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Research Article

EVALUATING THE IMPACT OF HYBRID SIMULATION IN ENHANCING THE LEARNING DOMAINS OF MEDICAL UNDERGRADUATES: A QUASI-EXPERIMENTAL STUDY

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ABSTRACT

Objective: Medical education, crucial for understanding physiological processes and clinical application, faces limitations in traditional methods. Simulation-based training addresses this gap, providing a secure environment for hands-on skill practice. The objectives of the study are to (1) evaluate the impact of simulation on enhancing the learning domains of medical undergraduates and (2) gauge students' perceptions of simulation based medical education (SBME) through a pre-validated, pre-designed questionnaire.

Methods: A quasi-experimental study, involving 60 medical undergraduates, selected by convenient sampling. The study began after obtaining approval from the Institutional Human Ethics Committee and obtaining informed consent from students. A pre-test was conducted for all 60 students followed by a lecture on simulation and then a post-test. The students were then divided into two groups: Group A – SBME using part-task trainers and standardized patients and Group B – (non-SBME) with video lectures on simulation. After 1 month, an assessment of all domains, namely cognitive, affective, and psychomotor, was done by post-test and objective structured clinical examination, respectively. Perception was obtained using the pre-validated questionnaire.

Results: The assessment scores of all domains of Group A (SBME) showed significant improvement $p<0.05$ except cognitive domain.

Conclusion: SBME is an effective teaching method for improving the learning domains of medical undergraduates.

Keywords: Hybrid simulation, Learning domain, Medical undergraduate, Perception.

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INTRODUCTION

Medical education is a complex and dynamic field that requires a thorough understanding of physiological and pathological processes, as well as the ability to apply this knowledge to real-life clinical scenarios. Traditional teaching methods have limitations in providing hands-on experience and preparing students for the challenges of clinical practice. Simulation-based training has emerged as a promising approach to bridge this gap by providing a safe and controlled environment for learners to practice and improve their skills.

Hybrid simulation is a relatively new approach that combines different simulation methods to provide a more realistic representation of clinical scenarios. Hybrid simulation offers the advantages of both high-fidelity simulation, which provides a realistic physical environment, and low-fidelity simulation, which allows for the exploration of complex scenarios and decision-making processes. Hybrid simulation can also integrate virtual and standardized patients (SP), as well as physical equipment, to provide a more immersive and interactive learning experience. It has also been found to have many advantages that can improve patient safety and reduce health-care costs through the improvement of the medical provider's competencies [1].

Simulation-based education (SBE) provides a structured, learner-centered environment in which novice, intermediate, and advanced practitioners can learn or practice skills without causing harm to patients [2]. Medical simulation allows the acquisition of clinical skills through deliberate practice rather than an apprentice style of learning [3].

Rationale: "To Err Is Human," a landmark report released by the Institute of Medicine United States in 1999 [4] estimated that medical errors cause injury to approximately 3% of hospital patients. The promise of simulation-based medical training offers useful opportunities to reduce risks to patients and learners, improve learners' competence and confidence, increase patient safety, and reduce health-care costs in the long run. Several studies have demonstrated the effectiveness of hybrid simulation in improving learner outcomes in medical education. In a randomized controlled trial, Liang *et al.* [5] compared the effectiveness of hybrid simulation versus high-fidelity simulation in improving knowledge retention and confidence in performing lumbar punctures among medical students. The results showed that the hybrid simulation group had higher scores on knowledge retention and confidence compared to the high-fidelity simulation group. Similarly, a systematic review by Fernandez *et al.* [6] found that hybrid simulation was effective in improving learner outcomes in surgical training, emergency medicine, and patient management. In a study by Bui *et al.* [7], medical students who participated in a hybrid simulation-based cardiac arrest training reported higher satisfaction with the training and felt more prepared to manage real-life cardiac arrest scenarios compared to those who received traditional training. Despite the potential benefits of hybrid simulation, there are also challenges and limitations to its implementation in medical education. A study by Zigmont *et al.* [8] identified the need for adequate resources, faculty training, and standardized assessment tools to ensure the success of hybrid simulation programs.

This study aims to highlight the importance of simulation as a new teaching method in undergraduate education and to assess the effectiveness of this approach.

