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Simulation-based education in an emergency medicine clerkship in Qatar: impact on academic performance and student perceptions

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Abstract

Background Simulation-based medical education (SBME) is increasingly used in emergency medicine (EM) training to enhance clinical skills and decision-making. However, its impact on undergraduate clerkship performance and student perceptions in the Middle Eastern context remains underexplored. This study aimed to evaluate whether the integration of high-fidelity simulation into a medical student EM clerkship in Qatar improves academic outcomes and enhances student satisfaction with the learning experience.

Methods Two clerkship students cohorts were compared: 63 students in a lecture-based education (LBE) group in 2022 and 67 students in an SBME group in 2024. Multiple-choice question (MCQ) and objective structured clinical examination (OSCE) scores were analyzed using independent sample t-tests. Demographic variables (age, gender) were collected, and qualitative feedback from the SBME group was analyzed using descriptive content analysis.

Results There were no statistically significant differences in academic performance between the lecture-based education (LBE) and simulation-based medical education (SBME) cohorts. The mean MCQ score was 29.2 (SD = 4.1) for the LBE group and 28.8 (SD = 4.3) for the SBME group ($p = 0.588$), with no meaningful difference (mean difference = +0.4, 95% CI: [-1.08, 1.84], Cohen's $d = +0.10$). OSCE scores were also comparable, with the LBE group scoring a mean of 24.8 (SD = 1.8) and the SBME group 25.2 (SD = 1.7) ($p = 0.192$; mean difference = -0.4, 95% CI: [-1.01, +0.21], Cohen's $d = -0.23$). Demographic characteristics were also similar between groups, with a mean age of approximately 23 years and around 70% of participants being female. Thematic analysis of feedback revealed three dominant themes: (1) *Enhanced clinical preparedness and confidence* – students felt better prepared for real emergencies after simulation practice; (2) *Active learning and realism* – the lifelike scenarios and hands-on approach helped bridge theory to practice in a safe environment; (3) *Positive engagement and recommendations* – students found simulation highly engaging and recommended increasing its use. One student wrote, *"The simulations were the most valuable part of the rotation, boosting my confidence in handling acute cases."* Minor challenges noted included initial anxiety during simulations and scheduling constraints, but overall perceptions were overwhelmingly positive.

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Conclusions While SBME in the emergency medicine clerkship did not lead to statistically significant improvements in exam performance, it was highly valued by students and associated with enhanced confidence, clinical preparedness, and engagement. These results support the continued integration of SBME into EM clerkship as a complementary approach to traditional teaching. Future studies with larger sample sizes and extended follow-up are warranted to evaluate the long-term impact and broader applicability of simulation-based medical education.

Keywords Simulation-based education, Emergency medicine, Medical clerkship, Mixed-methods, Student performance, Student perceptions

Introduction

The emergency medicine (EM) clerkship represents a pivotal component of undergraduate medical training at Qatar University, providing final-year students with structured exposure to acute care in a high-pressure environment. Within this clerkship, students encounter a diverse range of critical scenarios—including trauma, cardiac arrest, respiratory failure, and toxicological emergencies—requiring rapid decision-making and application of theoretical knowledge to real-world cases [1]. Students refine essential competencies such as triage, procedural skills, clinical prioritization, and interprofessional communication under the supervision of experienced EM physicians. A central feature of the clerkship is the emphasis on teamwork and collaboration with nurses, paramedics, and allied healthcare staff, which reflects the multidisciplinary nature of emergency care [2]. To further prepare students for the unpredictability of emergency settings, simulation-based education (SBME) has been integrated into the curriculum to supplement traditional learning methods.

The evolution of medical education over the past two decades has increasingly emphasized experiential, learner-centered approaches over passive, lecture-driven formats [3, 4]. SBME has emerged as a core strategy for developing clinical competence through repeated exposure to high-risk, low-frequency scenarios in a controlled, feedback-rich environment. Unlike didactic teaching, SBME enables students to practice critical procedures, manage dynamic clinical events, and receive formative feedback without compromising patient safety [5]. Evidence from international studies has shown that SBME can improve both technical and non-technical skills, including clinical reasoning, leadership, teamwork, and situational awareness—particularly in acute care domains like EM [5, 6].

