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Readiness towards Artificial Intelligence among Undergraduate Medical Students in Malaysia

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ABSTRACT

Artificial Intelligence (AI) technology is growing at a fast pace and permeates many aspects of people's daily lives. Medical students' inclination towards AI in the medical field increases the probability of successful AI adoption and its value in the medical field. This study was conducted to evaluate medical AI readiness among undergraduate medical students. A cross-sectional study was conducted from March 2022 to April 2022 in a private medical institution in Malaysia. A non-probability purposive sampling method was used to enroll students and a questionnaire was distributed online via Google forms. The questionnaire, captioned "Medical Artificial Intelligence Readiness for Medical Students (MAIRS-MS)", was used for data collection. The analysis included frequency tables, percentages, standard deviation, unpaired t-test, and Analysis of Variance (ANOVA) test. Out of 105 participants, 67.62% scored 53-83, followed by 24.76%, who scored 84-114, and 7.62%, who scored 22-52 on the medical artificial intelligence readiness scale. The mean of the total score of medical AI readiness obtained was 75.04. There were significant correlations between age and study year with the ability, vision, and ethics domains of medical AI readiness. A significant association was observed between previous training with all four domains of medical AI readiness. Policymakers and the educational sector should set up more AI training centers to provide and introduce basic courses on AI. More AI courses should be provided to younger populations to engage in AI digital information earlier, thus enabling them acquire more confidence in interacting with AI technology in the future.

Keywords: *Artificial intelligence, Medical artificial intelligence readiness, Medical students, Medicine*

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INTRODUCTION

Artificial intelligence (AI) is a broad field of computer science that focuses on creating intelligent machines. AI could further accomplish activities that would normally require human intelligence. Within the next ten years, every other post-millennial believes they would collaborate with robots and artificial intelligence. We envision the workforce's future, and whether it has any repercussions for the healthcare business (1). Artificial intelligence is a multidisciplinary field having roots in logic, statistics, cognitive psychology, decision theory, neuroscience, linguistics, cybernetics, and computer engineering. In 1956, a very small summer workshop at Dartmouth College launched the contemporary field of AI. Since then, Internet searches, e-commerce sites, goods and services recommender systems, picture and speech recognition, sensor technologies, robotic devices, and cognitive decision support systems have all been made possible by machine learning (ML) (2, 3).

Artificial intelligence has the potential to help alleviate the healthcare workforce shortage; AI works by learning data from computers and analyzing new data by mimicking human thought processes. Artificial intelligence increases the searching capacity of medical data and provides a decision support system at scales that are remolding the future healthcare system (4). Artificial intelligence can be used in clinical diagnosis where there is a shortage of medical doctors, as is the case in some countries. Moreover, AI could be applied in image analysis in radiology & histopathology to minimize the mistakes made by human beings. Artificial intelligence is also applicable in the interpretation of electrocardiogram (ECG) in emergencies, such as myocardial infarction, ventricular tachyarrhythmias, and atrial fibrillation (5). Other applications include detecting sleep disorders, epilepsy, electromyography (EMGA) analysis, and Doppler ultrasound analysis of intensive care unit (ICU) patients (6-8). According to a report from the National Academy of Medicine, the use of AI outside of the hospital has a great potential to improve health, such as remote sensors monitoring vital signs (9). Artificial intelligence has several benefits that can be applied in the medical field. For example, AI could be beneficial in handling patient data and interpreting results. This would help reduce the workload of healthcare workers to reduce the workload (10, 11). Speech recognition is another feature of AI that could facilitate the retrieval of patient data in the clinical sector (12). In the field of medical education, AI has been incorporated into various training programs such as technology-based computer-aided detection for mammography, machine learning, and involvement in engineering labs (13).

