ORIGINAL ARTICLE

The effect of medical informatics training on students' knowledge and attitude to use it in future medical work: a comparative study among Saudi medical students

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ABSTRACT

Introduction

The integration of medical informatics (MI) in medical education is crucial for preparing future healthcare professionals to effectively utilize technology in their practice. This study aimed to investigate the impact of MI training on Saudi medical students' knowledge and attitude towards using technology in future medical practice.

Method

A cross-sectional descriptive study was conducted among medical students at Saudi medical universities, employing a non-probability convenience sampling method. A standard pre-structured, self-reported questionnaire was used to collect data from 1508 students, with 1192 having undertaken an MI course and 316 not having undertaken the course. The validated questionnaire included two dimensions of knowledge and attitude and each dimension had 12 items.

Results

The mean scores of knowledge and attitude towards MI were significantly higher among students who had undertaken the MI course compared to those who had not ($p < 0.001$). The results highlighted the effectiveness of MI training in enhancing students' understanding of various MI concepts and applications, including electronic medical records, patient confidentiality, clinical decision support systems, telemedicine, e-prescriptions, evidence-based practice, and legal/ethical considerations in clinical informatics.

Conclusion

This result of this study highlights the significance of MI course in shaping students' perceptions and understanding of various aspects of healthcare, particularly in the context of EMRs, patient confidentiality, and the role of technology in healthcare. The findings provide valuable insights into the transformative impact of MI training on students' knowledge and attitude towards utilizing informatics in their future medical careers.

Keywords

Medical informatics, medical education, Saudi Arabia, healthcare technology, digital health literacy

INTRODUCTION

The integration of technology into healthcare has transformed the way medical professionals work, making it essential for them to possess the necessary knowledge, skills, and attitudes to effectively utilize medical informatics (MI) in their future practice [1]. MI is a field that combines healthcare and information technology to improve patient care, and its importance in medical education cannot be overstated4. MI training is essential for medical students to acquire the necessary skills to navigate the increasingly complex healthcare landscape,

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where technology plays a vital role. The integration of MI into medical education is crucial for several reasons. Firstly, it enables students to effectively utilize electronic medical records (EHRs), which are becoming the standard for documenting patient information1. Secondly, MI training helps students to develop skills in data analysis and interpretation, which are essential for evidence-based medicine3. Finally, MI education prepares students to work in a healthcare system that is increasingly reliant on technology, such as telemedicine and mobile health applications.

Studies have shown that medical students' knowledge and attitudes towards MI are critical in determining their ability to effectively utilize technology in healthcare [2][4]. The majority of medical students surveyed expressed hope for the future of artificial intelligence (AI) in healthcare and a desire to get a deeper understanding of its potential uses [2]. Another study examining healthcare students' knowledge, attitudes, and perspectives towards AI and its consequences found that students recognized the potential benefits of AI in healthcare, but also expressed concerns about its limitations and potential biases[4]. This is consistent with the idea that learning new computer skills can improve employability and increase the chances of employees progressing in their careers4. According to research by Vijayalakshm et al., students who took a beginner's computer class were more likely to see the use of computers in healthcare. This is in keeping with the idea that digital equity may be advanced by ensuring that all people have a firm grasp of the principles of computing.

While numerous studies have investigated the attitudes of medical students towards telemedicine and eHealth, with findings suggesting positive attitudes but insufficient knowledge1, there is a need to examine the impact of medical informatics training on Saudi medical students' knowledge and attitude towards using technology in future medical practice, particularly in the context of the Saudi healthcare system. Thus, the purpose of this research was to ascertain whether or not medical informatics education improved students' understanding of the subject and their disposition towards incorporating it into their future careers. Theoretically, given these results, medical students who have taken MI classes should know more about the usefulness of computers in healthcare and have a more favourable outlook on the subject than those who have just started medical school. We are unaware of any other study in Saudi Arabia that has previously highlighted the value of MI programs. It acts as an example for other medical schools to follow and promotes the inclusion of MI courses in their curricula. This study is significant, as it addresses the need for MI education in Saudi Arabia, where the healthcare sector still relies heavily on paper medical records, leading to scattered patient information and a shortage of MI professionals.