Despite the growing global adoption of simulation-based education (SBME), there is a paucity of research examining its impact within the Middle Eastern medical education context. In Qatar, the integration of simulation into undergraduate curricula is relatively recent, and its effectiveness—particularly within core clinical clerkships—remains underexplored. While studies from neighboring Gulf Cooperation Council (GCC) countries such as Saudi Arabia and the United Arab Emirates have reported improvements in student engagement, communication, and self-efficacy through simulation, few have directly linked these benefits to measurable academic outcomes [7]. Notably, no published research from Qatar has evaluated the effect of SBME on end-of-clerkship examination performance or compared it with traditional lecture-based education (LBE). This represents a critical gap in knowledge, especially as Qatar continues to prioritize educational innovation and workforce development in alignment with its national strategic goals.

To address this gap, we conducted a quasi-experimental study to evaluate the integration of simulation-based medical education (SBME) into the emergency medicine (EM) clerkship for medical students at Qatar University. The study aimed to quantitatively assess the impact of simulation on academic performance, specifically students' scores on multiple-choice questions (MCQs) and objective structured clinical examinations (OSCEs), while also qualitatively exploring their perceptions and experiences of simulation as a learning modality. We hypothesized that students exposed to SBME would demonstrate superior performance on final assessments and report increased confidence, preparedness, and engagement. By capturing both objective outcomes and subjective feedback, this study aims to generate context-specific evidence to inform curriculum development, guide educational policy, and support the broader integration of SBME into undergraduate medical education across the region.

Methodology

Study design and rationale

This quasi-experimental study was designed to compare the impact of lecture-based education (LBE) and simulation-based medical education (SBME) on final-year medical students' academic performance and perceptions during their Emergency Medicine (EM) clerkship. Data were collected using an anonymized questionnaire (see Appendix A). A randomized controlled trial (RCT) was not feasible due to institutional scheduling limitations and ethical concerns about withholding potentially beneficial simulation-based training. Therefore, a quasi-experimental, non-randomized design was chosen to facilitate comparison between naturally occurring student cohorts within an authentic educational environment.

The study compared two cohorts: the 2022 cohort, which received lecture-based education, and the 2024 cohort, which received fully developed simulation-based education. Although simulation was introduced in 2023, that year marked a pilot phase characterized by inconsistent delivery and faculty onboarding. To ensure methodological consistency and evaluate the effect of a mature, systematically delivered simulation program, the 2023 cohort was excluded from analysis.

Setting and participants

This study was conducted at Qatar University's College of Medicine, which follows a six-year undergraduate curriculum modeled on European standards. The emergency medicine (EM) clerkship is an eight-week core rotation in the final year, comprising four days of supervised clinical experience in the emergency department and one day of didactic teaching per week.

All final-year medical students enrolled in the EM clerkship during the 2022 ($n = 63$) and 2024 ($n = 67$) academic years were included, resulting in a total sample of 130 students. Both cohorts represented complete census samples of their respective academic years, and no exclusions or sampling were applied. Both cohorts followed an identical clinical rotation structure: four days of supervised emergency department experience and one didactic teaching day per week. Due to the fixed cohort sizes, an a priori sample size calculation was not performed; however, the relatively small class sizes, typical for medical colleges in Qatar, were considered when interpreting the results. While this may limit the statistical power to detect small differences, including all eligible students enhanced the study's representativeness.

Educational interventions

In 2022, didactic sessions followed a lecture-based model delivered in traditional classroom settings. In 2024, the curriculum shifted to a simulation-based model, conducted at the university's state-of-the-art clinical skills center. This facility incorporated medium- and high-fidelity mannequins, enabling students to engage in realistic and interactive scenarios. Students were divided into small groups of 6–8 and participated in case-based simulation exercises aligned with the week's teaching theme (e.g., trauma, cardiac emergencies). Each weekly didactic session was a 4-hour block. In the SBME cohort, this time was structured as follows: a 30-minute case introduction, a 90-minute high-fidelity simulation scenario (including set-up and participation), a 60-minute structured debrief led by EM faculty, 30 min for completing 8–10 case-aligned MCQs, and 30 min for interactive peer-reviewed case presentations. The LBE cohort's 4-hour session comprised two 90-minute traditional lectures, 30 min for MCQ practice, and 30 min for formal case presentations with faculty feedback. Table 1 summarizes the differences in didactic formats between the two cohorts.

Outcome measures

Primary quantitative outcomes included:

- Multiple-choice question (MCQ) scores (maximum 40 points).
- Objective Structured Clinical Examination (OSCE) scores (maximum 30 points).

Secondary outcomes included:

- Thematic analysis of student perceptions of SBME based on open-ended questionnaire responses (SBME cohort only).

