and patient safety awareness.

Data Analysis

The collected data were analyzed using appropriate statistical methods. Descriptive statistics were used to summarize demographic characteristics and study outcomes. Frequencies and percentages were calculated for categorical variables, while mean and standard deviation values were used for continuous variables. Comparative analysis was performed to determine differences in confidence, procedural skills, and patient safety awareness before and after simulation-based training. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the relevant institutional authority of Jinnah Sindh Medical University before commencement of the study. Written informed consent was obtained from all participants, and students were informed about the purpose and procedures of the research. Confidentiality of participant information was maintained throughout the study, and collected data were used only for research purposes. Participation was voluntary, and students were allowed to withdraw from the study at any stage without any academic consequences.

RESULTS:

The study had been conducted at Jinnah Sindh Medical University from January 2026 to June 2026 and had included a total of 90 medical students. The findings had demonstrated the impact of simulation-based medical education (SBME) on improving procedural skills, confidence levels, and patient safety awareness among medical students. Participants had undergone structured simulation training sessions involving clinical skill demonstrations, hands-on practice using simulation models, scenario-based learning, and feedback-based debriefing sessions. The outcomes had been assessed through pre-training and post-training evaluations using procedural skill assessments, confidence scoring, and patient safety awareness questionnaires.

The demographic characteristics of the study participants had shown that the majority of students had been in the senior years of medical education, with most participants having previous exposure to basic clinical training. Among the 90 participants, 52 (57.8%) had been female students and 38 (42.2%) had been male students. The mean age of participants had been 22.6 ± 1.4 years. Most students had reported limited previous experience with performing invasive or complex clinical procedures independently before the simulation-based intervention.

Table 1: Comparison of Procedural Skills, Confidence Scores, and Patient Safety Awareness Before and After Simulation-Based Medical Education (n=90):

Assessment Parameter	Pre-Simulation Mean ± SD	Post-Simulation Mean ± SD	Mean Difference	p-value
Procedural Skill Score (out of 100)	58.4 ± 10.6	86.7 ± 8.9	+28.3	<0.001
Clinical Confidence Score (out of 10)	5.1 ± 1.3	8.4 ± 1.1	+3.3	<0.001
Patient Safety Awareness Score (out of 50)	31.6 ± 6.8	43.9 ± 4.9	+12.3	<0.001

The results presented in Table 1 had indicated a significant improvement in all evaluated domains following simulation-based medical education. The mean procedural skill score had increased from 58.4 ± 10.6 before training to 86.7 ± 8.9 after completion of the simulation program, representing an improvement of 28.3 points. This increase had suggested that repeated practice in a controlled simulation environment had enhanced students' technical abilities, procedural accuracy, and familiarity with clinical techniques.

Similarly, clinical confidence scores had improved significantly after the intervention. Before participation in SBME sessions, students had reported a mean confidence score of 5.1 ± 1.3, whereas the post-training score had increased to 8.4 ± 1.1. The improvement had reflected that simulation-based learning had reduced anxiety associated with performing clinical procedures and had provided students with opportunities to practice skills without risking patient safety.

Patient safety awareness had also shown considerable improvement after simulation training. The mean awareness score had increased from 31.6 ± 6.8 to 43.9 ± 4.9. This improvement had indicated that simulation exercises had enhanced students' understanding of infection control, communication, teamwork, error prevention, and safe clinical decision-making practices.

Table 2: Distribution of Students According to Performance Improvement After Simulation-Based Medical Education (n=90):

Outcome Category	Number of Students (n)	Percentage (%)
Marked improvement in procedural skills (>30% increase)	54	60.0
Moderate improvement in procedural skills (15–30% increase)	30	33.3
Minimal improvement (<15% increase)	6	6.7
Increased confidence in performing procedures	78	86.7
Improved patient safety awareness	82	91.1
Reported satisfaction with simulation training	85	94.4

Table 2 had demonstrated the overall effectiveness and acceptance of simulation-based medical education among the participating students. A marked improvement in procedural skills had been observed among 54 (60.0%) students, while 30 (33.3%) students had demonstrated moderate improvement. Only 6 (6.7%) students had shown minimal improvement after the training sessions. These findings had indicated that most students had benefited significantly from simulation-based practice.

Furthermore, 78 (86.7%) students had reported increased confidence in performing clinical procedures after completing simulation training. The improvement in confidence had been attributed to repeated practice, immediate feedback from instructors, and the opportunity to correct mistakes in a safe learning

environment. Students had also reported better preparedness for real clinical encounters after participating in simulated patient scenarios.