MATERIALS AND METHODS

Medical students at Saudi medical universities were the subjects of a cross-sectional descriptive research that used a non-probability convenience sampling approach. The study included all willing medical students in their last year of school; the only criterion for exclusion was a lack of interest in taking part. 1508 students were enrolled in the study, among them, 1192 (79%) of them had undertaken MI Course, and 316 (21%) did not undertake MI Course.

Measures

Demographic information

The demographic form includes age, sex, university, and had taken a medical informatics course.

Students' knowledge and attitude to use MI in future medical practice

In order to gather information from the participants, a typical self-reporting questionnaire was utilised. With 12 items each, the questionnaire covered two aspects: attitude and knowledge. To make sure the questionnaire was appropriate for this study, it was validated by experts. The next step was to test the tool out with a small sample of students in a pilot study; the outcomes confirmed that the tool would work as intended. Because of this, we decided that no big changes were required.

The knowledge items were scored using a five-point Likert scale (1=strongly disagree, 2 = disagree, 3= neutral, 4 = agree, 5=strongly agree) and higher scores indicate higher knowledge. The total score ranges between 12 – 60. Corrected item-total correlation was 0.54-0.80 and Cronbach's Alpha was 0.926, which indicated the appropriate internal consistency of this dimension. The attitude items were scored using a three-point scale (0=no, 1 = Maybe, 2= yes) and higher scores indicate higher attitude. The total score ranges between 0 – 24. Corrected item-total correlation was 0.41-0.64 and Cronbach's Alpha was 0.873, which

indicated the appropriate internal consistency of this dimension.

Procedure

The questionnaire were administered to separate batches of students at different times in a group setting, typically in lecture halls. Prior to distribution, researchers provided a verbal explanation of the study's objectives and methods to all participants. Those who consented to participate comprised the final sample. It was explicitly stated that their responses would not influence their semester exam results. The questionnaires could be completed within 20-30 minutes. Permission was obtained from the university administrators. Participants were briefed on the study's aims and procedures to decide whether to participate. After verbal consent, they received the confidential questionnaire. The data collection tools did not contain any identifying information, ensuring the confidentiality of individual responses.

Statistical analysis

To ensure the normality and skewness of the data, histograms and the Kolmogorov-Smirnov test were employed. The dependent variables were found to be normally distributed, which justified the t-tests for comparing the data. We used SPSS 26 (SPSS Inc., Chicago, IL, USA) for all of our statistical analysis. For statistical purposes, a p-value of less than 0.05 was deemed significant.

RESULTS

Demographic Characteristics of Study Participants

There were 815 individuals (54.0% of the total) whose ages were between 22 and 24 years old; 388 (25.7% of the total) were 21 to 22 years old; 162 (10.7% of the total) were younger than 20 years old; and 143 (9.5% of the total) were older than 25 years old. There were 885 men and 623 females making up the study population.

Out of the 1508 study participants, 79% (n = 1192) had undertaken the Medical Informatics (MI) Course, while 21% (n = 316) had not. The participants were from various universities, with the majority (19.8%, n = 298) from Al Majmah University, followed by King Khaled University (15.5%, n = 233), Prince Sattam Bin Abdulaziz University (8.0%, n = 120), Umm Al-Qura University (4.5%, n = 68), and Batterjee Medical College (BMC) (3.9%, n = 59) (Figure 1).