Data collection

- **Academic Performance**: Final MCQ and OSCE scores were collected from institutional records. The MCQ exams included 80 questions covering diverse EM domains, including text-only and image-based

Table 1 Comparison of didactic sessions in Lecture-Based (2022) and Simulation-Based (2024) cohorts

Teaching Component	Simulation-Based Education (2024)	Lecture-Based Education (2022)	Session Duration
Lectures	Brief, targeted lectures during debriefs to reinforce learning points	Full-length, structured classroom lectures (Two 90-minute sessions)	SBME: 30 min intro; LBE: 180 min total
Simulation Scenarios	Weekly high- and medium-fidelity simulations covering core EM topics with guided debriefing	Not applicable	SBME: 90 min
MCQ Practice	8–10 case-aligned MCQs completed after each simulation session	MCQs related to lecture content assigned for self-study	SBME: 30 min; LBE: 30 min
Case Presentations	Interactive peer-reviewed presentations within simulation sessions	Formal presentations in lecture sessions with faculty feedback	SBME: 30 min; LBE: 30 min
Debriefing	60-minute structured, faculty-led debrief after each simulation	Not formally structured; Q&A within lectures	SBME: 60 min
Total Didactic Time			4 h per week (both cohorts)

items. The OSCE comprised structured clinical stations of 10 min each.

- **Student Perceptions**: Feedback from the 2024 SBME cohort was gathered via an anonymized post-clerkship survey distributed electronically via Microsoft Forms during the final week of the rotation. Students completed the survey on their own time, after the final examinations but before the official end of the clerkship period (see Appendix A). Students reflected on their confidence, skills development, and experience with simulation.

Statistical analysis

All analyses were performed using IBM SPSS Statistics (Version 29). Descriptive statistics (means, standard deviations, frequencies) were calculated for demographic and performance variables. Between-group comparisons of MCQ and OSCE scores were conducted using independent-sample t-tests after confirming equal variances via Levene's test. Significance was set at $p < 0.05$, and Cohen's d was calculated to estimate effect sizes. Power analysis was not conducted prior to the study, as cohort size was determined by the number of eligible students each academic year. This limitation may reduce the ability to detect small but meaningful differences between groups.

Thematic analysis of qualitative feedback from open-ended survey responses was conducted using a descriptive content analysis approach. Two independent reviewers coded the data and resolved discrepancies through consensus. While thematic labels were used, this process was exploratory and not intended to meet formal qualitative research rigor.

Ethical considerations

The study was reviewed and deemed Exempt under Category 3 of the Ministry of Public Health (MOPH) guidelines, which applies to research using existing educational data without personal identifiers. Ethical approval was obtained from the Qatar University Institutional Review Board (IRB-1732436-2) and Hamad Medical Corporation IRB (MRC-01-24-715). Written informed consent was not required due to the minimal risk involved. Participation in the feedback survey was voluntary, and submission was considered implied consent. The study complied with institutional policies and the principles of the Declaration of Helsinki.

Results

Student performance

The 2022 lecture-based education (LBE) cohort included 63 students, while the 2024 simulation-based education (SBME) cohort included 67 students. Across both cohorts, the demographic distribution was comparable: the majority were female (LBE: 71.4%, SBME: 68.7%) and the mean age was approximately 23 years. Table 2 summarizes the comparative performance on the multiple-choice question (MCQ) and objective structured clinical examination (OSCE) assessments. The MCQ mean scores were nearly identical (LBE: 29.2, SBME: 28.8), with a mean difference of +0.4 (95% CI: −1.04 to +1.84, $p = 0.588$, Cohen's d = +0.10), indicating no significant difference. Similarly, OSCE scores were closely matched (LBE: 24.8, SBME: 25.2), with a mean difference of −0.4 (95% CI: −1.01 to +0.21, $p = 0.192$, Cohen's d = −0.23). These negligible effect sizes suggest practical equivalence between LBE and SBME cohorts in both assessment formats.

Student feedback on simulation-based medical education (SBME)

Of the 67 students in the 2024 SBME cohort, 64 (95%) completed the post-clerkship survey. Quantitative responses showed overwhelmingly positive perceptions of simulation sessions (Table 3). Qualitative analysis of open-ended responses identified three key themes: (1) Enhanced Clinical Preparedness and Confidence, (2) Active Learning through Realism and Engagement, and (3) Positive Feedback and Curriculum Recommendations.

The most commonly reported benefit was increased clinical confidence, especially in managing emergencies such as airway compromise and cardiac arrest. Students valued practicing in a safe environment that reduced anxiety and boosted readiness for internship. The immersive nature of simulation—realistic scenarios, high-fidelity manikins, and real-time feedback—was frequently cited as more engaging and memorable than traditional teaching methods.

