Original Article

Integration of simulation-based patient teaching for medical students

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ABSTRACT

Medical education has adopted simulation-based training as a revolutionary method to overcome traditional academic difficulties that prevent students from connecting theoretical knowledge to real-world clinical practice. The research assesses the effects of high-fidelity simulation with the advanced human simulation mannequin on medical student development of diagnostic and therapeutic competencies. A quasi-experimental study was conducted with 160 fourth-year medical students, divided into an experimental group (n=106) exposed to 23 structured simulation sessions and a control group (n=54) receiving conventional training. The assessment of clinical competency used pre- and post-training Objective Structured Clinical Examinations (OSCEs), and confidence levels were evaluated through a 5-point Likert scale. The analysis used paired and independent *t*-tests to examine the data. The experimental group achieved a 27.9% improvement in OSCE scores after training (61 to 78/100, *p* < 0.001) which exceeded the control group's 9.4% improvement (64 to 70/100, *p* = 0.012). The simulation cohort experienced a 54–63% increase in self-efficacy scores, which ranged from 2.4–3.1 to 4.0–4.3, while controls experienced a 15–25% increase. The greatest improvements occurred in procedural confidence and diagnostic accuracy. The results confirm previous research that demonstrates that simulation training improves clinical reasoning abilities, procedural mastery, and communication competencies. Strategic planning must address scalability and resource demands. High-fidelity simulation provides substantial improvements to clinical competency and confidence, which supports its adoption in medical curricula. Future research needs to focus on longitudinal skill retention and cost-effectiveness analyses and cross-cultural adaptations to achieve optimal equitable implementation.

Keywords: Simulation-based training, Clinical competency, Medical education, OSCE, High-fidelity simulation

Introduction

Medical education has undergone significant transformation in recent decades, with simulation-based learning emerging as a cornerstone of modern pedagogical strategies. Simulation patient programs, which include virtual patients [1-4], standardized actors, and high-fidelity manikins, are designed to bridge the gap between theoretical knowledge and clinical practice by immersing learners in controlled, realistic scenarios [5]. The programs resemble medical care complexity so students may practice diagnostic thinking and procedural skills and interprofessional collaboration without compromising patient safety. Such simulations in the classroom help to promote the shift in healthcare education toward competency-based training, which demands students to demonstrate both technical and non-technical skills prior to clinical practice [6, 7]. Simulations are particularly important for teaching in the high-stakes inpatient care settings of hospital-based internal medicine education [8]. Through their involvement with these situations handling various patient groups, students acquire fundamental clinical skills,

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flexibility and empathy. The growing use of simulation technology shows its position as an educational tool improving conventional teaching strategies like lectures and bedside training to fulfill current healthcare needs.

Traditional medical education faces challenges to provide learners with adequate preparation for clinical practice unpredictability despite established simulation benefits. The conventional educational methods, which focus on passive learning and observation, may not provide students with sufficient preparation to handle urgent decisions and ethical challenges and emotionally demanding patient interactions. Internal medicine presents a significant learning gap because clinicians need to combine extensive information synthesis with specialty collaboration and critical care management of seriously ill patients [9]. New medical practitioners commonly express their struggle when moving from academic settings to clinical practice because they lack essential skills in critical thinking, communication, and situational awareness [10, 11]. Simulation-based training provides an effective answer through its structured experiential learning approach, which develops both competence and confidence. The implementation of these programs faces ongoing challenges because of resource limitations, faculty training requirements, and inconsistent curricular integration methods. The current evidence base lacks sufficient data about how simulation training affects both clinical [12, 13] performance and patient outcomes specifically in hospital environments [14].