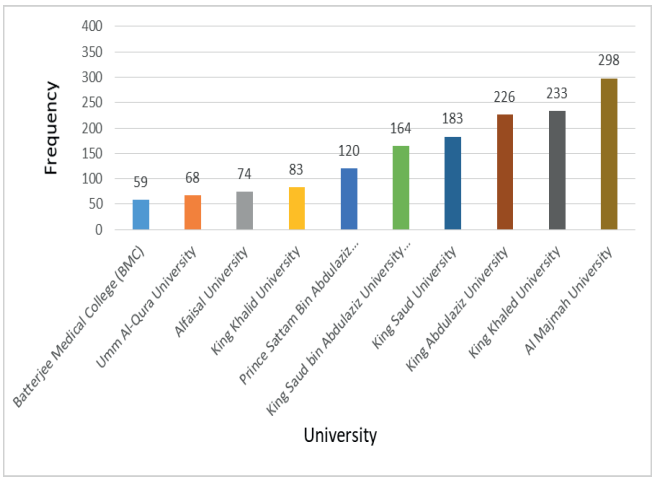

Figure 1: Distribution of participants as per university

Comparative Analysis of Students' knowledge to use MI in future medical practice

The mean scores of knowledge of the students who had undertaken MI course and the students who had not undertaken MI Course was 49.64 (7.96) and 35.97 (11.27), respectively. Statistical analyses showed that mean scores of knowledge was significantly different between the two groups ($t = 24.47$, $p < 0.001$).

The results of the comparative analysis of 12 knowledge dimension items are presented in Table 1, which provides a detailed summary of the findings.

Table 1: Comparative analysis of 12 knowledge dimension items among the students (n = 1508)

Knowledge Items	Mean (SD)		t	P-value
	Group A n = 1192	Group B n = 316		
1. Best method to communicate between different healthcare providers is through Electronic Medical Records?	3.88 (1.04)	2.90 (1.28)	14.2	p<0.001
2. Electronic medical record protects patients confidentiality more than the paper Medical Records	4.11 (1.06)	2.99 (1.30)	15.9	p<0.001
3. Electronic Medical Records improve and facilitate the transmission of patient's information between different healthcare facilities?	4.36 (0.93)	3.10 (1.38)	19.1	p<0.001

Knowledge Items	Mean (SD)		t	P-value
	Group A n = 1192	Group B n = 316		
4. Easiest method to find specific information within a patient medical record is by the use of an electronic medical record?	4.29 (1.01)	3.10 (1.34)	17.2	p<0.001
5. Comply with HIPAA (Health Insurance Portability and Accountability Act) standards is the recommended method to protect the confidentiality of patient medical records.	4.25 (0.92)	2.96 (1.32)	20.1	p<0.001
6. Use of a Clinical Decision Support System helps to reduce the risk of medical errors	3.89 (0.98)	3.05 (1.27)	12.6	p<0.001
7. Use of telemedicine is very important to overcome problems of the current healthcare system.	3.81(0.98)	3.09 (1.24)	10.9	p<0.001
8. Use of e-prescriptions help to reduce errors related to drugs and to improve patient safety?	4.22(1.02)	2.97 (1.29)	18.1	p<0.001
9. Reliance on evidence-based resources is essential to improve the quality of healthcare?	4.19(1.04)	2.97 (1.27)	17.7	p<0.001
10. In order to be updated with the latest medical information, a healthcare provider should read the latest medical literature by using reliable medical websites.	4.16 (1.04)	2.93 (1.34)	17.6	p<0.001
11. It is the responsibility of a physician to direct the patient to reliable medical websites such as Myoclinic, WebMD, and MedlinePlus?	4.24 (0.92)	2.96 (1.32)	20.0	p<0.001
12. A healthcare provider should have a reasonably good understanding of the legal and ethical issues involved in using clinical informatics applications.	4.24 (0.92)	2.96 (1.32)	20.1	p<0.001

Significance at P<0.05 level; Group A – the students who had undertaken MI course; Group B - the students who had not undertaken MI Course