Table 2 Comparison of MCQ and OSCE scores between LBE (2022) and SBME (2024) cohorts

Assessment	Cohort	Mean	Median	SD	Range	*p*-value	Mean Difference	95% CI	Cohen's d
MCQ	LBE (2022)	29.2	30	4.1	22–38	0.588	+0.4	−1.04 to 1.84	+0.10
	SBME (2024)	28.8	29	4.3	22–38				
OSCE	LBE (2022)	24.8	25	1.8	18–28	0.192	−0.40	−1.01 to +0.21	-0.23
	SBME (2024)	25.2	25	1.7	24–30				

MCQ total possible score: 0–40 (80 MCQs × 0.5 marks)

OSCE total possible score: 0–30

p-values based on independent samples t-tests; effect sizes calculated using Cohen's *d*

Table 3 Summary of survey responses to Simulation-Based Medical Education in the emergency medicine clerkship ($n = 64$)

Survey Question	Key Findings
1. How would you rate your overall academic performance in the Emergency Medicine Clerkship?	50% rated themselves "Outstanding," 50% "Above Average."
2. SBL has had a positive impact on my grades.	100% agreed (50% "Strongly Agree," 50% "Agree").
3. How engaging did you find the SBL sessions compared to traditional lectures?	87.5% found SBL more engaging (48.4% "Much More Engaging," 39.1% "More Engaging"); no negative responses.
4. How effectively do you think SBL sessions enhanced your understanding of emergency medicine concepts?	87.5% rated them "Effective" or "Very Effective"; 12.5% "Unsure."
5. How confident do you feel in applying the skills learned in SBL to real-world scenarios?	100% felt confident (50% "Very Confident," 50% "Confident").
6. Please rate the quality of the instruction and feedback provided during SBL sessions.	65.6% rated quality as "Good" or "Very Good"; 34.4% "Unsure."
7. Overall, how satisfied are you with the inclusion of SBL in the Emergency Medicine Clerkship?	87.5% satisfied (50% "Satisfied," 37.5% "Very Satisfied"); 12.5% "Neutral."
8. Would you recommend continuing the use of SBL in this clerkship for future students?	100% answered "Yes."
9. I recommend continuing the use of SBL in this clerkship for future students.	81.3% agreed (43.8% "Strongly Agree," 37.5% "Agree"); 18.8% "Unsure."

Table 4 Summary of qualitative themes and subthemes from student feedback

Theme	Subthemes	Representative student quotes
1. Enhanced Clinical Preparedness and Confidence	- Improved confidence in managing emergencies - Familiarity with emergency protocols (e.g., ACLS) - Teamwork and communication - Reduced anxiety before internship	"After practicing a cardiac arrest in sim, I felt far more confident about running a code."
2. Active Learning through Realism and Engagement	- High realism and scenario immersion - Hands-on experiential learning - Multisensory engagement (visual, auditory, kinesthetic) - Real-time feedback and reflection	"It felt like a real resuscitation, which made the learning stick."
3. Positive Feedback and Recommendations	- Strong endorsement for simulation - Suggestions to expand or diversify cases - Interest in interprofessional simulation - Minor logistical suggestions	"Simulation should be a part of every major rotation." "Add a trauma or pediatric scenario."

Students strongly supported the continued use and expansion of SBME. Suggested improvements included adding trauma or pediatric cases and incorporating interprofessional elements. Criticisms were rare and mainly related to session timing. Overall, feedback confirmed SBME as a highly effective and well-received element of the emergency medicine clerkship. The alignment between student-reported gains and performance outcomes supports its broader use in undergraduate medical education across the Middle East.

Qualitative findings: student perceptions

All students in the simulation cohort provided qualitative feedback regarding their simulation experience, yielding rich insights into their perceptions [Table 4]. Through thematic analysis, we distilled their responses into three major themes, with several subthemes, as described below. Overall, students' comments were overwhelmingly positive about the simulation-based education, highlighting its value in the clerkship.

Theme 1: enhanced clinical preparedness and confidence

A dominant sentiment was that simulation training made students feel more prepared and confident to handle real emergency situations. Nearly every student mentioned this benefit in some form. They reported that managing acute scenarios in simulation improved their clinical reasoning and decision-making skills under pressure. For example, one student wrote, *"After practicing a cardiac arrest in sim, I felt far more confident about running a code on the hospital floor."* Students described gaining a better grasp of emergency algorithms (like ACLS protocols) and feeling more capable of performing critical interventions (airway management, defibrillation, etc.) as a result of the simulations. This boost in confidence was not only in technical skills but also in communication and teamwork. Several comments noted that working through scenarios with peers and faculty feedback helped them learn how to communicate in emergencies and coordinate as a team. Students appreciated that the simulations created a safe space to make mistakes and learn from them, which in turn reduced their anxiety

about encountering similar cases in real life. By the end of the clerkship, many stated they felt significantly less apprehensive and more "practice-ready" for internship, attributing this to the simulation experience.