The study examines a structured simulation program in internal medicine education to address information gaps about the efficacy of simulation-based training in mitigating unpreparedness risks and enhancing professional capabilities in future medical practitioners. The study has significant consequences, since enhanced training quality results in increased patient safety and greater efficiency within the healthcare system. Through its comprehensive examination of hospital-based internal medicine training programs, the research adds to the corpus of information on simulation-based instruction. The present study investigates how extended integrated simulation programs affect learners' preparedness for practice by means of a comprehensive assessment of their immediate abilities and their capacity to retain knowledge and adapt to new circumstances and work with other healthcare professionals. The study provides a comprehensive educational impact assessment of simulations by analyzing instantaneous skills and evaluating knowledge retention, adaptability in new environments [15-17], and interprofessional collaboration [18]. Using its examination of faculty members' implementation challenges and high-fidelity technology cost-effectiveness, the paper investigates two understudied implementation concerns.

The research establishes optimal curriculum design methods that focus on scalability and contextual adaptability for various institutional environments. The study demonstrates how simulation training leads to better patient-centered care and clinical decision-making, thus supporting the need to prioritize experiential learning in medical education policy. The research contributes to competency-based training discussions by offering practical methods to develop healthcare professionals who possess both technical expertise and humanistic compassion for modern healthcare needs.

Study design

Osh State University conducted this quasi-experimental study with 4th-year medical students studying hospital therapy [19]. The hospital therapy 1 module occurred in a 14-week course that met once a week for two hours. The hospital therapy 1 course is part of the seventh semester of the academic programm. This 5-credit course serves as the sole source of less common diseases in respiratory and cardiovascular medicine; those remaining part of internal medicine, such as gastroenterology, nephrology, rheumatology, and hematology, students continue in the eighth and ninth semesters as hospital therapy 2. The students divided into two groups: n=160 students in total, with n=106 students in the experimental group using simulated patients and a control group conducted from n=54 students using traditional teaching methods. The demographic information of the students (age, gender, previous medical education, and experience) was collected before the start of the study. The experimental group participated in a series of 23 (45 hours) structured simulation sessions designed to mimic real-life clinical scenarios using the human simulation mannequin simulator. Scenarios included managing tension pneumothorax, diagnosing lung abscess, and addressing cardiomyopathy. Each session concluded with immediate feedback from instructors. In contrast, the control group received traditional instruction through didactic lectures, case-based discussions, and paper-based tutorials facilitated by experienced clinicians. In order to assess students, they were provided an objective structured clinical examination (OSCE) as a pre-training assessment and a post-training assessment. Used standardized checklists to assess clinical competencies, such as history taking, physical examinations, diagnosing, treatment plans, and patient communication.

Materials and Methods

Experimental group

The experimental group's students took part in the following organized training sessions based on simulation.

Every session involved practicing various clinical scenarios relevant to topics in hospital therapy subjects. Examples of included managing of tension pneumothorax, handling a patient with a lung abscess, and dealing with the cardiomyopathy. As a simulation patient, we implemented a human simulation mannequin, which reproduces the skeleton and anatomical structure of a person. The advanced human simulation mannequin is a wireless system, a fully functional wireless computer that allows the teacher to monitor and make adjustments during training, and has distinctive and unique characteristics and features that make training more realistic. The mannequin reproduces the skeleton and anatomical structure of a person with characteristic features and properties. It is human-sized and has very realistic skin. Available options: eye movements, eyelids, and pupillary reaction to light; bleeding, sweating, lacrimation, and urination; playback speech; changes in the color of the skin; imitation edema, pneumothorax; respiratory movement; pulse on carotid, radial, and femoral arteries; simulation of convulsive seizures; auscultation of lungs and heart; ECG monitoring (normal and pathological), etc. Although this simulation patient can exhibit symptoms and conditions that students must diagnose and treat.

Students engaged in hands-on practice, allowing them to apply theoretical knowledge in a controlled, realistic environment. They performed taking medical histories, physical examinations, developing differential diagnoses, and formulating treatment plans. After each simulation session, students received immediate feedback from teachers and peers. Feedback focused on clinical skills and communication abilities, and to enhance learning and promote continuous self-assessment and growth, they encouraged reflection on their performance, discussing “what went well” and “what could be improved.”