The data showed that 69.2% of students who took the MI course believed that Electronic Medical Records (EMRs) are the best method for communication between healthcare providers, compared to only 30.4% of those who did not take the course. Similarly, 77.1% of MI course students agreed that EMRs offer better protection of patient confidentiality than traditional paper-based records, whereas only 32.3% of non-MI course students shared this opinion. These findings suggested that the MI course effectively conveys the value of EHRs and EMRs in enhancing patient care and confidentiality. The course also seems to influence students' views on the ease of finding specific information within patient medical records, with 83.7% of MI course students agreeing that EMRs make it easier, compared to 38.0% of non-MI course students. Furthermore, a significant majority of MI course students (87.1%) believed that EMRs improve and facilitate the transmission of patient information between healthcare facilities, whereas only 39.2% of non-MI course students shared this opinion. The results also indicated on the importance of complying with Health Insurance Portability and Accountability Act (HIPAA) standards to protect patient medical records, with 84.4% of MI Course students agreeing on this, compared to 31.7% of non-MI course students. Additionally, the course appears to emphasize the role of Clinical Decision Support Systems (CDSSs) in reducing medical errors, with 69.1% of MI course students agreeing on this, compared to 36.1% of non-MI course students. The data suggested that students who have undertaken the MI course have a significantly more positive view of the importance of telemedicine in overcoming problems in the current healthcare system compared to those who have not undertaken the course. This is reflected in the higher percentage of MI course students who agree that telemedicine is very important (64.1% vs 36.8%). Similarly, a significant majority of MI course students (81.1%) believed that the use of e-prescriptions helps to reduce errors related to drugs and improve patient safety, whereas only 30.7% of non-MI course students share this opinion. This suggests that the MI course has a positive impact on students' understanding of the benefits of telemedicine and e-prescriptions in improving healthcare outcomes. In addition, compared to students in other MI courses, those in this one are more likely to think that using resources supported by evidence is critical to enhancing healthcare quality (79.8% vs. 29.1%). This proves that students' comprehension of the significance of evidence-

based practice in healthcare is positively affected by the MI course. Moreover, whereas just 31.0% of students from non-MI courses hold this view, 80.3% of MI course participants think that healthcare workers should study the newest medical literature utilising reputable medical websites to be informed with the latest medical information. This shows that students' awareness of the significance of keeping up with the most recent medical information is positively affected by the MI course. The statistics also revealed that compared to students of other MI courses, 83.7% of them believe that it is the duty of a doctor to refer patients to trustworthy medical websites. It may be inferred from this that the MI course enhances students' comprehension of how doctors can direct patients to reliable health resources. Lastly, whereas just 31.7% of students who did not take a MI course shared this view, 84.4% of MI course participants felt that healthcare practitioners should have a decent grasp of the ethical and legal considerations associated with clinical informatics applications. It appears that the MI course enhances students' comprehension of the ethical and legal aspects related to clinical informatics.

Comparative Analysis of Students' attitude to use MI in future medical practice

The mean scores of attitude of the students who had undertaken MI course and the students who had not undertaken MI Course was 18.87 (4.34) and 15.33 (5.07), respectively. Statistical analyses showed that mean scores of attitude was significantly different between the two groups ($t = 12.40$, $p < 0.001$).

Table 2: Comparative analysis of 12 attitude dimension items among the students (n = 1508)