Theme 2: active learning through realism and engagement

Students highly valued the realism of the simulation scenarios and the active learning format. Participants reported that the use of high-fidelity manikins, monitor readouts, and case scripts provided an immersive experience. *"It felt like a real resuscitation, which made the learning stick,"* commented one student. This experiential learning approach contrasted with traditional lectures or reading; students noted that by actively *doing* the procedures and managing the case themselves, they understood and retained the material better. Many described the simulation sessions as the highlight of the clerkship that kept them engaged. They also appreciated the immediate debrief and feedback, which helped them reflect on what went well or what they missed. For instance, a student mentioned that after a simulation case of sepsis management, the instructor's feedback on timely antibiotic administration and fluid resuscitation clarified key concepts that were previously confusing. The combination of visual, auditory, and kinesthetic learning in simulation was cited as beneficial for different learning styles. Moreover, the real-time stress in simulations (alarms sounding, patient actor in distress) taught them to keep calm and think critically, an experience they found invaluable and somewhat difficult to get from routine clinical shifts where students often observe more than act. Some did note that initially the realism induced anxiety – *"I was nervous when the manikin was 'crashing'"* – but they quickly learned to channel that stress constructively. Overall, this theme underscores that the authenticity and interactive nature of simulation made learning more effective and enjoyable for the students.

Theme 3: positive feedback and recommendations for curriculum

The third theme encompasses the strong positive feedback students gave about the simulation component, along with constructive suggestions. Universally, students endorsed the integration of simulation into the clerkship, with many stating that it should be continued and even expanded. *"Simulation should be a part of every major rotation,"* one student opined, reflecting a view that this teaching method was among the most beneficial in their medical education. Students recommended increasing the number of simulation sessions, citing that more exposure would reinforce skills further. A few suggested diversifying the scenarios (for example, adding a trauma case or pediatric emergency if not already included) to cover a broader range of emergencies. Another common suggestion was to incorporate interprofessional elements – e.g., involve nursing students or residents in the scenarios – to mimic real ER team dynamics, aligning with the growing interest in interprofessional simulation-based education.

There were relatively few criticisms. A minority of students (approximately 3–4 comments) felt that the scheduling of simulations could be optimized; for instance, one student noted that having a simulation session on the first day was overwhelming, and they would have preferred an introductory period before jumping into scenarios. Another student mentioned that *"the simulation lab environment is great, but it still can't 100% replicate the chaos of the real ER,"* acknowledging a limitation of simulation fidelity. These comments echo known challenges in simulation-based learning (such as maintaining suspension of disbelief and emotional stress). Importantly, no students indicated that the simulation was a waste of time or detracted from other learning — on the contrary, even those who experienced stress ultimately viewed it as a beneficial challenge.

In summary, the qualitative feedback indicates that students perceived simulation-based education as highly beneficial, citing improved preparedness and engagement, and recommending its expansion. This positive subjective experience, combined with the finding that SBME did not compromise academic performance (as scores were equivalent to the LBE cohort), supports its value as an engaging educational complement that fulfills distinct learning objectives not fully captured by traditional assessments.

Discussion

This study compared the effectiveness of simulation-based medical education (SBME) and lecture-based education (LBE) in preparing final-year medical students during their emergency medicine (EM) clerkship at Qatar University. While quantitative analysis revealed no statistically significant differences in multiple-choice question (MCQ) or objective structured clinical examination (OSCE) scores between the LBE (2022) and SBME (2024) cohorts, the qualitative data provided important insights into students' learning experiences. Students in the SBME cohort consistently reported enhanced clinical preparedness, improved teamwork, and greater confidence—highlighting the unique educational value of simulation-based learning, particularly in high-stakes fields like EM. While we acknowledge the limitation of not having comparative qualitative data from the LBE cohort, the specific nature of the feedback—centering on the immersive, hands-on practice of managing acute crises in a safe environment—strongly suggests these perceived benefits are directly attributable to the simulation modality itself, rather than merely the completion of an

EM clerkship. Students explicitly linked their increased confidence to the act of "doing" (e.g., "running a code") in simulation, distinguishing it from the observational or theoretical learning more typical of a traditional rotation.