Control group

Students in the control group continued with traditional instructional techniques, excluding the use of simulated patients. Students in the control group followed a traditional hospital therapy curriculum without exposure to simulation-based training. Instruction was primarily delivered through didactic lectures, where experienced faculty members presented theoretical aspects of respiratory and cardiovascular diseases using standard textbooks, guidelines, and multimedia presentations. Lectures emphasized fundamental concepts, disease mechanisms, diagnostic pathways, and treatment protocols. Students were expected to engage by taking notes, asking questions, and participating in classroom discussions to reinforce theoretical knowledge. In addition to lectures, case-based learning sessions were conducted, where students discussed paper-based clinical case studies in small groups. These sessions encouraged critical thinking and collaborative diagnostic reasoning. However, all cases remained in a written or verbal format, without physical interaction with simulated or real patients. Small group tutorials were led by experienced clinicians who facilitated deeper understanding through Socratic questioning. Students practiced formulating differential diagnoses, developing management plans, and defending their clinical reasoning in a group setting, guided but not demonstrated through patient interaction. To assess knowledge retention, students regularly completed multiple-choice question (MCQ) quizzes after every major topic. These quizzes emphasized theoretical understanding but did not directly assess procedural or communication skills. Unlike the experimental group, there was no structured practical component involving patient examination, clinical decision-making in real-time, or feedback on interpersonal skills. Learning remained primarily passive and cognitive, rather than hands-on.

Ethical approval

This study received formal approval from the Institutional Review Board (IRB) Committee of Osh State University, Osh, Kyrgyzstan. All students were provided with oral and written information detailing the study's goals, methods, potential risks, benefits, and their right to withdraw at any time. Participation was voluntary, and oral informed consent was obtained from all participants, with assurance of anonymity throughout the study. All demographic and performance data were anonymised using coded identities to protect participant privacy; access to the research team only allowed access to this anonymization. Data storage followed institutional guidelines for physical and electronic security to guarantee adherence to global norms for critical medical and educational research. Using non-invasive simulation technology and minimizing training exposure to actual patients helped to reduce hazards in the research design. Moreover, debriefing sessions followed the simulation to handle any psychological or emotional issues resulting from clinical settings. The conventional training approaches of the control group reflected accepted curriculum, therefore guaranteeing fair educational chances. This study was conducted in accordance with the principles of the Declaration of Helsinki [20].

Evaluation and assessment

Comparative comparisons between experimental and control cohorts allowed student performance in the hospital treatment module to be assessed under a quasi-experimental pre-post intervention approach. Pre-training and post-training Objective Structured Clinical Examinations (OSCEs) a validated assessment tool using standardized checklists to evaluate proficiency in history-taking, physical examination, diagnostic accuracy, treatment planning, and patient communication و quantitatively measured clinical competency. Concurrently, self-reported confidence in clinical abilities was assessed using a 5-point Likert scale administered pre- and post-intervention. The instrument comprised five items: (Q1) “I feel confident performing clinical assessments”; (Q2) “I am comfortable diagnosing clinical conditions”; (Q3) “I am confident managing patient care”; (Q4) “I feel prepared to communicate effectively with patients”; and (Q5) “I can integrate theoretical knowledge into clinical practice efficiently.” Responses were anchored on a scale from *Strongly Disagree* (1) to *Strongly Agree* (5), with higher scores reflecting greater self-efficacy.

Statistical analysis

IBM SPSS Statistics Version 23 (IBM Corp., Armonk, NY, USA) was used for data analysis. Within the experimental and control groups, pre- and post-training clinical competence scores—derived from OSCE assessments—were compared using a paired-sample *t*-test. We defined statistical significance at *p* 0.05.

Results and Discussion

The demographic analysis indicated that 12 individuals (93.80 percent) in the experimental group were female, while the control group comprised 4 female students, with an average age of 22.69±0.81 years **(Table 1)** [21].

Table 1. Demographic characteristics, baseline equivalence, and OSCE score outcomes for experimental and control groups. Values represent frequencies (%), mean ± standard deviation (age), or raw scores (OSCE), with *p*-values indicating intergroup statistical significance.