attitude Items	Mean (SD)		t	P-value
	Group A n = 1192	Group B n = 316		
1. Will you use an Electronic Medical Record in your future medical practice?	1.73 (0.53)	1.36 (0.72)	10.17	p<0.001
2. Will you prefer to spend your internship and residency in hospitals that use Electronic Medical records rather than hospitals that rely on paper medical records?	1.71 (0.57)	1.30 (0.77)	10.61	p<0.001
3. Will you ask healthcare facilities to rely on an Electronic Medical Record instead of a paper medical record?	1.64 (0.59)	1.23 (0.76)	10.08	p<0.001
4. Will you use a Computerized Physician Order Entry in your Future medical practice?	1.63 (0.59)	1.31 (0.71)	8.11	p<0.001
5. Will you use a Clinical Decision Support System in your future medical practice?	1.59 (0.59)	1.28 (0.72)	7.98	p<0.001
6. Will you use telemedicine in your future medical practice?	1.48 (0.61	1.23 (0.72)	6.05	p<0.001
7. Do you agree that medical textbooks are not the only method to keep me updated with required medical knowledge?	1.20 (0.78)	1.22 (0.76)	0.45	0.647
8. Will you not resist using clinical informatics applications?	1.40 (0.73)	1.23 (0.75)	3.62	p<0.001
9. If you are not sure about the diagnosis or treatment of a patient during the delivery of care, will you use reliable medical websites?	1.54 (0.63)	1.22 (0.73)	7.80	p<0.001
10. In order to be a life-long learner, will you use reliable medical websites to find up-to-date medical information?	1.62 (0.61)	1.31 (0.73)	7.66	p<0.001
11. Will you have confidence in the use of clinical informatics applications in my future medical practice?	1.62 (0.57)	1.28 (0.73)	8.77	p<0.001
12. In general, will you be enthusiastic about the use of health information technology in patient care in your future medical practice?	1.70 (0.56)	1.34 (0.74)	9.57	p<0.001
Significance at P<0.05 level; Group A – the students who had undertaken MI course; Group B - the students who had not undertaken MI Course				

Table 2 shows the outcomes of the comparison of 12 attitude dimension elements.

According to the statistics, electronic health records (EHRs) will be used more frequently by 77.6% of students who took the MI course, as opposed to 50.9% of students who did not. When asked about their future careers in medicine, 77.4% of MI course students would rather work for a hospital that uses electronic medical records (EMRs) than one that uses paper records, compared to 49.4% of non-MI course students. The percentage of students who would rather see healthcare institutions use an electronic medical record (EMR) than a paper one in the future is higher among MI course participants (69.8% vs. 43.4%). On top of that, whereas just 45.6% of students who did not take a MI course shared the belief that CPOE will be used in their future medical practice, 69.2% of MI course students held this view. Also, whereas just 43.4% of students who did not take a MI course shared this view, 64.1% of those who did say they would employ CDSSs in their future medical practice. In addition, whereas just 40.5% of students who did not take a MI course held the belief that telemedicine will be utilized in their future medical practice, 53.9% of those students did. Among students enrolled in MI courses, 54.7% said they would not hesitate to use clinical informatics apps, compared to just 42.4% of students enrolled in non-MI courses. While just 39.6% of students who did not take a MI course shared this view, 61.1% of those students said they would consult reputable medical websites if they had doubts about a patient's diagnosis or treatment while providing care. On top of that, 69.1% of MI course participants said they would utilize trustworthy medical websites to get current medical information if they were a lifelong learner, compared to 47.2% of non-MI course participants. Students enrolled in MI courses were more likely than those enrolled in non-MI courses to express confidence in their ability to employ clinical informatics tools in their future medical practice (66.2% vs. 44.9%). Lastly, compared to students who did not take a MI course, 75.4% of those who did said they would be excited about using health information technology in patient care in their future medical practice.

DISCUSSION

The findings of this study underscore the significant MI training on Saudi medical students' knowledge and attitude towards utilizing MI in their future medical practice. The stark contrast in mean knowledge scores between students who underwent MI training and those who did not highlights the effectiveness of such courses in enhancing students' understanding of various MI concepts and applications. Specifically, MI course students demonstrated a deeper comprehension of EMRs, patient confidentiality, clinical decision support CDSSs, telemedicine, e-prescriptions, evidence-based practice, and legal/ethical considerations in clinical informatics.

Moreover, the positive shift in attitude towards MI observed among students who received MI training signals a readiness to embrace technological advancements in healthcare. These students expressed greater willingness to utilize EMRs, CPOE, CDSSs, telemedicine, and other clinical informatics applications in their future medical practice. Their preference for healthcare facilities equipped with electronic medical records further emphasizes the perceived benefits and efficiency associated with digital healthcare systems (Sheikh et al., 2011). If we are serious about enhancing healthcare quality and safety, we must embrace and utilise EHRs effectively. However, there are a number of obstacles that prevent EHRs from being widely used and used to their full potential, especially when it comes to clinician-to-clinician contact and data exchange. With the ability to enhance healthcare quality through the provision of real-time access to patient information, the adoption of EMRs is vital for the future of electronic health services. Finding out how doctors feel about electronic medical records (EMRs), especially when it comes to their communication and data sharing capabilities, is crucial. Because of the beneficial effects on health information interchange and the decrease of medical mistakes, the significance of workplace computer access was also highlighted. Doctors who work in offices with computers often feel that patients may put more faith in them and that they are more productive when they share patient records electronically. Additionally, a positive attitude towards EMR system adoption is predicted by lack of previous experience and computer access at work.

