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Early Clinical Simulation Exposure may Enhances Academic Performance of Medical Students: A Quasi-Experimental Study in Saudi Arabia

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Abstract

Objective: The traditional medical curriculum in Saudi Arabia needs to undergo major reforms to make it more student-centric, relevant, interesting and contemporary. This unmet need can be fulfilled by the use of "Early Clinical Exposure" (ECE) techniques, employed via simulation based medical education (SBME) courses, integrated into the medical curriculum. This study delivered ECE via SBME, to third year pre-clinical students, and assessed its impact on their fourth-year academic scores.

Methods: SBME modules designed by expert faculty members were delivered through a peer-assisted learning model, spread over a three-week period, at a well-equipped medical simulation laboratory at our teaching hospital, in Jeddah, Saudi Arabia. Students who attended this SBME intervention were tracked for their performance in their fourth year, versus the control group.

Results: Of the 401 third year students included in the study, only 30.2% consented to attend the SBME course, while 69.8% comprised the control group. The overall study population obtained a mean score of 40.27 in the fourth-year final examination. The male and female students who attended the SBME module obtained a statistically significantly higher mean score versus the non-attendees ($P = 0.0018$). Among the SBME course attendees, no statistically significant difference was noted between the scores of males and females ($P = 0.187$).

Conclusion: SBME exposure during the pre-clinical years has a significantly positive impact on the performance of students, in the core clinical years at medical college. It holds promise in reducing redundancies in medical education, making medical studies more interesting, relevant, contemporary and practical. It facilitates seamless transition of students from pre-clinical to clinical years in medical college. Implementation of early SBME courses at the pre-clinical level, mandated and supported by government initiatives, would be a huge step forward in the medical education in Saudi Arabia.

Keywords: Simulation based medical education, early clinical exposure, academic performance, medical curriculum, Saudi Arabia

Introduction

Medical education in Saudi Arabia has witnessed a dynamic period of change and improvement since the last two decades. The kingdom has seen a surge in the number of medical colleges and universities. The government and private organizations have shown renewed interest in the field of medical education, providing it a new impetus to grow and prosper.[1]

In lieu of this positive and forward transformation, there has also been a growing demand from medical students and faculty, to revisit and revamp, the traditional curriculum and conventional teaching methodologies, being practiced at medical colleges since the last several decades. The general consensus has been that the current curriculum and teaching patterns are marred by several redundancies and areas of irrelevance. Greater theoretical learning in the early years with a lack of proportionate clinical or practical exposure has been a frequent grievance. The student-teacher community has been feeling a dire need to make the curriculum more contemporary, modern, relevant, practical, and less tedious.[1-3]

To address this concern, in 2005, the National Commission for Academic Assessment and Accreditation was formed, to assess the pros and cons of higher studies in the country.[4] Later, the Ministry of Higher Education also introduced some major reforms in medical education.[5] The common objective of these government-led initiatives has been to make medical education in Saudi Arabia more student-centric, simplified and include greater modalities of early practical exposure. The collective opinion has been that such changes can make the medical curriculum more productive and better enhance the learning abilities of students. It also holds promise in reducing the stress levels among students and in improving their overall quality of life.[1-3]

This unmet need can be largely fulfilled by the use of "Early Clinical Exposure" (ECE) techniques employed via simulations of real-world clinical situations. Such simulation based medical education (SBME) courses use tools like anatomical simulators, computer assisted models, virtual reality, role plays, case scenarios, mannequins simulating patients and environmental simulators, to name a few. Past research has shown that the early use of SBME tools during the pre-clinical years in medical colleges, prepares medical students to deal with real-world clinical challenges that are foreseen in the subsequent clinical years of medical training. This facilitates seamless transitioning from classroom training to clinical practice. This reduces their stress, anxiety and improves students' quality of life, as they step into the core clinical years of their medical education.[2,3]

In Saudi Arabia, at large tertiary care teaching hospitals like King Abdulaziz University, medical graduate studies are divided typically into three phases. The first phase is the foundation course of medical science which spans from the first to the third year. The second phase is clinical medicine which includes the fourth and the fifth years where the student learns about the application of basic medical science into clinical practice. The third phase is the internship performed at hospitals to gain hands-on clinical experience.[1] Among these phases of medical education, the second phase is perhaps the most challenging and critical, wherein students undergo a transition from theoretical concepts to their application in real-life clinical situations. At this stage, several students underperform, feel stressed and lack the clinical skills, needed to cope

with the demands of this transition from theory to practice. The need for ECE via SBME teaching models is direly felt at this juncture.[2,3]

Although ECE via SBME is a growing need of medical students in Saudi Arabia, its large-scale adoption across medical colleges in the country, especially at the pre-clinical level is yet to be achieved.[2] To the best of our knowledge, there exists a paucity of data from leading medical institutions in Saudi Arabia, regarding the benefits of implementing early clinical simulation programs.

