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Integrating Simulation- Based Learning in Clinical Skills Training: Impact on Medical Student Competency

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ABSTRACT

Background: Simulation-based learning (SBL) is a new and innovative approach that improves the clinical skills of medical students by allowing standardized training and immediate feedback in comparison to existing methods. The purpose of this study was to determine the effect of the SBL on the competency of medical students in the core clinical skills.

Methods: This collaborative study was a randomized controlled study carried out between September and December 2024 at Superior University and involved a sample of 120 third-year medical students. The sample was chosen through a non-probability consecutive sampling method and randomly divided into two groups. Group A had conventional clinical training, whereas Group B had simulation-based activities, whereby included the use of objective structured clinical examination (OSCE) -based scenarios, high-fidelity manikins, and standardized patients. OSCE score and self-reported confidence surveys were included as pre- and post-intervention assessments. Statistical analysis was done on SPSS version 26.0 (IBM Corp., Armonk, NY).

Results: The OSCE scores that were calculated post-intervention were much better in Group B than in Group A ($p = 0.002$), with statistically significant tests reporting that improvement was most notable in terms of procedural and communicative error avoidance set. The level of group B confidence in history taking ($p = 0.001$), physical examination ($p = 0.002$), communication ($p = 0.001$), and procedural skills ($p = 0.001$) was also significantly higher.

Conclusion: Simulation-based learning proved to be effective in improving objective clinical performances as well as the self-perceived performance among medical students.

Keywords: Simulation Training, Clinical Competence, Medical Education, Teaching Methods, Patient Simulation, Educational Measurement.

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INTRODUCTION

risk-free experience simulating real clinical situations [1]. Simulation, in contrast to traditional bedside learning, permits repetition of practice, immediate feedback, and a standardized exposure to clinical conditions, which are not usually present during the clinical rotations [2]. It is especially useful in the development of psychomotor skills, communication, clinical reasoning and decision-making abilities core competencies within the current medical curricula [3].

Several simulation modalities (high-fidelity mannequins, virtual reality systems and standardized patients) have been introduced into the undergraduate medical education within the past decade with encouraging results [4]. Research has identified better scores in Objective Structured Clinical Examination (OSCE), decreased anxiety and student confidence with interventions of simulations [5]. In addition, it has been noted that incorporating simulation in competency-based education models has resonated well with the moves towards the global production of safer, competent graduates [6].

Although its effectiveness has been demonstrated, in a large number of the low- and middle-income countries, access to structured simulation is still limited by financial and infrastructural limitations [7]. Moreover, comparative evidence between SBL and traditional instructional practices, especially when it comes to the objective clinical expertise and self-evaluation, is yet to be developed [8]. The effects of simulation that can be measured when implemented as part of an existing clinical skills training program are therefore required to be investigated [9].

The purpose of this study is to determine the impact of incorporating a structured simulation-based learning module to the third-year undergraduate clinical skills training course on the competency of medical students as determined by OSCE performance and self-reported confidence using a comparison with conventional teaching. The aim is to present evidence on educational worth of simulation in impoverished academic environments.

METHODS

This collaborative study was a randomized controlled study carried out between September and December 2024 at Superior University and that involved a sample of 120 third-year medical students (Ref: RS/3508). The OpenEpi version 3.0.0 (Atlanta, GA, USA) was used to calculate the sample size based on the prior studies that showed moderate effect size of simulation on performance of OSCE. The sample consisted of 120 third year MBBS students who were enrolled using non-probability consecutive sampling. Randomization was done by sealed envelope method, wherein the subjects were divided into two groups (Group A: Conventional Clinical Skills Training n=60) and Group B: Simulation Based Training n=60).

The inclusion criteria were third year undergraduate students in medicine with completed basic science modules about to start their clinical rotations. Students who had previous formal training in simulation or failure to take part and those who had to repeat the year were excluded.

All the participants signed written informed consent. Group A was taught by the routine methods of instructions such as lectures, bedside clinical exposure, and physical examination on fellow students. The modules that were provided to the group B included structured simulation-based modules that consisted of high-fidelity mannequins, standardized patients, and the OSCE scenario-based simulation modules. Both groups were equally exposed to the same material with regard to clinically taught skills (history-taking, examination, communication, and procedural techniques).

They were both evaluated at baseline and post-intervention assessment on a set of an Objective Structured Clinical Examination (OSCE) checklist rated by blinded assessors. A validated Likert-scale questionnaire of self-reported confidence was therefore used. A pre-designed performa was used to record all the data obtained.