The study's results are in line with previous research that has shown how important it is to teach medical informatics to the next generation of healthcare workers so that they can successfully use new technologies. To guarantee that healthcare personnel are equipped to use new technology, understand data, and incorporate it into clinical decision-making, it is essential that they

get effective training and instruction. This is of utmost importance when considering electronic health records (EHRs), since insufficient training and education might impede their adoption and have a detrimental effect on the standard of nursing documentation. It is suggested that electronic health record (EHR) education and training use a multi-pronged approach, focussing on the clinical workflows of doctors. Supporting interactive and workflow-based material may need the use of blended learning methodologies, such as e-learning, peer coaching, and simulation training. Furthermore, training should extend beyond the initial implementation phase, with a focus on continuing enrichment opportunities to maximize the potential of EHRs. Assessing training needs and user skill levels, creating a training timeline based on goals, and establishing a representative training team are also critical components of successful EHR training.

Furthermore, the results highlight the importance of integrating MI education into medical curricula to meet the evolving needs of modern healthcare systems. By equipping medical students with the necessary knowledge and skills in informatics, educators can empower them to become competent and tech-savvy practitioners capable of delivering high-quality, patient-centered care in the digital age. Informatics curricula at medical schools have several positive effects. It improves students' clinical competence, which in turn boosts their self-assurance in their ability to use bioinformatics databases to unique clinical scenarios. Additionally, MI helps students become more proficient with medical data management, strengthens the health system's digital infrastructure, opens the door to precision medicine, and raises awareness of the medico-legal and ethical concerns surrounding health digitalization. Students preparing to become doctors in the future will be better prepared to deal with the medico-legal and ethical considerations that arise from the use of digital technologies in patient care, as well as with the data and infrastructures that make up the health system as a whole. There is a present gap between medical school teaching and modern practice, thus it is crucial that medical schools think about how to provide students with the digital competences they'll need to thrive in clinical practice.

Limitation.

The study's methodology and design are not without their limitations, which may have influenced the outcomes and conclusions. Because it uses self-report questionnaires, which could be influenced by social desirability bias, this study has several drawbacks. Also, like other cross-sectional studies, this one can't prove causation, which is a major drawback of this research method. Also, the present study's generalizability is limited due to the convenience sampling method. Future research should focus on identifying the factors that influence attitudes towards computers in healthcare. Replicating this study across the country would also be beneficial. Despite these limitations, the findings of this study can still provide valuable insights for healthcare educators and administrators to develop effective MI course.

CONCLUSION

This result of this study highlights the significance of MI course in shaping students' perceptions and understanding of various aspects of healthcare, particularly in the context of EMRs, patient confidentiality, and the role of technology in healthcare. The course appears to have a profound impact on students' opinions, with a significant majority of those who undertook the course agreeing on the importance of EMRs, and CDSSs in improving healthcare outcomes. Functionally, the results provide valuable insights into the transformative impact of MI training on Saudi medical students' knowledge and attitude towards utilizing informatics in their future medical careers. By acknowledging the significance of MI education and fostering a culture of lifelong learning in healthcare, stakeholders can foster a generation of healthcare professionals adept at harnessing technology to improve patient outcomes and advance the field of medicine. To the best of our knowledge, this study is the first of its kind in Saudi Arabia to highlight the significance of MI education. It also uses this study as a model for other medical schools to follow in their pursuit of MI education for their medical students.

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