Hence, this experimental pilot study was designed to gain a preliminary insight into the utility and benefit of ECE via SBME, at a leading medical university in Jeddah, Saudi Arabia. It assessed the benefit of early clinical simulation exposure, by delivering SBME to third year medical students and tracking its impact on their fourth-year examination scores.

Materials and Methods

An experimental pilot study was conducted among third-year medical students. The study intervention comprised a voluntary non-profit summer course, to deliver ECE via SBME methods. As the intervention involved peer-assisted learning, the instructors in this SBME module were fourth- and fifth-year medical students. They were chosen through an interview and selection process, assessing their clinical and lecturing skills. Third year students were explained the benefits of this SBME course and were given a choice to volunteer for the same.

The study intervention had a mix of classroom-based theoretical and simulation-based clinical sessions. The content of the curriculum and all the educational reference material utilized for this intervention was reviewed by specialists from respective academic faculties at King Abdulaziz University Hospital (KAUH). The unit of biomedical ethics and research committee at KAUH approved the study in January 2020 and consent was obtained from the participating students prior to study commencement.

The course was spread over a period of three weeks and was conducted at the simulation center of KAUH. It consisted of 5-hour daily sessions for five consecutive days, amounting to a total of 25 hours of integrated medical sessions per week. The first week began with sessions on the cardiovascular system, followed by sessions on the gastrointestinal tract and the respiratory system in the second week; and concluded with the nervous system detailed in the final week. The instructors imparted basic understanding on each of these systems and also included common and emergency conditions related to these systems.

The students were briefed about the learning objective of every session, prior to commencement. Sessions on each system comprised three hours of theoretical tutorials in the morning, followed by two hours of skill-based learning in the skill lab, every afternoon. This included a simulation session, either via role-playing or using a simulator. The students were then given time to reflect on the experience of the session and derive their conclusions and inferences from the learning obtained in the session. This was followed by a debriefing session wherein students detailed their thoughts based on the learning experience. Then came in active experimentation, wherein students analyzed how this learning experience and its outcome could be put to practical use in their future clinical coursework.

Learning sessions on each of these systems, were followed by a skill-based examination. Examinations were spread over 10 sessions and a total of 20 hours. The examinations were designed as simulation-based case scenarios, needing a structured clinical assessment of the case and clinical treatment planning. Simulators used included a high-fidelity simulator, a standardized patient, a low-fidelity trainer and a computer-based system. Patient-physician role-plays were also included.

Students who attended this SBME module were tracked for their performance in their fourth year of medical college and were compared with their control group peers who did not undergo the SBME course. The statistical analysis of the study was based on the fourth-year examination results of students who attended the SBME course. Fourth year performance of the course attendees and their control group counterparts (non-attendees) was compared and these results were expressed as a percentage.

Descriptive statistics were used to summarize the data. Variables were expressed as the mean ± standard deviation (mean ± SD). The Independent Samples *t*-test compared the means of two independent populations. The Statistical Package for Social Sciences (SPSS) version 20.0 was used for this analysis.

Results

A total of 401 third year medical students participated in this study, with a comparable number of male and female students enrolled (Table 1).

Of the 401 students included in the study, only 30.2% consented to attend the SBME course, while the large majority of 69.8% chose to remain in the control group without undergoing the intervention (Table 2).

The interventional group of SBME course attendees had a higher female population. From the study sample of 401 students, 25.6% of the males and 34.7% of the females chose to attend the SBME course (Table 3).

The overall study population (n = 401) obtained a mean score of 40.27 in the fourth-year final examination. Overall, females had a statistically significantly higher mean score as compared to males (P = 0.024) (Table 4).

Table 1. **Gender-wise distribution of the overall study population (N = 401)**

	Frequency (n)	Percentage (%)
Male	199	49.6
Female	202	50.4
Total	401	100.0

Table 2. **Frequency of attendees of the SBME course versus non-attendees**

	Frequency (n)	Percentage (%)
Not attended	280	69.8
Attended	121	30.2
Total	401	100.0

SBME, Simulation based medical education.

Of note, the students who attended the SBME course, obtained a statistically significantly higher mean score in the fourth-year final examination versus their non-attendee counterparts ($P = 0.001$) (Table 5).