Aims

1. Evaluate the impact of simulation on enhancing the learning domains of medical undergraduates

2. Gauge students' perceptions of simulation-based medical education (SBME) through a pre-validated, pre-designed questionnaire.

Intervention
Video lecture versus simulation.

Outcome measures
Pre-test score and post-test score after the video lecture and after simulation for the cognitive domain.

Affective and psychomotor skill assessment using objective structured clinical examination (OSCE) checklist.

The perception of the students was gauged using a pre-designed pre-validated questionnaire.

METHODS

This quasi-experimental study conducted at a tertiary medical center, involving 2nd-year MBBS students as the subjects. Convenient sampling to utilized to select a sample size of 60 participants who met the inclusion criteria of providing consent for participation. Exclusion criteria included, students who were absent on the days of the study.

The study focused on demographic variables such as age and sex, as well as outcome variables comprising pre-test and post-test scores, along with OSCE checklist scores. Data collection took place from August 20th to September 20th, 2022.

To collect data, pre-test and post-test assessments administered to evaluate students' knowledge levels. In addition, skills were assessed using the OSCE method, utilizing a standardized checklist of basic life support procedures. Furthermore, a pre-validated and pre-designed questionnaire was distributed to gather additional information related to the study variables.

Overall, this methodology aimed to systematically investigate the impact of certain interventions on the knowledge and skills of 2nd-year MBBS students within the specified study duration.

Data collection procedure
The study began after obtaining approval from the Institutional Human Ethics Committee. (Annexure: I). Informed consent was taken from the students for both audio and video recording and its publication (Annexure: II). Pre-test was conducted for all 60 students followed by a lecture on SBME. Post-test-I was conducted for both groups to assess the cognitive domain (Table 1).

The students were then divided into two groups. One group controls and the other group undergoes simulation practices. Group A students underwent training in simulation, which included SP and manikins, and Group B students (control) received video lectures. Post-test-II was conducted for both groups after their sessions either in simulation or video lectures, to assess the cognitive domain. Attitude and psychomotor domain assessment of both groups were done by OSCE using the standard checklist for cardiopulmonary resuscitation (CPR) (Annexure: III). For observing uniformity in assessment, the skill of the students only in CPR was taken for this study. At the end of the study, the perception of the students was obtained using a pre-validated pre-designed questionnaire.

RESULTS

Sixty medical undergraduates participated in the study. For analysis, statistical significance was considered for a confidence interval of 95% or $p<0.05$. The mean scores of the pre-test and post-test were analyzed using a non-parametric test, the Wilcoxon signed-rank test (Table 2).

The post-test score was significant $p<0.0001$ compared to the pre-test score (Fig. 1).

Analysis of the mean of the post-test score of the two groups compared by Mann–Whitney U test. The increase in the cognitive domain in SBME group after the intervention was not significant, p.111 (Fig. 2).

However, after SBE, the post-test score (cognitive domain) increased from 20.11 to 20.88 (intervention group) but for the control group, there was a reduction from 19 to 17.23 (Fig. 3). Psychomotor skill assessment score of both groups analyzed using independent t-test. In the skill assessment between the groups, SBME group showed a significant improvement in the score $p<0.0001$ (Fig. 4). From the perception of the students, 49% had the opinion that simulation supports the development of clinical skills and 40.8% opined simulation-based learning (SBL) should be integrated into the medical education curriculum. However, 32.7% had the opinion that constant usage of SBL will lead to deterioration of communication skills with real patients (Table 3).

Table 1: Flowchart of methodology

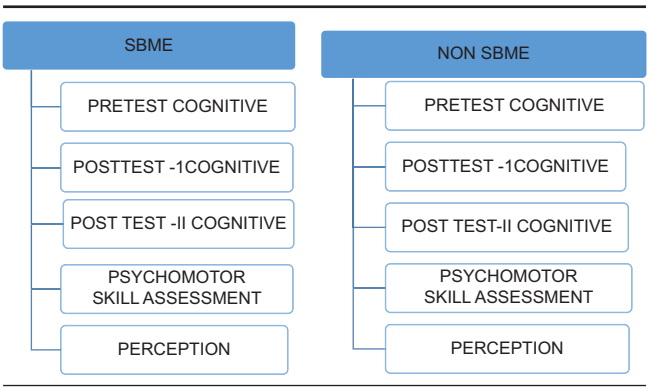

Table 2: Non-parametric tests: Wilcoxon signed-rank test

Scores	n=34
Score pre-test	12.2±4.2
Score pre-test	19.6±6.7
Asymp. Sig. (2-tailed)	p<0.0001