Null findings in summative assessments are not uncommon in SBME literature and often reflect the difficulty of capturing the full spectrum of clinical competencies through traditional testing formats. Prior studies have also found that while SBME may not consistently improve test scores, it enhances learners' self-efficacy, teamwork, procedural skills, and decision-making under pressure—competencies not easily measured through MCQs or OSCEs alone [8–10]. In our study, the negligible effect sizes for both assessments suggest practical equivalence in cognitive outcomes, supporting the view that SBME complements, rather than replaces, traditional didactic methods.

When considered in a regional context, this study addresses a significant gap. Despite the growing adoption of SBME in GCC medical schools, few published studies have rigorously evaluated its impact on performance outcomes or student perceptions. For example, a study in Saudi Arabia found improvements in student engagement and self-perceived readiness after integrating simulation into clinical clerkships, but no significant differences in exam scores [7]. Similarly, a recent study among nursing students emphasized the value of SBME for experiential learning related to cardiopulmonary resuscitation training program but highlighted challenges related to faculty availability and curricular integration [8]. To our knowledge, this is the first study from Qatar to compare LBE and SBME models within the EM clerkship and triangulate both objective performance and subjective feedback.

Implementing a high-fidelity SBME curriculum requires significant investment in faculty time, specialized equipment, and physical space. In our context, this shift was facilitated by Qatar's strategic investment in healthcare education infrastructure, such as the state-of-the-art clinical skills center used in this study. To manage faculty resources, we leveraged a core group of EM faculty who received dedicated training in simulation facilitation and debriefing. While resource-intensive, the equivalent knowledge acquisition outcomes (as measured by MCQ/OSCE scores) between SBME and LBE suggest that simulation did not come at the cost of core content mastery. This allows educators to frame SBME not as a replacement for knowledge transfer, but as a value-added investment in developing the non-technical, praxis-oriented competencies critical for EM. The challenge remains one of scalability and sustainability, requiring institutional commitment to ongoing faculty development and resource allocation.

Cultural and institutional factors also play a role in how SBME is implemented and perceived particularly in the Middle East [9, 10]. Qatar's evolving healthcare education system has seen rapid growth in infrastructure—such as simulation centers—but faces ongoing challenges in faculty training, resource allocation, and curricular alignment. In addition, medical students in Qatar often come from diverse educational and cultural backgrounds, which may influence their comfort with active learning, teamwork, and assertive communication during simulation. These contextual factors must be considered when designing and evaluating SBME programs to ensure relevance and effectiveness across varied learner profiles [10].

Beyond general resource considerations, implementing SBME in Qatar presented unique contextual challenges and opportunities. The rapid development of the medical education ecosystem meant faculty had varying levels of prior simulation experience, necessitating a significant upfront investment in facilitator training to ensure debriefing quality and consistency. Furthermore, the diverse, multinational student body—with varied levels of prior exposure to active, team-based learning—required careful facilitation to ensure all students felt comfortable participating in high-stakes scenarios. However, Qatar's compact, well-resourced academic medical center environment also provided a unique advantage: the close integration between the university and the major hospital system (Hamad Medical Corporation) allowed for seamless alignment of simulation scenarios with real-world clinical practices and priorities seen in the local ED, enhancing the perceived relevance and authenticity of the training for students.

Students in this study expressed strong appreciation for the practical, immersive nature of simulations—particularly the opportunity to rehearse emergency procedures in a low-risk environment. These findings echo global evidence that high-fidelity simulations improve confidence and procedural readiness in EM training [8–10]. However, the perceived benefits were tempered by common challenges, such as insufficient practice time and difficulty transferring simulated skills to real clinical settings. Students called for more frequent, longer simulations to reinforce skills and enhance realism. These concerns are consistent with prior studies, which suggest that sustained exposure to diverse clinical scenarios in simulation is necessary for long-term retention and transferability [11–13].

SBME also demonstrated unique value in promoting critical thinking and real-time decision-making. The structured yet unpredictable nature of EM scenarios requires rapid prioritization, situational awareness, and adaptability. While students noted that existing scenarios enhanced these skills, some also pointed to the scripted

nature of cases and the mechanical limitations of mannequins as detracting from realism. Several recommended more open-ended, unscripted simulations that mirror the ambiguity and pressure of actual clinical encounters. Integrating adaptive simulation technologies or branching scenarios that evolve based on student decisions could further improve engagement and critical reasoning [14, 15].