Many countries comprehend that AI is a foundational technology and are competing to obtain a worldwide innovation gain in AI. The United States is currently leading in AI technology, closely followed by China, and the European Union. These nations are building up and improving their AI ecosystem, and racing in the development of both conventional semiconductors and the microchips

that power the AI frameworks (14-16). Among undergraduate medical students, both positive and negative attitudes towards AI have been reported. In a survey with by 121 students participating and 52 clinical faculty of Medical College of Georgia (MCG), most of the participants understood the importance of AI and its probable application in clinical settings; for instance how it can be helpful in patient care training (17), and medical education to revolutionize healthcare. Another study done amongst pathologists showed a positive attitude towards possible increased efficiency and quality assurance in the field of pathology (18). In a previous study conducted by Dos Santos (2019) to assess the attitude of undergraduate medical students towards artificial intelligence in radiology and medicine, 52% of the 263 students were aware of the application and implications of AI in radiology and medicine; 83% of the respondents believed in the ability of AI to accurately detect pathologies in radiological examinations (19). A study was conducted in Timisoara, enrolling a total of 928 students in technical and humanistic specializations at two universities to determine the perceptions of students on the development of AI. The result from this study clearly revealed that a great number of respondents manifest a positive attitude towards the emergence and usage of AI, and believe AI will influence society for the better (20). Christian J. Park did a survey on 256 students from each year of medical school to evaluate the students' perceptions of radiology and other medical specialties in relation to AI (21). From this study, over 75% agreed that AI would have a significant role in the future of medicine and most (66%) agreed that diagnostic radiology would be the specialty that is the most affected. The study shows that US medical students are optimistic about the applications of AI that could significantly influence practice in medicine, particularly in radiology (21).

Some undergraduate medical students had shown negative perceptions of the integration of AI in medical practice. They reported their concerns about time constraints amidst a huge curriculum (17). While some students agreed that they feel anxious about loss of future job prospects with the involvement of AI (22,23). According to a report on artificial intelligence in 2019, it had been mentioned that "Humans were always far better at inventing tools than using them wisely" (24, 25). To be effectively prepared for AI in the medical field, medical educators will need at least a basic understanding of AI in connection with learning and teaching, and the extent of AI integration with medicine (26). A study conducted in the UK revealed that the majority of students (78%) were concerned about working with, and expected to have prior training in AI (27). In the same research, after receiving basic training, the students felt more confident about AI (27). Furthermore, in a provincial survey done in Ontario, out of 321 medical students, 79% agree that more preparation was needed in medical education to increase readiness for the impact of AI in medicine, and 68% of the respondents think that AI training should begin at the university matriculation examination (UME) level. A high level of expectations for the integration of AI into healthcare and high confidence level to obtain AI proficiencies in undergraduate medical education was shown in that study (28). Ontario medical students' association also posted a position paper stressing the importance of training medical students for the inevitable transformative change that AI was going to make in healthcare settings (29).

Inequality of online access is an issue of consideration in this study. According to Antonio and Tuffley (2021), two-thirds of the world's population do not have access to the internet, with many of these being women. Meanwhile, women are 25% less likely to be online compare to men in developing countries. This scenario leads to a failure of empowering women with the knowledge and skills to access the benefits of current digital technologies (30). A study conducted among 707 elementary students in China revealed that male students reported higher confidence and readiness for AI compared to female students after attending an AI course (31).

Digital awareness is the acquisition of the knowledge, skills, and attitude required for individuals to use digital tools effectively. In this age, people are more digitally active, it makes it more important to see how literate they are digitally and helps them evaluate the information online with the help of these resources. The usage of electronic devices by medical students has undoubtedly been increasing

in recent years. Electronic devices connect users to the world and allow access to information instantaneously, and enable interaction with others effortlessly. A study on the use of electronic devices by medical students in Malaysia has been conducted to investigate the types of devices used by the students, the purpose of using them, and the impact on academic performances. It was found that students significantly embrace the use of electronic devices for academic purposes and have high levels of digital awareness (32).

Artificial intelligence is still a new field to be explored, especially its applicability in different healthcare departments; however, the potential of AI is promising and can increase the quality of healthcare around the world. Because the literature on AI among the medical student population in Malaysia is limited, it is crucial to investigate the readiness towards AI among medical students for future application. Therefore, this study is aimed at determining the readiness (cognition, ability, vision, ethics) among undergraduate medical students in Malaysia towards artificial intelligence.