Demographic information	Frequency (%) experimental/control	p-value
Male	94/50	
Female	12/4	
Gender distribution	93.80% / 92.59%	0.84
Age	22.69 ± 0.81	
Pre-train OSCE score	61/64	0.10
Post-train OSCE score	78/70	<0.0001

Each participant have successfully completed the previous faculty therapy curriculum. Whereas the control group scored 64 out of 100, the experimental group's initial pre-training OSCE score was 61. While the average OSCE scores in the experimental group were much higher at 78 out of 100, the post-training OSCE score in the control group was 70 out of 100. The comparison of mean differences revealed a significant increase in the experimental group of 17 (p-value = 0.0001), compared to a difference of 7 in the control group (p-value = 0.012). Evaluated pre-training and post-training for each clinical skill. The comparison of pre- and post-training results between the experimental and control groups was conducted using a paired t-test**. Table 2** summarizes the calculation of mean difference and p-values that forms the statistical analysis. Within the experimental group, the students showed a clear increase in median scores from pre-training to post-training; the control group showed a modest gain in median scores throughout the same time.

Table 2. Pre- and post-training OSCE score distributions for experimental and control groups, including mean ± standard deviation (SD), score ranges, mean differences, and statistical significance (*p* < 0.05).

Group	Time	Mean OSCE score	Standard deviation	Lowest score	Highest score	Mean deference	p-value
Control	Pre-Training	64	±4.5	55	70		
Control	Post-Training	70	±4.9	60	78	7	0.012
Experimental	Pre-Training	61	±5.2	50	70		
Experimental	Post-Training	78	±4.8	70	85	17	0.0001

The enhancement in OSCE scores indicates a rise in students' confidence and proficiency after the training. We performed statistical analysis, utilizing paired t-tests, to assess the significance of these improvements. The experimental group exhibited a notable increase in mean scores (mean difference of 17 points, p-value=0.0001), reflecting a significant improvement in confidence levels. By comparison, the control group showed a modest increase (mean difference of 7 points, p-value=0.012), suggesting a lesser but still significant confidence boost. **Table 3**. Comparing the experimental group to the control group, the results of the 5-point Likert scale confidence evaluation showed that the experimental group regularly obtained better post-training ratings in all clinical capacities. The violin plot demonstrates how OSCE scores changed between pre-training and post-training for both experimental and control groups **(Figure 1)**. The experimental group demonstrates both increased median scores and greater variability of positive score changes than the control group. The OSCE score differences show that the experimental group achieved greater improvements after the intervention. The experimental group achieved both greater median score growth and wider positive score changes than the control group. The results indicate that the intervention produced positive effects on clinical performance. Future research needs to include bigger participant numbers to confirm these observed effects.

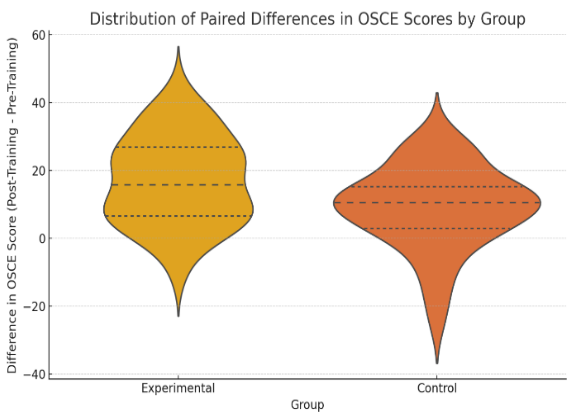

Figure 1. Distribution of Paired Differences in OSCE Scores by Post-training and Pre-training Group.

The mean confidence scores prior to training in the experimental group varied between 2.4 and 3.1, whereas the scores following the training exhibited a notable increase, reaching between 4.0 and 4.3. Conversely, the pre-training scores for the control group varied between 2.6 and 3.2, while their post-training scores showed a moderate increase, reaching between 3.3 and 3.7. The most significant enhancement in the experimental group was noted in Performing Clinical Procedures (+1.8 points), whereas the control group exhibited more modest advancements across all areas [22, 23], with improvements varying from +0.5 to +0.8 points. The results highlight the profound influence of simulation-based training on the confidence levels of students **(Figure 1)**.

