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Academic Performance of Medical Students in Online Versus Traditional Classroom Teaching in Orthopedic Surgery: Comparison of Two Cohorts

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1. Abstract

1.1. Aim: This study evaluates the effectiveness of online learning in enhancing academic performance in orthopedic surgery compared to traditional classroom teaching.

1.2. Methods: We analyzed the grades of 530 senior medical students (321 male, 209 female), comparing those in online classes (n=260) to in-person classes (n=270).

1.3. Results: Female students in online classes had significantly higher grades than those in-person (33.7±4.5 vs. 30.1±3.8, $p < 0.001$). Male students in online classes also outperformed their in-person peers (31.5±4.8 vs. 30.2±4.5, $p = 0.015$). Overall, female students scored higher than males (31.9±4.5 vs. 30.8±4.7, $p = 0.009$).

1.4. Conclusion: Online teaching can enhance academic performance in orthopedic surgery with adequate support.

2. Introduction

Remote online teaching for medical students during the recent pandemic lock-down has made a major paradigm shift in our perception of medical education. It has shown to be an effective educational approach with multiple advantages such as providing high quality medical education with less financial burden and a solution for shortage of academic teaching staff. Nevertheless, it requires a proper infrastructure for telecommunication and internet technologies [1]. Online teaching generally involves different e-learning platforms, virtual training, or videoconferencing [2]. In spite well-established measures have been implemented to assess the quality of online education (such as the use of appropriate methods, the course content adaptation, etc.) [3]. Some students face challenges due to limited non-verbal communication, limited interactive learning experience between students and academic staff as well as lack of accessibility to required educational materials [4]. According to a study conducted in Germany, many medical students were concerned about the disadvantages of online teaching and reported that not all aspects of medical education could be digitized, such as bedside teaching and clinical examination [2]. However, the literature is scarce and controversial on the impact of online teaching on the academic performance of medical students in comparison to traditional classroom teaching. Some studies reported reduced academic performance in the online teaching cohorts [5, 6]. In contrast, another study revealed a significant improvement in the academic performance of students who took online courses compared with those who took in-person classes [7, 8, 9]. Another study revealed no significant difference between the online versus traditional teaching methods in regard to the academic performance [10]. A systematic review of 16 articles comparing online teaching to regular teaching in medical education revealed that seven articles reported no significant difference between these

teaching methods, while nine articles reported a significant improvement in the academic scores of the online learning groups [10]. Owing to this controversy in the literature and a lack of studies that assess academic performance using quantitative measures, such as exam scores and student grades, we conducted our study to assess the impact of online teaching on students' academic performance to determine whether the theoretical component of a surgical specialty such as orthopedic surgery can be learned efficiently using online modalities.

3. Materials and Methods

3.1. Study Design

In this observational study, we compared the learning outcomes of senior medical students at King Saud University Medical School who completed fully online orthopedic surgery courses since against the learning outcomes of those who took similar courses in person. EQUATOR guideline was followed in our study which included the "Defined Criteria to Report Innovations in Education (DoCTRINE)".

3.2. Study Participants

We collected the grades of 530 fourth-year medical students. Of the total participants, 321 (60.6%) were male, and 209 (39.4%) were female. Inclusion criteria included students who are enrolled in the academic year of (2020-2021) and (2021-2022) studying medicine in there 4th year in King Saud University. We excluded any medical students who were not enrolled in the mentioned above academic years. A total of 270 students (50.9%) attended in-person classes in the academic year of (2021-2022), while 260 students (49.1%) attended online classes in the academic year of (2020-2021). The grades represented the students' written exam scores using multiple-choice and short-answer question formats. Study materials and learning resources for both groups (online and in-person classes) were similar. No changes were made to the course curriculum or the format and content of the lectures. The same instructors taught the same topics to both groups. Students in both groups took their tests in person, and the exam questions were framed according to a standardized course objective and were carefully and thoroughly reviewed by an assessment and evolution exam center to ensure that they represented the learning outcomes of the course. Students and faculty received proper training for online classes, including clear and comprehensive tutorials from the IT department on how to utilize the online platform optimally. Technical support staff were available online during the lectures to assist with any issues, and a fast internet connection was made available. At the end of each session, both in person and online, students were presented with a short answer quiz, which was implemented to encourage them to attend classes. There were no student dropouts in either of the two courses. The difference in the number of students enrolled in the two courses was not the result of any student dropout but rather the normal year-to-year variation in medical student enrollment. In both groups, students sat for their written exams in person; thus, both studying platforms involved the same exam experience.