METHODS

Study design and sampling

This cross-sectional study was conducted from March 2022 to April 2022, among undergraduate students in a private medical university in Malaysia. The sample size was estimated by using "Epi Info" statistical software, version 7.2.5.0. The expected frequency of understanding of AI was 83% in a previous study (28). The margin of error was 7% with a 95% confidence level. Taking a non-response percentage of 10% into consideration, the final estimated sample size for this study was 108.

In this study, the respondents were recruited by purposive sampling. Since this study intended to assess the readiness towards AI among medical students, only MBBS students were purposively recruited from the study institution (while the students from the other programs such as dental and foundation in medical sciences were excluded from the study). The inclusion criteria were MBBS students in the study university who willingly consented to participate in this study as well as completed all the required parts of the provided questionnaire. The exclusion criteria were students who did not consent to participate in the study and those who failed to complete the required parts of the questionnaire.

Data collection and analysis

The data was collected by the distribution of questionnaires via Google forms. Informed consent was obtained from the study respondents. In this study "Medical Artificial Intelligence Scale (MAIRS-MS)" was used after getting permission from the original developer (33). The original questionnaire MAIRS-MS was utilized in this study as it applied to all medical students worldwide. Group discussion was carried out with four medical students to ascertain the clarity of the question items. The respondents' demographic data were collected as follows, age, gender, ethnicity, and semester of study. Regarding medical artificial intelligence readiness for medical students (MAIRS-MS) questionnaire, a total of four domains were included, namely cognition, ability, vision, and ethics (33). The cognitive coefficient domain included items that measure a participant's cognitive readiness regarding terminology, knowledge related to medicine, application of artificial intelligence, artificial

logic, intelligence applications, and data science. Ability domain elements included items that measure a participant's ability to select and use the appropriate medical application for artificial intelligence. The vision domain assessed a participant's ability to describe constraints, strengths, and shortcomings linked to medical artificial intelligence, as well as anticipate opportunities and risks, and carry out concepts. The ethics domain assessed a participant's adherence to legal and ethical norms and rules when employing AI in healthcare. The responses to the MAIRS-MS questionnaire were recorded with a 5-point Likert scale, with the options of strongly agree, agree, neutral, disagree, and strongly disagree depending on the respondent's opinion. In the last section, questions about awareness of artificial intelligence usage in the medical field, previous training on AI, and attitude to including AI competencies into medical programs were included. As for the demographics profile and other questions regarding artificial intelligence, the respondents had to fill in based on the categories provided.

The data collected were entered into Microsoft Excel and the compiled data was statistically analyzed using Epi Info version 7.2.5.0 and PASW statistic software (Version 18). Descriptive statistics was applied to the demographic variables. Furthermore, inference and associated independent variables such as age, gender, study year, ethnicity, awareness of AI usage, the experience of previous AI training, attitude towards including AI competencies in the medical program, and medical AI readiness were analyzed by using unpaired t-test and one-way analysis of variance (ANOVA) test. The level of significance was set at $p \leq 0.05$ with a 95% confidence level.

Ethical consideration

The ethical approval to conduct this study was granted by the Research Ethic Committee, Faculty of Medicine, Manipal University College Malaysia.

RESULTS

Table 1 reports the sociodemographic characteristics of the respondents. A total of 105 respondents participated in this survey. The age of the respondents was classified into two groups for this study; 69 (65.71%) were aged 22–25, while the rest 36 (34.29%) were aged 19–21 years. Among the respondents, approximately one-third were male (35.24%) and two-thirds were female (64.76%). When evaluating the academic years, the majority of the respondents were in their clinical years (71.43%) (Table 1). The respondents' gender distribution corresponded to that of the student population at the study institution. However, there were fewer pre-clinical years' respondents in this study than clinical years.