The statistical values were evaluated with the SPSS version 26.0 (IBM Corp., Armonk, NY). The qualitative data are expressed by frequencies and percentages. The quantitative variables were given as the mean value with standard deviation. Chi-square tests and independent t-tests were used and $p < 0.05$ was regarded as statistical significant.

RESULTS

A total of 120 medical students were involved in the study and were randomly selected into the two equal groups, where 60 students were given Conventional Training (Group A) and 60 students were exposed to Simulation-Based Learning (Group B). The mean age of participants was 21.7 ± 1.2 years with an age range of 20 to 26 years. Altogether, there were 66 (55%) females and 54 (45%) males.

Table 1: Baseline Characteristics of Study Participants (n = 120)

Variable	Group A (Conventional) *n = 60*	Group B (Simulation-Based) *n = 60*	p-value
Age (years, mean ± SD)	21.7 ± 1.1	21.6 ± 1.2	0.67
Gender			
Male	28 (46.7%)	26 (43.3%)	0.71
Female	32 (53.3%)	34 (56.7%)	
Previous OSCE Attempts	1.1 ± 0.3	1.0 ± 0.4	0.34

Baseline OSCE Score	56.3 ± 5.2	56.6 ± 5.5	0.78
Baseline Confidence Score	3.0 ± 0.6	3.1 ± 0.5	0.42

χ^2: Chi-square test; $p<0.05$ was considered statistically significant

Table 1 gives the demographic and academic baseline characteristics of the two groups. Statistical analysis was done on continuous variables by independent samples t-test and on categorical variables by chi-square tests. Demographic and academic comparability was found at baseline as there were no statistically significant differences between the groups regarding age (p = 0.67), gender distribution (p = 0.71), baseline scores OSCE (p = 0.78), previous OSCE attempts (p = 0.34), and baseline levels of confidence (p = 0.42). These findings suggest that there was no selection bias since the baseline characteristics of the two groups were well balanced.

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Table 2: Post-Intervention OSCE Scores across Clinical Domains

Clinical Skill Domain	Group A (Conventional) *Mean ± SD*	Group B (Simulation-Based) *Mean ± SD*	p-value
History Taking	62.8 ± 5.4	70.1 ± 4.6	0.001
Physical Examination	64.2 ± 6.1	72.3 ± 5.3	0.002
Communication Skills	60.3 ± 5.9	69.5 ± 5.0	0.001
Procedural Skills	58.7 ± 6.2	67.4 ± 5.7	0.003
Overall OSCE Score	61.5 ± 5.6	70.1 ± 4.9	0.001

P<0.05 was found statistically significant

Table 2 shows the post-intervention OSCE scores in both groups in the different clinical areas. Group B (simulation-based training) demonstrated a better performance in all of the domains that were assessed compared with Group A (conventional training). The overall OSCE mean score was 70.1± 4.9 in Group B, which is significantly higher than the 61.5 ±5.6 in Group A (p = 0.001). The greatest discrepancy was observed in procedural skills (67.4 ± 5.7 vs. 58.7 ± 6.2; p = 0.003), followed by communication skills (69.5 ± 5.0 vs. 60.3 ± 5.9; p =0.001); The scores of the history taking and physical examination also showed statistically significant differences ($p<0.05$) highlighting the overall efficacy of simulation-based procedures. This implies that simulation training proves more effective in improving clinical performance in all domains of OSCE.

Table 3: Change in Self-Reported Confidence Pre- and Post-Intervention

Domain	Group A Pre	Group A Post	Group B Pre	Group B Post	p-value (Post)
History Taking	3.0 ± 0.6	3.3 ± 0.7	3.1 ± 0.5	4.0 ± 0.6	0.001
Physical Examination	2.9 ± 0.7	3.2 ± 0.6	3.0 ± 0.6	3.9 ± 0.5	0.002
Communication	2.8 ± 0.8	3.1 ± 0.7	2.9 ± 0.6	3.8 ± 0.5	0.001
Procedural Skills	2.7 ± 0.7	3.0 ± 0.6	2.8 ± 0.7	3.7 ± 0.5	0.001

Table 3 gives the differences in the scores of self-reported confidence before and after the intervention in the four clinical domains. Group B (simulation-based training) alleviated the post-intervention scores significantly more than Group A (conventional training) in all of the domains that were tested. The most significant increase was recorded in history taking (Group B: 4.0 ± 0.6 vs. Group A: 3.3 ± 0.7; $p = 0.001$ populations) followed by communication (3.8 ± 0.5 vs. 3.1 ± 0.7; $p = 0.001$ populations) and procedural skills (3.7 ± 0.5 vs. 3.0 ± 0.6). Independent t-tests were used to find all comparisons to be statistically significant ($p < 0.05$).