Patient safety awareness had improved among 82 (91.1%) students, showing that SBME had effectively promoted safe clinical practices. Students had developed better awareness regarding prevention of medical errors, proper procedural steps, communication skills, and teamwork during clinical situations.

Overall, 85 (94.4%) students had expressed satisfaction with the simulation-based learning approach. The high satisfaction rate had reflected those students had considered simulation training an effective educational method for bridging the gap between theoretical knowledge and practical clinical application. The findings had supported the role of SBME as an important educational strategy for improving procedural competence, confidence, and patient safety awareness among medical students.

DISCUSSION:

The present study had explored the role of simulation-based medical education (SBME) in enhancing procedural skills, confidence, and patient safety awareness among medical students. The findings had demonstrated that students who had participated in simulation-based training showed noticeable improvement in technical abilities, self-confidence, and understanding of safe clinical practices. Simulation-based learning had provided a controlled and risk-free environment where students had been able to practice clinical procedures repeatedly without exposing real patients to potential errors [10]. This educational approach had contributed to the development of essential clinical competencies and had supported the transition from theoretical knowledge to practical application.

The improvement in procedural skills observed among participants had highlighted the effectiveness of simulation as an educational strategy. Before simulation training, many students had demonstrated limited practical experience and had faced difficulties in performing procedures accurately [11]. Following structured simulation sessions, students had shown better hand-eye coordination, improved procedural accuracy, and greater familiarity with clinical equipment and techniques. These findings had suggested that repeated practice using simulation models had strengthened psychomotor skills and had allowed learners to identify and correct mistakes during the learning process. Similar educational studies had reported that simulation-based teaching had improved competency in procedures such as venipuncture, catheterization, airway management, and basic life support skills among medical trainees [12].

The study had also revealed a significant increase in students' confidence levels after participation in simulation-based education. Prior to the intervention, several students had expressed hesitation and anxiety when performing clinical procedures due to limited exposure and fear of causing harm. Simulation training had reduced these concerns by providing opportunities for active participation, feedback, and reflection. The supportive learning environment had encouraged students to practice independently and had improved their readiness to manage clinical situations [13]. Enhanced confidence had been considered an important outcome because confident healthcare providers were more likely to communicate effectively, make appropriate decisions, and perform procedures with greater efficiency.

Patient safety awareness had also improved among medical students after simulation-based training. The simulation environment had allowed learners to experience realistic clinical scenarios involving communication challenges, procedural complications, and decision-making processes. Through these experiences, students had developed a better understanding of infection control measures, correct procedural steps, teamwork, and prevention of medical errors [14]. The inclusion of debriefing sessions after simulations had played an important role in helping students analyze their performance and recognize areas requiring improvement. This reflective process had promoted a culture of safety and continuous learning.

The findings had supported the concept that simulation-based medical education had addressed several limitations associated with traditional clinical teaching methods. In conventional training settings, opportunities for students to perform procedures had often depended on patient availability, clinical

workload, and ethical considerations. Simulation had overcome these barriers by offering standardized learning experiences where every student had received equal opportunities for practice. Furthermore, simulation had enabled educators to assess students' performance objectively and provide immediate feedback, which had enhanced the overall learning experience [15].

Despite the positive outcomes, the study had recognized certain challenges associated with simulation-based medical education. Implementation of simulation programs had required significant financial investment, trained faculty members, and appropriate facilities. Limited access to advanced simulation technology could restrict its use in some medical institutions. However, the benefits of improving clinical competence and reducing potential patient harm had justified the integration of simulation into medical curricula. Even low-cost simulation models had been found valuable for teaching basic procedural skills.

Overall, the study had indicated that simulation-based medical education had been an effective approach for improving procedural skills, increasing confidence, and strengthening patient safety awareness among medical students. The findings had emphasized the importance of incorporating structured simulation training into undergraduate medical education to better prepare future healthcare professionals. Regular simulation sessions, combined with effective feedback and assessment strategies, had the potential to enhance clinical readiness and promote safer patient care practices.

CONCLUSION:

The study had demonstrated that simulation-based medical education had played a significant role in improving procedural skills, confidence levels, and patient safety awareness among medical students. The findings had indicated that students who had participated in simulation-based training had shown better practical performance, improved decision-making abilities, and greater confidence in performing clinical procedures compared with traditional learning approaches. Simulation had provided a controlled and risk-free environment where students had practiced essential skills, received immediate feedback, and developed better preparedness for real clinical situations. The approach had also enhanced awareness regarding communication, teamwork, and prevention of medical errors, contributing to safer patient care practices. Overall, simulation-based medical education had been an effective educational strategy that had bridged the gap between theoretical knowledge and clinical application. Its integration into medical curricula had been recommended to strengthen competency-based training and improve future healthcare outcomes.

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