Teamwork and communication—key competencies in EM—were also reported to improve through SBME. Students valued the opportunity to practice coordinated responses under pressure, develop clarity in verbal exchanges, and observe team dynamics. These findings reinforce the view that SBME creates a psychologically safe space to experiment with leadership and delegation, essential for managing medical crises [16, 17]. However, issues such as unequal participation and limited leadership training were also noted. Embedding formal leadership roles and rotating responsibilities during simulations may help ensure all students benefit from team-based learning opportunities [18].

Feedback emerged as one of the most influential components of the SBME experience. Students consistently highlighted the importance of immediate, specific debriefing in helping them reflect on their actions, identify errors, and plan for improvement [19]. However, variability in faculty availability and feedback quality was a recurrent concern. These challenges are not unique to this setting—Middle Eastern studies have also identified faculty workload and inconsistent debriefing practices as barriers to high-quality simulation instruction [20]. Addressing this requires not only increasing trained faculty presence but also developing standardized feedback frameworks and investing in faculty development to ensure consistency and depth in learner support [20].

In summary, while SBME and LBE produced similar academic outcomes in this study, the immersive, student-centered design of simulation-based learning clearly contributed to richer clinical skill development and greater learner engagement. These findings support the integration of SBME as a complementary pedagogical tool in EM education in Qatar and across the GCC, particularly for fostering non-cognitive competencies that are critical for clinical readiness.

Limitations and implications for medical education

This study has several limitations that should be acknowledged. First, the cohorts were not randomly assigned to the lecture-based education (LBE) or simulation-based education (SBME) conditions, which introduces the possibility of selection bias and limits the strength of causal inferences. As a quasi-experimental design, the study lacked the randomization typical of controlled trials, thereby reducing the robustness of the effect estimates.

Second, assessment of student performance occurred immediately after the clerkship, without any follow-up to evaluate long-term knowledge retention or clinical skill transfer. The absence of longitudinal data limits our understanding of how sustained the benefits of simulation-based education may be over time.

Third, while the study included all eligible final-year emergency medicine students during the two academic years, the overall sample size was modest and determined by cohort enrollment. A formal power calculation was not conducted, and as such, the study may have been underpowered to detect smaller but educationally meaningful differences between groups.

Fourth, qualitative feedback was obtained only from the 2024 SBME cohort and on a voluntary basis, which may introduce response bias. Those with strong positive or negative experiences may have been more inclined to participate. Additionally, the potential **Hawthorne effect**—whereby participants alter their behavior or responses because they are aware of being studied—may have influenced the nature of the qualitative feedback. The lack of similar qualitative data from the 2022 LBE cohort precludes a comparative analysis of student perceptions across the two instructional modalities.

Finally, the study was conducted at a single institution in Qatar, which may limit the generalizability of findings to other educational contexts. Cultural norms, faculty expertise, and resource availability can influence how simulation is implemented and perceived.

Despite these limitations, this study contributes important insights into the ongoing discourse on best practices in medical education, particularly in the Middle East, where empirical evaluations of simulation-based learning remain limited. The findings emphasize the unique strengths of simulation-based education in cultivating non-technical competencies—such as critical thinking, communication, teamwork, and leadership—that are essential for emergency medicine practice but often underdeveloped in traditional lecture-based formats.

The lack of a statistically significant difference in examination performance between SBME and LBE cohorts should not be interpreted as evidence of equivalence alone; rather, it underscores the complexity of measuring educational effectiveness through standardized assessments. Student feedback clearly highlighted the added value of simulation in boosting clinical confidence and readiness for real-world scenarios—outcomes that may not be fully captured by MCQs or OSCE scores.

To maximize the benefits of simulation-based learning, future educational strategies should focus on extending practice time, diversifying and increasing the realism of clinical scenarios, improving faculty availability and the quality of feedback, and promoting inclusive, team-based learning environments. Incorporating these refinements

will help optimize simulation programs and ensure students are better prepared for the realities of emergency care.

Conclusions

This study demonstrates that simulation-based medical education (SBME) is a valuable complement to emergency medicine clerkship training in Qatar. The study also highlights that successful implementation in similar contexts requires strategic planning to address resource intensity and faculty development needs. Future work should explore hybrid models that optimize the cost-benefit ratio of SBME and investigate its long-term impact on clinical performance. While no statistically significant differences were found in traditional assessment scores between lecture-based and simulation-based cohorts, qualitative findings highlight SBME's unique role in strengthening clinical and non-technical skills. Students reported greater confidence, improved critical thinking, and enhanced teamwork—core competencies essential in high-pressure emergency settings and often underemphasized in lecture-based formats.