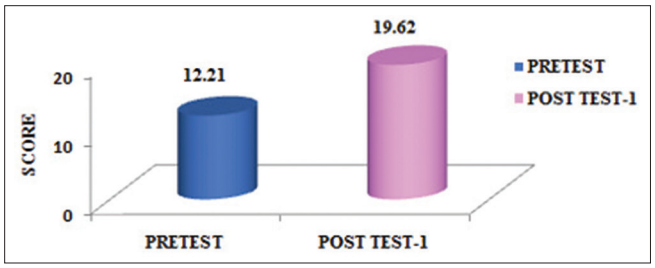

Fig. 1: Comparison of pre- and post-test scores after didactic lecture on simulation

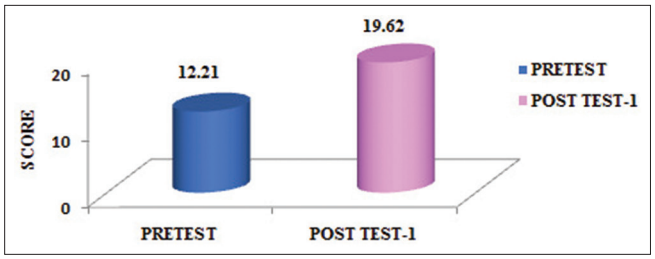

Fig. 2: Pre- and post-test scores after didactic lecture on simulation

Table 3: Perception of students on SBME: 5 point Likert scale

	Statements	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
		1	2	3	4	5
1.	Simulation supports the development of clinical skills	0	0	6 (12.2%)	19 (38.8%)	24 (49%)
2.	Simulation helps to reduce the problem of getting patients during exams	0	0	12 (24.5%)	21 (42.9%)	16 (32.7%)
3.	Constant usage of SBL will lead to deterioration of the communication skill with real patients	1(2%)	3 (6.1%)	12 (24.5%)	17 (34.7%)	16 (32.7%)
4.	SBL(Simulation Based Learning) improves patient's safety	0	2 (4.1%)	14 (28.6%)	17 (34.7%)	16 (32.7%)
5.	SBL should be integrated into the medical education curriculum	0	0	11 (22.4)	18 (36.7%)	20 (40.8%)
6.	Teacher will minimize his/her effort in clinical teaching if SBL becomes a part of the curriculum	3 (6.1%)	9 (18.4%)	18 (36.7%)	12 (24.5%)	7 (14.3%)
7.	More of SBL will minimize the empathy towards patients	7 (14%)	7 (14.3%)	17 (34.7%)	12 (24.5%)	6 (12.2%)
8.	SBL is relatively costly than employing a trained resource person for training	1 (2%)	5 (10.2%)	25 (51%)	11 (22.4%)	7 (14.3%)
9.	SBL minimizes the stressful learning environment usually seen in wards	0	4 (8.2%)	15 (30.6%)	19 (38.8%)	11 (22.4%)
10.	SBL will help to see and manage even rarest of cases in medicine	6 (12.2%)	4 (8.2%)	10 (20.4%)	18 (36.7%)	11 (22.4%)

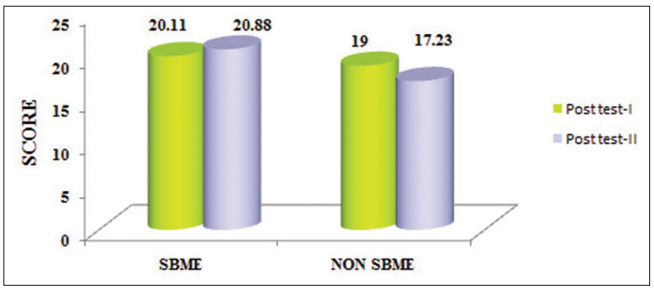

Fig. 3: Cognitive domain post-test I and II comparison of simulation-based medical education and Non-simulation-based medical education