Table 1: Sociodemographic characteristic of undergraduate medical students (n=105)

Variables	Frequency (%)
Age	
< 22 years	36 (34.29)
≥ 22 years	69 (65.71)
Mean (SD)	22.05 (1.54)
Minimum - Maximum	19 – 25

Gender	
Male	37 (35.24)
Female	68 (64.76)
Ethnicity	
Malay	10 (9.52)
Chinese	59 (56.19)
Indian	25 (23.81)
Others	11 (10.48)
Academic year	
Pre-clinical years	30 (28.57)
Clinical years	75 (71.43)

Table 2 shows the domain of AI readiness among the respondents. The normality test was assessed for all the domains of MAIRS-MS. The skewness and kurtosis of the domains were as follows: cognitive domain (-0.18, -0.77), ability domain (-0.68, 0.47), vision domain (-0.59, -0.39), and ethics domain (-0.72, 0.47). Therefore, the data was assumed to be the normal distribution. The cognitive domain had the highest mean score of 27.61 (standard deviation: 8.08), which was followed by the ability, vision, and ethics domain scores respectively. The mean of the total score of medical AI readiness was 75.04 (standard deviation: 20.56) (Table 2).

Table 2: Subscale of Artificial Intelligence readiness among undergraduate medical students in MUCM (n=105)

Subscale	Mean (SD)	Minimum – Maximum
Cognitive	27.61 (8.08)	8.0 – 40.0
Ability	27.17 (8.68)	8.0 – 40.0
Vision	10.19 (3.26)	3.0 – 15.0
Ethics	10.07 (3.54)	3.0 – 15.0
Total score	75.04 (20.56)	22.0 – 110.0

The results of this study showed that the mean score of AI readiness was 75.04. The mean score of the cognitive domain was 27.61, the ability domain was 27.17, the vision domain was 10.19, and the ethics domain was 10.07. From these mean scores, it was found that most of the undergraduate medical students (67.62%) had a total score of 53-83 marks, followed by 24.76% of students having a total score of 84-114 marks, and 7.62% of the students having a total score of 22-52 marks in the medical artificial intelligence readiness scale. This showed that majority of the students had an average score on the medical artificial intelligence readiness scale.

Table 3 shows the result of the association between the demographic characteristics of the respondents, previous exposure to AI, and the medical artificial intelligence readiness scale among the undergraduate medical students. The age of the respondents was significantly associated with the ability (P 0.047), vision (P 0.007), and ethics domains (0.008). Similarly, pre-clinical year students reported significantly higher readiness scores across three domains: ability (P 0.005), vision (P 0.001), and ethics domains (P <0.001). Furthermore, those who had attended AI training before had significantly higher readiness scores across the domains; cognitive (P <0.001), ability (P <0.001), vision (P <0.001), and ethics (P <0.001) (Table 3).

Table 3: The association between characteristics of respondents, previous experience and Artificial Intelligence readiness among undergraduate medical students (n=105)

Variable	Medical Artificial Intelligence Scale							
	Cognitive		Ability		Vision		Ethics	
	Mean (SD)	P	Mean (SD)	P	Mean (SD)	P	Mean (SD)	P
Age								
<22 years	28.72 (9.83)	0.310	29.50 (9.26)	0.047	11.36 (3.39)	0.007	11.33 (3.61)	0.008
>22 years	27.03 (7.0)		25.96 (8.17)		9.58 (3.04)		9.41(3.34)	
Gender								
Male	26.92 (6.29)	0.521	25.78 (8.20)	0.229	9.95 (2.67)	0.573	9.70 (2.98)	0.440
Female	27.99 (8.92)		27.93 (8.90)		10.32 (3.56)		10.26 (3.82)	
Ethnicity								
Malay	25.20 (6.32)	0.624	23.60 (7.07)	0.307	9.80 (2.25)	0.629	9.40 (2.41)	0.360
Chinese	28.44 (9.07)		28.39 (9.75)		10.56 (3.61)		10.54 (3.82)	
Indian	26.84 (6.24)		25.60 (6.03)		9.76 (2.86)		9.84 (3.47)	
Others	27.09 (7.76)		27.45 (8.50)		9.54 (2.98)		8.64 (2.73)	
Study year								
Pre-clinical	29.73 (10.12)	0.088	30.87 (9.55)	0.005	11.83 (3.43)	0.001	12.03 (3.51)	<0.001
Clinical	26.76 (7.00)		25.69 (7.90)		9.53 (2.97)		9.28 (3.26)	
Awareness of the use of Artificial Intelligence								
Yes	28.20 (8.12)	0.086	27.42 (9.12)	0.506	10.20 (3.44)	0.921	10.20 (3.64)	0.408
No	24.53 (7.32)		25.88 (5.72)		10.12 (2.15)		9.41 (3.02)	
Attended Artificial Intelligence training before								
Yes	32.10 (8.56)	<0.001	31.71 (9.00)	<0.001	11.48 (3.74)	<0.001	11.76 (3.69)	<0.001
No	24.62 (6.18)		24.14(7.03)		9.33 (2.60)		8.94 (2.97)	
Attitude to include Artificial Intelligence competencies in medical programme								
Yes	27.72 (8.22)	0.653	27.07 (8.84)	0.706	10.14 (3.33)	0.575	10.13 (3.60)	0.584
No	26.44 (6.62)		28.22 (7.12)		10.78 (2.44)		9.44 (2.88)	