Table 3 presents the comparison of self-reported confidence levels across five clinical domains before and after training for both the experimental and control groups, assessed using a 5-point Likert scale. In the experimental group, there was a significant increase in confidence across all domains, with mean differences ranging from 1.5 to 1.7 points ($p < 0.001$ for all questions). Pre-training scores in the experimental group ranged from 2.6 ± 0.7 to 3.0 ± 0.6, while post-training scores improved markedly to a range of 4.2 ± 0.6 to 4.5 ± 0.4. In contrast, the control group also demonstrated statistically significant improvements in confidence, but the magnitude of change was smaller. Mean differences ranged from 0.6 to 0.9 points, with p-values between 0.035 and 0.042. Pre-training scores in the control group varied from 2.7 ± 0.6 to 3.0 ± 0.5, increasing to post-training scores between 3.5 ± 0.5 and 3.8 ± 0.6. Overall, the experimental group showed greater gains in self-reported confidence across all measured clinical domains compared to the control group.

Table 3. Pre- and post-training self-reported confidence levels (5-point Likert scale) across clinical domains for experimental and control groups. Values represent mean ± standard deviation, mean differences, and statistical significance (*p* < 0.05).

Group	Question Number	Pre-training Mean ± SD	Post-training Mean ± SD	Mean Difference	P-value
	Q1	2.8 ± 0.6	4.3 ± 0.5	1.5	<0.001
	Q2	2.7 ± 0.7	4.2 ± 0.6	1.5	<0.001
Experimental	Q3	2.9 ± 0.5	4.4 ± 0.4	1.5	<0.001
	Q4	3.0 ± 0.6	4.5 ± 0.4	1.5	<0.001
	Q5	2.6 ± 0.7	4.3 ± 0.5	1.7	<0.001
	Q1	2.9 ± 0.6	3.5 ± 0.5	0.6	0.042
	Q2	2.8 ± 0.7	3.6 ± 0.6	0.8	0.038
Control	Q3	2.9 ± 0.5	3.7 ± 0.5	0.8	0.036
	Q4	3.0 ± 0.5	3.8 ± 0.6	0.8	0.039
	Q5	2.7 ± 0.6	3.6 ± 0.6	0.9	0.035

Simulation-based training integrated into hospital therapy education produced both statistically significant and educationally meaningful results, which demonstrate its transformative ability to connect theoretical knowledge with clinical readiness [5, 24]. The research demonstrates that simulation-based training in hospital therapy curricula produces significant educational benefits that lead to better clinical skills and increased learner confidence than traditional teaching approaches. Students who received structured simulation training achieved statistically significant clinical competency improvements that surpassed the performance of students in traditional learning settings [25, 26]. The experiential learning approach produced the most noticeable improvements in clinical domains that needed hands-on clinical reasoning, procedural execution, and patient communication skills. Simulating-trained students' self-assessment confidence increased significantly as they felt better prepared to manage complex clinical scenarios. The control group exhibited very modest gains, indicating that conventional teaching strategies have limits in fostering practical preparation. The results correspond with contemporary teaching strategies emphasizing active learning experiences that link theoretical knowledge to pragmatic uses [27].

This study aimed to determine the effects of simulation-based training using a high-fidelity mannequin on the clinical skills and confidence levels of fourth-year medical students in hospital therapy, in contrast to conventional teaching methods. This study demonstrated a significant enhancement in the post-training OSCE scores of the pilot group, highlighting the effectiveness of simulation-based teaching methods. The experimental group achieved a baseline score of 61/100 before improving to 78/100 after intervention, while the control group showed a baseline score of 64/100 that increased to 70/100 thus demonstrating simulation-based training outperformed traditional training in clinical competency development. The OSCE score trajectories show that the experimental group experienced a 27.9% improvement, whereas the control group achieved only a 9.4% gain. The significant difference between these results demonstrates that simulation-based training provides faster clinical skill development, especially when using high-fidelity simulation with feedback. The control group showed limited improvement because didactic methods fail to provide students with essential practice opportunities and real-world application scenarios. The study confirms simulation as a fundamental educational approach for developing competent clinical practitioners.