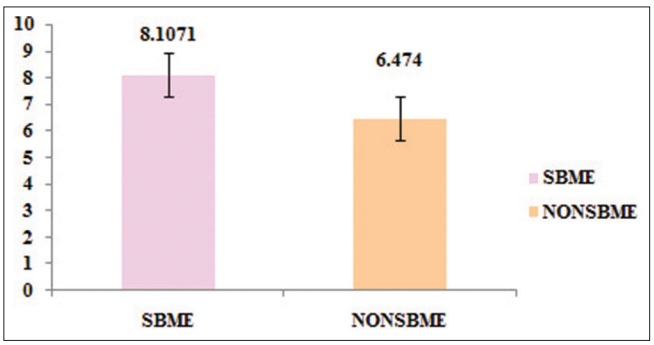

Fig. 4: Psychomotor skill assessment score p<0.0001

Non-parametric tests were used in all analyses as the values did not follow normal distribution. Normality tests were done using SPSS using the tests Kolmogorov–Smirnov and Shapiro–Wilk.

DISCUSSION

Hybrid simulation can be as effective as high-fidelity simulators in certain training scenarios [9]. According to Scalese *et al*. [10], SBE allows trainees to hone their skills in a risk-free environment. Large-scale, multiple-modality, hybrid simulation during medical student field training by Goolsby and Deering [11] is an achievable educational model with positive learning outcomes and student satisfaction. The findings of the study by Oh *et al.* [12] suggest that simulation-based learning using SPs might have a positive impact on self-efficacy and learning motivation that affects knowledge and clinical skill acquisition. In our study, improvement in cognitive domain was not significant. However, when the post-test scores (cognitive) of Group A after the hybrid simulation were analyzed, apparent improvement in the cognitive

Fig. 5: Cardiopulmonary resuscitation using manikin

Fig. 6: Standardised patient – enacting Respiratory arrest

domain was shown after the hybrid simulation. However, on statistical analysis by Mann–Whitney U test, it was found to be insignificant p=0.917.

Some studies done elsewhere suggest that simulation-based learning is effective in enhancing affective learning, improving self-assessment abilities, and promoting students' achievement outcomes [13-16]. Hybrid simulation has been shown to improve psychomotor domain skills in medical students during emergency medicine clerkship [17,18]. There are studies which suggest that simulation-based learning is effective in improving psychomotor skills, decreasing anxiety, and increasing self-efficacy and learning motivation in various educational

Fig. 7: Standardised patient (SP) and Confederate. Confederate is enacting role of husband of SP

settings [19]. A hybrid model for teaching pediatric and gynecology examination is feasible and greatly accepted by the trainees. Such a model of training can improve trainees' skills. It could be potentially used in teaching more difficult procedures [20].

Our study also confirmed the improvement in psychomotor skills of the students when the hybrid simulation was used for learning (Figs. 5-7).

Simulation-based learning helped in the development of clinical skills, even SBL minimized the stressful learning environment and improved the confidence of the students in acquiring better psychomotor skills. This innovative approach has notably heightened the affective and psychomotor competencies of aspiring medical students. Proficiency in psychomotor skills is particularly vital for primary care physicians who serve as the initial point of contact for patients seeking medical assistance.

Limitation

- Period of the present study was shorter: If simulation-based learning is integrated into the medical education curriculum, the outcome will be better
- Initial investment for acquiring manikins is on the higher side but there will be a notable impact on skill development in the long run
- It takes much time for giving simulation training to each student. Furthermore, training a person to function as a SP also will take time in the early stages. If there is an increase in the faculty strength, this also can be overcome.

CONCLUSION

SBME is an effective teaching method for improving the learning domains of medical undergraduates, especially the affective and psychomotor skills.

ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee, Karuna Medical College, Palakkad, Kerala, India (IHEC No. KMCH/IHEC/11/2022).

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AUTHORS' CONTRIBUTION

Regina Roy contributed to the conceptualization, methodology, formal analysis of the data, validation of the study and writing of the original draft. Indla Ravi contributed to the data collection, supervision, review, and editing of the manuscript. Thangam C. contributed to the data collection and supervision. All authors have read and agreed to the final version of the manuscript.

CONFLICT OF INTEREST

None declared.

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