The simulation-based education proved to have a significant effect on improving the individual confidence in all areas of clinical skills, including history taking and procedural performance.

DISCUSSION

This research investigated the comparison of the simulation-based training with the practice of conventional teaching methods in developing clinical competence and confidence in medical students. The findings revealed that though both groups have experienced an improvement after the intervention, the simulation-based group had a substantial rise in their OSCE performance and self-rated confidence in core clinical areas. Remarkably, Group B scored higher in overall OSCE compared to Group A, as well as showed a change towards competence in procedural skills, communication and physical examination skills. These results indicate that undergraduate medical education including simulation-based strategies can stimulate the learning and use of practical clinical skills and competencies.

These results are consistent with the previous findings indicating the usefulness of simulation in reducing the knowledge-practice gap between theoretical and real-life clinical work [10,11]. Previous investigations have pointed out that simulation can enhance other aspects, besides psychomotor, such as enhanced retention of procedural techniques and confidence in the learner during high-stakes clinical conditions [12]. Especially in areas where real time feedback and repetitions are of utmost importance like in history taking, procedural skills and communication, simulation allows students to make mistakes under no risk to the patient [13,14]. Within this controlled environment, it is possible

to master core competencies that are necessary to exercise patient-centered care besides fostering the decision-making, teamwork, and critical thinking [15].

Simulation-based training is an instructional approach that resolves various deficiencies of conventional training [16]. Traditional bedside education is neither standardized nor determined by the availability of patients and can place students under the influence of inconsistent teaching [17,18]. Simulation, conversely, provides an equal clinical exposure, timely feedback and a chance of deliberate practice, which is essential in delivery of competency-based learning outcomes [19]. Moreover, it can be of specific value in the low-resource regions where clinical experiences are scarce, and there is a proliferation of medical schools [20]. A scalable educational tool is provided by the reproducibility and comparability of the learning outcomes regarding the low- to high-fidelity manikins and structured scenarios usage [21].

Simulation effectiveness can be elaborated upon using various theories of adult learning which highlights the importance of experiential learning, reflection, and self-controlled feedback [22]. Its use in learning allows active learning which is an essential part of adult education and has been linked to enhanced long term performance [23,24]. In the given work, the significant increase in self-rated confidence as well as improvement of the procedural and communication skills indicate the psychological safety and the learner-focused environment of simulation-based settings [25].

Nevertheless, a number of shortcomings have to be mentioned. It was a single-center study, that is, there was a small sample size which can be a limitation to the generalizability of findings. In addition, long-term retention of clinical competence was not evaluated as the follow-up was rather short. Self-reports of confidence used in the study can also create a bias in responses. Future multi-institutional randomized studies with long follow-up are required to confirm the effects of simulation on clinical outcomes and cost-effectiveness relative to standard modes[21,22]. In spite of these shortcomings, results support the increased adoption of simulation into undergraduate programs, including training students in clinical rotation and high-stakes exams like the OSCE. Simulation is an innovative intervention in teaching that supplements the conventional learning experience and fills the existing competency-based medical education gaps.

CONCLUSION

The evidence, all altogether, is early, but it suggests that simulation-based training is an informative addition to conventional approaches of enriching clinical competence in medical education. During the intervention period, history taking, physical examination, communication, and procedural skills were advanced significantly and especially among those participants who took part in the simulation-

based group. These data indicate that the modality of experiential, interactive learning is associated with increased clinical readiness and self-confidence in core competencies. Notwithstanding the promising results, the larger multicentered research based on objective evaluation of the performance is necessary to make simulation-based education a regular part of clinical training during undergraduate studies.

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CONFLICT OF INTEREST

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ETHICAL APPROVAL

This collaborative study was a randomized controlled study carried out between September and December 2024 at Superior University and that involved a sample of 120 third-year medical students (Ref: RS/3508).

AUTHORS' CONTRIBUTION

All authors contributed equally as per ICMJE

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