These findings suggest that SBME enriches the educational experience by bridging the gap between theory and practice. To maximize its impact, future initiatives should address challenges such as limited practice time and scenario realism, while enhancing faculty feedback. Refining simulation delivery can further improve student preparedness and promote more effective, practice-ready clinical training.

Appendix A

Questionnaire survey on the effectiveness of simulation-based learning in the emergency medicine clerkship

Legend

This survey assessed students' perceptions of simulation-based medical education (SBME) and its impact on their academic performance, learning experiences, and confidence in applying skills to real-world emergency scenarios. It included demographic questions, Likert-scale items comparing SBME to traditional lectures, and open-ended questions exploring the most beneficial aspects and challenges of SBL. Responses were collected from 96 students in the 2024 cohort, and qualitative feedback was categorized into common themes for further analysis.

Introduction to participants

Thank you for participating in our study to evaluate the effectiveness of simulation-based learning (SBL) in the Emergency Medicine Clerkship. Your feedback is invaluable in understanding the impact of SBL on your learning experience and academic performance. This survey should take approximately 10 min to complete.

Confidentiality notice

Your responses will be kept confidential and will only be used for research purposes.

Section 1: Demographic Information.

1. Age (years).
2. Gender.

- Male.
- Female.

Section 2: Academic Performance.

4. How would you rate your overall academic performance in the Emergency Medicine Clerkship?

- Poor.
- Below Average.
- Average.
- Above Average.
- Outstanding.

5. SBL has had a positive impact on my grades?

- Strongly agree.
- Agree.
- Unsure.
- Disagree.
- Strongly disagree.

Section 3: Experience with Simulation-Based Learning.

6. How engaging did you find the SBL sessions compared to traditional lectures?

- Much less engaging.
- Less engaging.
- About the same.
- More engaging.
- Much more engaging.

7. How effectively do you think SBL sessions enhanced your understanding of emergency medicine concepts?

- Very ineffective.
- Ineffective.
- Unsure.
- Effective.
- Very effective.

8. How confident do you feel in applying the skills learned in SBL to real-world scenarios?

- Totally not confident.
- Not confident.
- Unsure.
- Confident.
- Very confident.

9. Please rate the quality of the instruction and feedback provided during SBL sessions.

- Very poor.
- Poor.
- Unsure.
- Good.
- Very good.

10. What aspects of SBL did you find most beneficial for your learning? [Free text]
11. Were there any challenges or limitations you experienced in SBL sessions? If so, please describe. [Free text]

Section 4: Overall Satisfaction and Feedback.

12. Overall, how satisfied are you with the inclusion of SBL in the Emergency Medicine Clerkship?

- Very dissatisfied.
- Dissatisfied.
- Neutral.
- Satisfied.
- Very satisfied.

13. Would you recommend continuing the use of SBL in this clerkship for future students?

- Yes.
- No.

14. I recommend continuing the use of SBL in this clerkship for future students.

- Strongly agree.
- Agree.
- Unsure.
- Disagree.
- Strongly disagree.

15. Additional comments or suggestions to improve the SBL experience: [Free text]

Author contributions
KB: Conceptualization, Methodology, Formal Analysis, Writing – Original Draft, Project Administration AU: Data Curation, Investigation, Resources, Writing – Review & Editing AE: Validation, Visualization, Software (Statistical Analysis), Writing – Review & Editing SB: Literature review, critical review and manuscript writing AY: Methodology, Investigation, Formal Analysis, Writing – Review & Editing.

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Data availability
The datasets used and analyzed during this study are available upon reasonable request. Researchers interested in accessing the data may contact the corresponding author. Access will be granted in compliance with relevant ethical guidelines to ensure the confidentiality and protection of participant information.

Declarations

Ethical approval & IRB Declaration
This study was reviewed and deemed Exempt under Category 3 of the Qatar Ministry of Public Health (MOPH) guidelines, which applies to research using existing, anonymized educational data. Formal approval was obtained from both: Qatar University Institutional Review Board (QU-IRB Reference: 1732436-2). Hamad Medical Corporation IRB (HMC-IRB Reference: MRC-01-24-715)

Human ethics & consent to participate
Not applicable for exam performance data (retrospective, anonymized academic records). Implied consent was obtained for voluntary feedback surveys (Survey participants received written information about the study's purpose and their rights to withdraw, submission indicated participation agreement).

Consent to publish
Not applicable (no identifiable personal data included in results or publication).

Compliance
The study adhered to institutional policies and the Declaration of Helsinki. Minimal risk was confirmed by both IRBs, and no written consent was required for de-identified data analysis.

Competing interests
The authors declare no competing interests.

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