DISCUSSION

This study aimed to assess the readiness towards artificial intelligence among undergraduate medical students in Malaysia. Their readiness was measured through the total marks that the students scored on the medical artificial intelligence readiness scale, which included four domains: cognitive, ability, vision, and ethics. A higher score indicated a higher agreement with the survey questionnaire statements, and a higher level of readiness towards artificial intelligence among undergraduate medical students in a private medical university in Malaysia.

In this study, the majority of the students had an average score on the medical artificial intelligence readiness scale. This result is supported by a previous cohort study in the UK, whereby nearly half of the total 484 medical students from UK medical schools responded they had a clear understanding of the basic computational principles that underpin AI (27). In a previous study among 928 students enrolled in technical and humanistic specializations at Timisoara (2018), 66.8% of the male and 51.5% of the female respondents believed that artificial intelligence development would bring positive

influences towards the future society. Furthermore, over half of the respondents stated that the development of AI will bring benefits to humankind, especially in the medical field. In addition, more than two-thirds of the respondents manifested a positive attitude towards the impact of AI on efficiency and simplification of human daily activities (20).

In this study, there were significant interdependences between age and ability, vision, and ethics domains of medical AI readiness. Younger students, aged less than 22 years, were better at assessing and using AI applications compared to older students with ages equal to or more than 22 years. However, there was no significant relationship between age and the cognitive domain of AI readiness. Based on the study results, both categories of medical students had a high mean score in all four domains. This showed that all the respondents were comfortable interacting with technology and as willing to embrace digital information as were their digital relatives, the generation z. They were raised in the digital era, grew up with digital gadgets, and were more confident working with AI technology (34).

This study showed that gender had was not significantly associated with medical AI readiness. This result was supported by a previous cross-sectional survey done on 707 elementary students who were engaged in an AI course in Beijing, China, in 2018 (31). It was found that there were no significant gender differences in students' AI literacy. The aforementioned finding indicates that both genders are receiving equal AI literacy education and exposure. Contrary to the stereotype of people claiming that engineering and technology are male-dominated fields, females are majoring in computer science and AI education programs. This might be caused by equal delivery and training of AI technology in school curriculum and classroom irrespective of gender. Society should continue to encourage this positive culture to motivate more females to reduce the stereotype in the community. In contrast, a previous study conducted among 928 students in technical and humanistic specializations at Timisoara (2018) reported that male respondents had a higher degree of artificial intelligence information and literacy. However, more male students (65.2%) and fewer female students (42%) appeared to be less concerned about the development of artificial intelligence (20). Interestingly, in a previous study by Dos Santos et al. (2019), male respondents were more confident in using AI applications and less fearful of AI technologies (19). A significant difference between gender and AI integration into clinical practice was established in a previous study on physician perspectives on the integration of artificial intelligence into diagnostic pathology, done by Sarwar (2019), in Canada. In this study, males were more comfortable working with computer science technology than females (18).

A significant correlation between study year and medical AI readiness was established in this study. Preclinical students were found to have a higher degree of ability, vision, and ethics component of medical AI readiness compared to clinical students. However, there was no significant association between study year and the cognitive domain of medical AI readiness. In a previous provincial survey conducted in Ontario which had 321 medical students participating, the majority of students (79%) claimed that their medical education was inadequately preparing them to work alongside AI tools or applications. They agreed that more preparation was needed in the medical program to increase their AI readiness level (28).