3.4. Data Analysis

Data were entered into Microsoft Excel (Version 16.12; Microsoft, Redmond, CA) spreadsheets and then analyzed using SPSS (Version 22.0. IBM Corp., Armonk, NY). Categorical data were presented as frequencies and percentages, and continuous data were presented as means and standard deviations. Learning methods and gender were presented as frequencies and percentages, while grades were presented as means and standard deviations. We compared grades by learning method and gender for both groups using a t-test or a Mann–Whitney test, as appropriate. All p-values were two-tailed, and $p < 0.05$ was considered significant.

4. Results

Figure 1 illustrates the grade distribution of students by learning method. For in-person classes, the grades ranged between 16 and 40, with a median of 30.9. For online classes, the grades ranged between 20.5 and 40, with a median of 32.6. As shown in Table 1, students who attended online classes had significantly higher grades than those who took in-person classes (32.4±4.8 versus 30.2±4.3, $p < 0.001$). For male students, those who attended online classes had significantly higher grades than those who received regular learning (31.5±4.8 versus 30.2±4.5, $p = 0.015$). Similarly for female students, those who took online classes had significantly higher grades than those who attended in-person classes (33.7±4.5 versus 30.1±3.8, $p < 0.001$). However, irrespective of the learning method, female students obtained significantly higher grades than male students did (31.9±4.5 versus 30.8±4.7, $p = 0.009$). As shown in Figure 2, the difference in grades between the two learning methods was 3.61 (95% confidence 2.47–4.74) for females and 1.27 (95% confidence 0.25–2.29) for males. Additionally, the variability in grades was higher among male students than among female students, as evidenced by the wider interquartile range in the latter group.

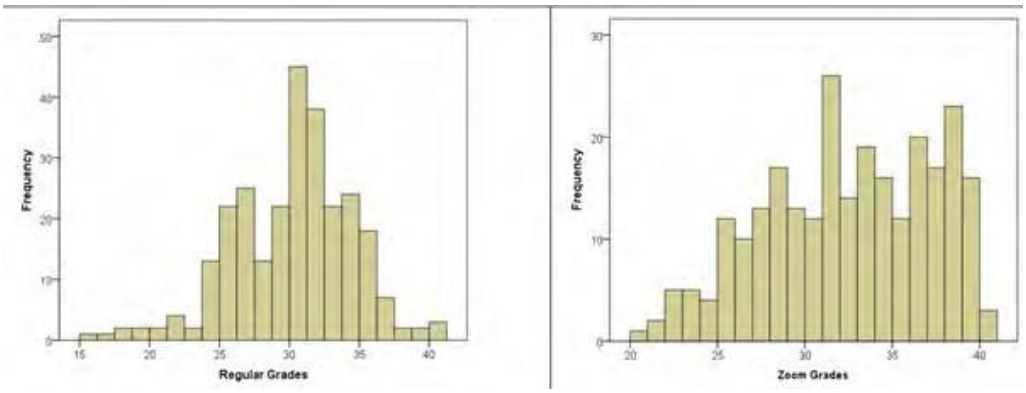

Figure 1: Distribution of grades of orthopedic surgery classes in the fourth-year medical students by learning methods (N=530).