The pre-training OSCE scores demonstrated that both groups exhibited similar baseline competencies in clinical skills. The engaging practice with a human simulation mannequin, designed to replicate authentic clinical situations and offer prompt feedback, probably played a significant role in this enhancement. The authenticity of the human simulation mannequin, particularly its capacity to replicate symptoms and conditions like tension pneumothorax, lung abscess, and cardiomyopathy, offered students a hands-on and engaging educational experience that conventional approaches could not achieve.

The systematic review conducted by N. Alrashidi *et al*. in 2023 illustrates that simulation-based teaching enhances both self-confidence and clinical competencies in learners. The simulation sessions provided an opportunity for nursing students to engage in history taking, conduct physical examinations, formulate diagnoses, and develop treatment plans within a structured setting [28]. The hands-on experience, along with prompt feedback, contributed to the improvement of clinical skills and strengthened students' capacity to manage intricate medical scenarios. Several studies have highlighted the importance of simulation training in enhancing the communication skills of students [29-31]. This interaction probably bolstered students' confidence in their communication skills, a conclusion backed by studies showing that simulation training improves communication abilities in medical environments. The research conducted by W. Sun *et al*. (2024) highlights that simulation training offers a secure setting for students to hone their skills, resulting in improved outcomes in clinical evaluations [32]. The results indicate that the training intervention significantly enhanced students' confidence in the application of clinical skills. The notable enhancement in OSCE scores within the experimental group underscores the beneficial effects of specialized training initiatives on students' confidence and practical skills in clinical environments.

Future recommendation

Future medical pedagogy transformation through simulation requires balancing technological progress with inclusive teaching methods to extend laboratory-based [33-35] innovations into real-world healthcare complexities [36, 37]. The following recommendations, based on this study's findings and literature gaps, present practical approaches to enhance simulation effectiveness while overcoming implementation obstacles.

Longitudinal skill retention studies

Assessments should be conducted after training to determine how well clinical competencies and confidence levels from simulation training persist. The assessment of skill maintenance from high-fidelity simulations during clinical rotations should be conducted to develop curricular reinforcement strategies [5].

Specialty-specific simulation modules

Simulation-based training should be expanded to include underrepresented specialties such as emergency medicine and surgery as well as complex and low-frequency clinical scenarios, including septic shock and acute neurological crises. This would address gaps in exposure and prepare learners for diverse, high-stakes environments [38].

Integration with real-world clinical practice

Examine hybrid training models that integrate simulation-based education with supervised patient contact to evaluate their combined impact on competency acquisition. This method would maximize resource efficiency while maintaining the practical relevance of learned competencies [39].

Faculty development programs

Create standardized training modules for educators to improve debriefing quality and scenario design and feedback delivery. The educational outcomes of simulation depend on faculty proficiency to achieve maximum pedagogical potential and institutional consistency [40].

Cost-benefit and accessibility analyses

Assess the economic viability of expanding high-fidelity simulation programs in resource-constrained environments. Examine virtual reality platforms and low-cost manikins as alternatives to make simulation education accessible to all while maintaining educational effectiveness [41].

Conclusion

This study demonstrates that integrating simulation-based teaching into the hospital therapy curriculum significantly enhances medical students' diagnostic accuracy, therapeutic decision-making, and procedural skills. By using advanced tools such as the human simulation mannequin, students engaged in deliberate practice, iterative feedback, and contextual skill application—elements largely absent in traditional didactic teaching methods. The findings align with global trends emphasizing competency-based medical education, highlighting experiential learning as a critical strategy to bridge the gap between theoretical knowledge and clinical practice. Simulation training not only develops technical competencies but also fosters resilience and adaptability, which are essential for modern healthcare professionals facing increasingly complex clinical environments. Moreover, simulation-based programs provide standardized clinical training experiences, improving clinical preparedness and reducing novice practitioner errors. The results affirm simulation as both an educational and professional development tool.

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