The males as well as females, who attended the SBME course, scored significantly higher scores in their fourth-year final examination versus their non-attendee counterparts, $P = 0.027$ and $P = 0.019$ respectively. However, among the course attendees, no statistically significant difference was noted between the scores of males and females ($P = 0.187$). Among the non-attendee control group, females scored significantly higher than the males ($P = 0.010$) (Table 6).

The overall trend of the results clearly demonstrated, significantly higher fourth year examination scores, for students who attended the SBME course, as compared to the controls.

Discussion

It is noteworthy that out of the 401 students enrolled in this pilot study, only 121 (30.2%) students consented to attend the SBME course. The large majority of participants in the study sample chose to remain in the control group, without undergoing the SBME intervention. This finding reveals a serious lack of awareness regarding the importance of SBME during pre-clinical years. A similar lack of awareness has been reported in a comprehensive literature review on SBME by D.R. Pai.[6] This finding also underlines the urgent need to spread awareness about the benefits of SBME among students and teachers and to promote the large-scale adoption of early SBME programs in medical colleges.

Table 3. **Summary of gender-wise distribution of attendees and non-attendees**

Group	Male		Female	
	Frequency (*n*)	Percentage (%)	Frequency (*n*)	Percentage (%)
Not attended	148	74.4	132	65.3
Attended	51	25.6	70	34.7
Total	199	401	202	100.0

Table 4. **Descriptive statistics of fourth year scores (overall study population, gender-wise)**

Study population	*N*	Scores obtained (Mean)	SD	*P*-value	*t*-value
Overall	401	40.27	12.140		
Males	199	38.69	16.635	0.024	2.253
Females	202	41.85	10.888		

SD, Standard deviation.

Table 5. **Difference in the total scores between the attendees of the SBME course versus non-attendees**

	Group		Mean difference 90% CI	*t* value	*P* value
	Not attended	Attended			
	Mean ± (SD)				
Total scores	37.41 ± 15.949	42.44 ± 11.160	5.03 (1.89, 8.17)	3.150	0.001

CI, Confidence interval; SBME, Simulation based medical education.

Table 6. **Summary of comparison of the scores of attendees of the SBME course versus non-attendees with gender-wise break-up**

	Group		Mean difference 90% CI	*t* value	*P* value
	Not attended	Attended			
	Mean ± (SD)				
Male	34.92 ± 18.445	41.09 ± 12.382	6.1 (0.69, 11.65)	2.220	0.027
Female	39.89 ± 13.274	43.79 ± 10.012	3.9 (0.63, 7.18)	2.348	0.019
Mean difference 90% CI	4.97 (1.15, 8.79)	2.70 (–1.34, 6.74)			
t value	2.561	1.324			
P value	0.010	0.187			

CI, Confidence interval; SBME, Simulation based medical education; SD, Standard deviation.

Between 2018–19, the Saudi Commission for Health Specialties embarked on the initiative to introduce simulation-based learning in residency programs, which addressed training gaps in various specialties.[7] We believe that for pre-clinical students too, a similar strong mandate for SBME programs, needs to be initiated by higher governmental authorities. We further believe this will help drive large-scale implementation of SBME in medical colleges across the country and will encourage faculty members, college managements and senior peers, to get trained to deliver such programs to pre-clinical students.

The overall study sample (n = 401) was well balanced with respect to gender, with a comparable number of males (49.6%) and females (50.4%) included. However, the gender-wise breakup of the SBME course attendees revealed a notably higher female participation (34.7% females versus 25.6% males). In our opinion, this demonstrates that female medical students tend to show greater interest in new learning modalities and are more receptive to SBME programs than their male counterparts. This finding resonates well with past research showing female gender as one of the parameters of greater academic attainment in higher education.[8] Females have a stronger sense of self-regulation and sense of responsibility as compared to males, which results in better learning outcomes.[9] Regarding the lower participation of male students in the SBME course, we believe more effort and academic counseling by faculty and senior peers would be needed, to garner greater male participation in such early simulation interventions.

In the overall study population (n = 401), male students scored significantly lower in their fourth-year examination versus females (P = 0.024). Especially males in the non-attendee control group had a significantly lower mean fourth year score as compared to their female counterparts (P = 0.010). In sharp contrast to this, among the SBME course attendees, males and females had similar mean fourth year scores. This shows that the early SBME course could bring the male and female students' scores at par with each other in the fourth year, especially benefitting the male students. Males who attended the SBME course had a 6.17-point higher mean score than their male counterparts in the control group, whereas a mean rise of only 3.9 points was seen among females who attended the course versus the controls. Hence, the SBME course achieved a more pronounced improvement among male medical students in the study. This is perhaps because female students tend to have better pre-intervention baseline academic performance than males.[10-14] Thus, it is the male students who seem to have a greater scope of improvement post SBME, due to a lower pre-intervention baseline. However, this observation needs to be further validated through future studies.