No significant association between awareness of AI use in the medical field and medical AI readiness was found in this study. However, based on the findings of this study, the majority of the students showed a high degree of awareness of the use of AI in medicine. A cohort study was done on 484 medical students from 19 out of 34 UK medical schools, and it was found that the majority (88%) of the students were aware and had a positive attitude towards the role and use of AI in healthcare (27). In a previous provincial survey study of 321 medical students at 4 medical schools in Ontario, it was found that 76% of the respondents were aware and showed optimism regarding AI performance in clinical decision-making and diagnosis-establishment. In addition, 83% believed that interpretation of diagnosis making by AI would be attained within 25 years (28). Interestingly, a previous study by Dos

Santos et al. (2019), found that around 68% were unaware of the AI application in radiology while 52% were aware of certain AI technologies. Eighty-three per cent (83%) of the respondents trusted AI technology in detecting pathologies in radiological examinations (19).

This study showed that there was a significant association between previous training and medical AI readiness. In a previous cohort study in the UK, out of 484 medical students, students who received previous training in AI were more positive towards medical AI readiness and were more prepared to collaborate with AI technology. Students who had previous AI training were more likely to choose the radiology profession. This might be because the interested students are more aware of the limitations of AI that preclude AI replacement of radiologists (27). In a survey involving 121 students and 52 clinical faculty of Medical College of Georgia (MCG), students and faculty both agreed that AI will revolutionize medical practice, improve future healthcare systems, and it should be part of medical education and training (17).

In this study, there was no significant link between attitude towards including AI competencies in medical programs and medical AI readiness. However, a majority of the students showed a positive attitude to the integration of AI in medical programs. This result is supported by a previous survey that was conducted at four medical schools in Ontario, with 321 medical students (28). The result showed that 72% of students agreed when asked whether medical training should include AI competencies, and approximately 52% of them agreed that AI training should be mandatory. Seventy-nine per cent (79%) agreed that more preparations were needed in medical education for the impact of AI in medicine. In a previous study on medical students' attitudes towards artificial intelligence by Dos Santos (2019), out of 263 students, 71% of the respondents agreed with the inclusion of AI competencies in medical programs (19).

Limitations

There are some limitations to this study. Since it was a cross-sectional study, we could not gauge any changes in attitude and ability to use AI technology over time. Another limitation in this study was a possibility of the presence of social desirability bias; participants might have responded however they thought would be favorable to the researcher, rather than choose responses that resonated with them. This study was conducted in one private medical institution and respondents were recruited by non-probability sampling, therefore generalization of the findings might be limited in other settings. Since this study was a quantitative cross-sectional study, the findings were not able to explore details of the student's attitudes and perceptions towards AI.

Conclusion and recommendations

In conclusion, medical artificial intelligence readiness among medical students studying in the university was fairly adequate. The majority of the students reported a broad and deep interest in AI topics, and were optimistic about AI applications in medicine. There was a significant correlation between age, study year, and previous training with the medical AI readiness. Therefore, undergraduate medical students should be encouraged to get involved with and expose themselves to AI technology training. The more the students are exposed to AI technology, the higher the level of their AI readiness, ensuring their higher confidence to work together with AI technologies in medicine in the future. Policymakers and medical educators should set up more AI training centers to provide AI training courses either online or offline to introduce and provide basic courses on AI. Medical schools should design and include more interesting medical AI knowledge into their programs and provide appropriate practical AI training for medical students. Apart from the ability to work with AI technology, students should also learn and be concerned about the ethics of artificial intelligence.

Solutions should be found to reduce the societal risks from intelligent machines. Future qualitative research should explore medical students' attitudes and perceptions towards AI. Furthermore, future research should take into account the potential changes in medical AI readiness with regards to time. Artificial intelligence knowledge and skills related to the medical field should be improved among medical students to ensure a healthy AI ecosystem that leads to the development of innovative AI technologies and firms.

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