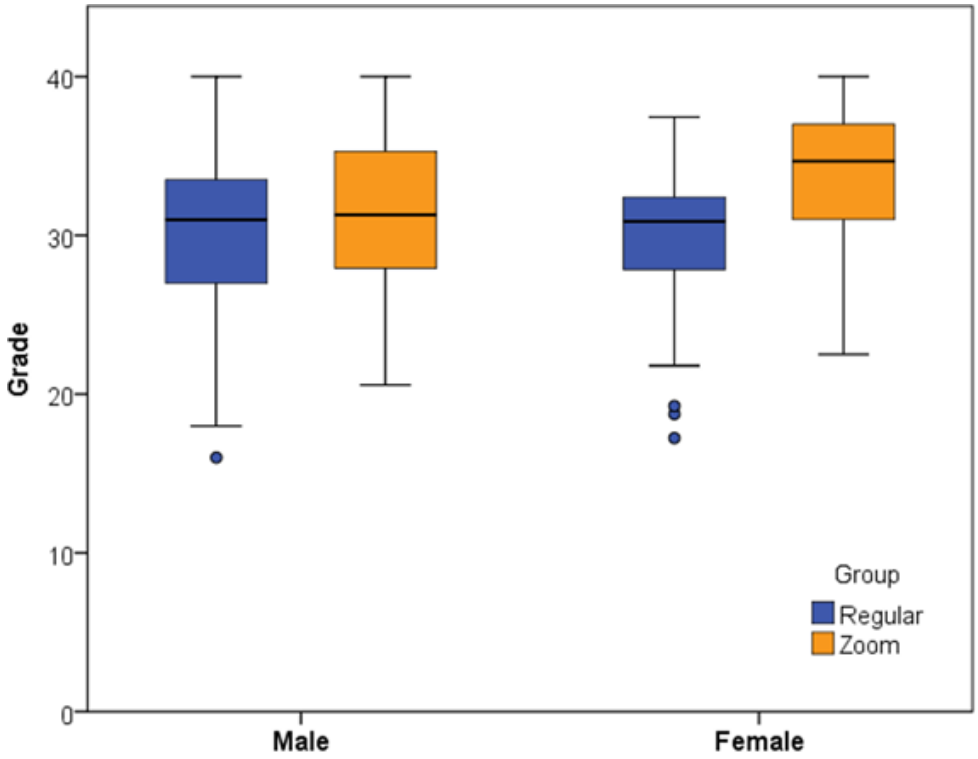

Figure 2: Grades of orthopedic surgery classes in of the fourth-year medical students by learning methods and gender.

Table 1: Grades of orthopedic surgery classes in the fourth-year medical students by learning methods and gender.

Category	Number	Frequency	Mean	Standard Deviation	P-value	Test
Learning methods					<0.001	M-W
Regular	270	50.90%	30.2	4.3		
Zoom	260	49.10%	32.4	4.8		
Total	530	100.00%	31.3	4.7		
Gender					0.009	M-W
Male	321	60.60%	30.8	4.7		
Female	209	39.40%	31.9	4.5		
Total	530	100.00%	31.3	4.7		
Learning methods in males					0.015	t-test
Regular	168	52.30%	30.2	4.5		
Zoom	153	47.70%	31.5	4.8		
Total	321	100.00%	30.8	4.7		

Learning methods in females					<0.001	t-test
Regular	102	48.80%	30.1	3.8		
Zoom	107	51.20%	33.7	4.5		
Total	209	100.00%	31.9	4.5		

5. Discussion

Online education offered several advantages, especially the possibility to learn anytime and anywhere.10 Kim JW et al. found that online classes are generally favored and provide more interactive discussions compared with in-person classes [11]. Additionally, a systematic review conducted by George et al. [12]. Revealed that online teaching yielded equivalent results in terms of knowledge and skills gained and student satisfaction [12]. Another study conducted in Italy, which compared online and in-person physiotherapy classes, showed no difference in students' satisfaction levels between the two learning methods, but online classes yielded higher performance grades than in-person classes did [13]. However, a study in Korea that evaluated the academic performance of students in 19 different courses found that the average test scores decreased for most online courses [14]. Various reasons were suggested for this decline, such as the unfamiliarity to online classes, the fact that most of the faculty did not have proper training to deliver online classes, and the lack of technical support [14]. Another study demonstrated that even though students had more time to study when courses were delivered online, the majority of them preferred traditional teaching for better understanding of the course materials and topics [15]. We observed a significant improvement in students' academic performance in online classes compared with that in in-person classes. The results indicate that when proper technical support is provided for faculty and students, online teaching could be considered for orthopedic surgery. These results are valuable for medical school course curriculum planners which suggest that virtual online teaching could be implemented in the medical school curriculum for orthopedic surgery rotation and probably for other surgical and clinical rotations. Although we did not measure competency in terms of clinical and surgical skills among medical students and mainly focused on the didactic aspect of learning orthopedic surgery knowledge, our study has multiple strengths, including the standardized course learning materials and study aids, a uniform course format and content, and the same faculty and lectures for both groups. We found that having a readily available online technical team and receiving appropriate online teaching prior to class, to ensure in-depth understanding and optimal use of the online platform, were crucial for the students in our study; they ensured a smooth transition to online learning and helped students achieve their learning goals. In addition, taking a quiz in the form of short-answer questions at the end of each class had a positive impact on students' attendance and engagement in both groups. One of the limitations of our study we did not measure the sample size using power analysis we depended on the number of the students enrolled in the academic year that we compared.

6. Conclusions

Online teaching has become more popular in many educational institutions because of its cost and time efficiency, provided that the right technical support is in place. Our study demonstrates that there has been significant improvement in the academic performance of students in online classes compared with that in in-person classes. It also shows that, with proper technical support, online teaching could be considered for orthopedic surgery courses. Therefore, proper technical support for faculty and students must be established. Future studies should focus on the possibility of using advanced online teaching modalities, such as virtual reality technology for clinical and clerkship activities.

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