On the basis of this pilot study, we infer that the success of ECE via SBME programs is largely dependent on participation from maximum number of students from both genders. We recommend that enrollment in SBME based modules should be made available and mandatory at all medical colleges for preclinical students. We understand that SBME is a complex intervention having its own implementational and logistic challenges. Therefore, we reiterate the need for country-wide government initiatives supported by institutional bodies, to overcome these challenges.[7]

In this study, ECE delivered via SBME, to third year medical students, yielded a significantly positive impact on their fourth-year examination scores. Control group students had a mean score of 37.41 ± 15.949 whereas students who underwent the SBME course had a significantly higher mean score of 42.44 ± 11.160 (P = 0.001). This 5.03-point mean increase in the scores achieved by the SBME intervention group, demonstrates the efficacy of ECE via SBME, in improving students' medical understanding, knowledge, skills and performance in their core clinical years at college. A growing body of evidence supports the efficacy and utility of SBME in improving academic performance of medical students. Wang S. et. al., conducted a single center study in a cohort of 1178 students to explore the efficacy of SBME in improving academic performance. The authors demonstrated statistically significant enhancement in clinical knowledge, doctor-patient communication, operation skills and humanistic care; among the SBME attendees versus the controls.[15] The meta-analysis by McGaghie et al., showed the superiority of SBME versus traditional teaching methods in medical colleges (P < 0.001), with SBME being more effective in the acquisition of specific clinical skills.[16] A systematic review of nineteen studies conducted by Mclnerney et al. also evaluated the impact of SBME on medical students' performance. The results showed simulation training to have a positive effect when used across a wide range of medical and surgical specialties, in acute and non-acute scenarios. Studies in this meta-analysis revealed a statistically significant improvement due to SBME, in the clinical skills of medical students such as history taking, physical examination, clinical chest examination, cardiac auscultation, breast examination, resuscitation skills, emergency care skills, surgical techniques and non-emergent clinical scenarios.[17] SBME is certainly at the forefront of next-generation reforms in medical education.[18]

Clinical years in the medical college present a completely new experience and challenge to students as compared to the pre-clinical phase. ECE via SBME acts as a precursor to the actual clinical experience, familiarizing students with real-time clinical problems, situations, patient handling and providing early glimpses into the process of overall in-clinic management. Hence, early SBME holds promise in making the transition from the pre-clinical phase to clinical years; easier, smoother and more seamless.[19]

Limitations

The third-year medical students who underwent the SBME program were followed up only until their fourth-year examinations. However, the long-term objective of such studies should focus on understanding the influence of ECE using SBME, in the final clinical practice of a graduate and this would warrant the need to follow-up even after the students have graduated and started clinical practice. It would not only help in understanding the longer effects of the simulation-based peer-assisted learning, but also provide valuable feedback from the practitioners for improving the current medical curriculum.

The students in the SBME intervention and control groups may have some confounding factors as they were not matched for demographics, skills, and baseline scores prior to SBME. Also, senior students who provided peer-assisted learning, most probably differed in their capabilities like clinical knowledge and skills, teaching and communicating abilities. They were given a basic training on the conduct of the module, but

yet were largely dependent on their inherent talent and aptitude to deliver the SBME sessions.

It cannot be ascertained with complete surety that the improved fourth year performance in the SBME group is attributable only to the simulation-based intervention. This is because other personal and academic factors might have also played a positive role. In other words, the control and study groups were not fully comparable during the SBME course as well as during the following year, until their performance in the final examination.

Moreover, this study was conducted only in the medical department and not in other fields in the medical school program such as surgical rotation.

Conclusion

This pilot study shows that ECE via SBME, delivered during the pre-clinical years of medical studies can have a significantly positive impact on the performance of students, in the subsequent core clinical years at medical college. Early SBME courses can play an instrumental role in facilitating a seamless transition from pre-clinical to clinical years in medical studies and in reducing the stress and anxiety associated with this transition. Moreover, large scale implementation of early SBME courses across the country, mandated and supported by government initiatives, would be a huge step forward in the modernization of medical education. Early SBME holds great promise in reducing redundancies and outdated practices in medical education and to make medical studies more interesting, relevant, contemporary and practical.

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Conflicts of Interest

The author reports no conflicts of interest in this work. ■

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