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Research Article

Evaluation of the Medical Artificial Intelligence Readiness Status of Medical Faculty Students: A Cross-Sectional Study

Tıp Fakültesi Öğrencilerinin Tıbbi Yapay Zeka Hazır Bulunuşluk Durumlarının Değerlendirilmesi: Kesitsel Bir Çalışma

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Abstract

Aim: This study aims to evaluate the readiness status of medical faculty students regarding medical artificial intelligence and to determine whether it varies according to demographic characteristics. **Materials and Methods:** The study population consists of medical faculty students in Kayseri province. Accordingly, 368 medical faculty students voluntarily participated in the cross-sectional study conducted between June 1 and July 15, 2024. The "Medical Artificial Intelligence Readiness Scale" consisting of 22 items, was used in the study, and data were collected through a survey technique. The SPSS software package was used for the analysis of the collected data, employing descriptive analysis, correlation analysis, t test, and ANOVA. **Results:** The study revealed that medical school students' level of readiness for medical artificial intelligence and their mean scores in the skill, foresight and ethical sub dimensions were high, while their mean scores in the cognitive sub dimension were low. In addition, medical faculty students' medical artificial intelligence readiness levels and cognitive, skill, foresight and ethical sub dimension averages significantly differed according to demographic characteristics (gender, age and class). **Conclusion:** The research findings indicate that medical school students have above-average readiness for medical artificial intelligence. This study is considered to guide the development of a new curriculum in medical education and to provide significant practical contributions to the medical education literature.

Öz

Amaç: Bu çalışma tıp fakültesi öğrencilerinin tıbbi yapay zeka hazır bulunuşluk durumlarını değerlendirmek ve demografik özelliklere göre farklılık gösterip göstermediğini ortaya koymak amacıyla yapılmıştır. **Gereç ve Yöntem:** Araştırma evrenini Kayseri ilindeki tıp fakültesi öğrencileri oluşturmaktadır. Bu doğrultuda 01 Haziran-15 Temmuz 2024 tarihleri arasında yapılan kesitsel çalışmaya 368 tıp fakültesi öğrencisi gönüllü katılmıştır. Çalışmada 22 ifadeden oluşan "Tıbbi Yapay Zeka Hazır Bulunuşluk Ölçeği" kullanılmış olup veriler anket tekniği ile toplanmıştır. Elde edilen verilerin analizinde SPSS paket programı kullanılmış olup verilerin analizinde tanımlayıcı analizler, korelasyon analizi, t-testi ve ANOVA analizlerinden yararlanılmıştır. **Bulgular:** Çalışma, tıp fakültesi öğrencilerinin tıbbi yapay zeka hazır bulunuşluk düzeyleri ile beceri, öngörü ve etik alt boyut puan ortalamalarının yüksek, bilişsel alt boyut puan ortalamalarının ise düşük olduğunu ortaya koymuştur. Ayrıca, tıp fakültesi öğrencilerinin tıbbi yapay zeka hazır bulunuşluk düzeyleri ile bilişsel, beceri, öngörü ve etik alt boyut ortalamalarının demografik özelliklere (cinsiyet, yaş ve sınıf) göre anlamlı farklılıklar gösterdiği tespit edilmiştir. **Sonuç:** Araştırma bulguları tıp fakültesi öğrencilerinin tıbbi yapay zeka konusunda ortalamanın üzerinde bir hazır bulunuşluğa sahip olduğunu göstermektedir. Bu çalışma, tıp eğitiminde yeni bir müfredatın gelişiminde yol gösterici bir çalışma olacağı ve tıp eğitimi alan yazınına uygulamaya yönelik önemli katkılar sağlayacağı değerlendirilmektedir.

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INTRODUCTION

Artificial intelligence (AI) consists of systems that acquire abilities similar to human intelligence, performing tasks such as learning, problem-solving, perception, and decision-making while continuously improving themselves. Today, innovations in the field of artificial intelligence have begun to significantly impact not only production, banking, education, transportation, and psychology but also the healthcare sector. AI technologies, which facilitate physicians' work by providing solutions to numerous health problems, are further accelerating the interaction between medicine and artificial intelligence (1, 2).

Applications of artificial intelligence in the healthcare field allow for the collection, classification, and analysis of health data; conduct imaging procedures (such as radiology and pathology); support diagnostic, therapeutic, and surgical applications; and alert relevant staff and patients when necessary. Considering the benefits and contributions of these processes, adapting to and effectively using medical artificial intelligence applications has become necessary for healthcare professionals (1).

Especially in today's digital age, it is believed that health technologies will make significant contributions to improving the quality of healthcare services and ensuring effective and efficient service delivery (2). With medical artificial intelligence applications, it is possible to quickly and accurately analyze conditions such as lung diseases, eye diseases, breast cancer, and skin cancer (3, 4). Additionally, artificial intelligence applications can facilitate the diagnosis of cardiovascular diseases through the analysis of heart examinations and diagnose certain psychological and neurological diseases through the analysis of speech patterns. Furthermore, AI is capable of performing specific procedures in robotic surgery. As a result, AI applications help provide healthcare services to more patients by reducing the workload of healthcare workers and preventing time loss (5-7). In this context, the use of artificial intelligence applications in the healthcare field has been increasing in recent years. Medical AI applications are believed to enable physicians to make reliable and accurate diagnoses, implement effective treatments, prevent erroneous practices, and reduce patient waiting times (8, 9).

Considering the rapid changes and transformations in technology, the development of artificial intelligence technologies and potential challenges will significantly impact medical education. Therefore, medical students should learn about clinical AI systems and modelling methods before graduation to use and adapt to continuously evolving AI technologies. Their awareness should be increased, and they should be prepared for AI applications through professional practice (10, 11). Owing to the limited information on artificial intelligence in the medical education curriculum and the uncertain knowledge levels of students, the readiness for behavioral change toward artificial intelligence technologies is highly important. Readiness is defined as being psychologically, socially, behaviorally, cognitively, and sensorially prepared to engage in an activity (12). Evaluating readiness status enables the identification of an individual's current state toward technology, the determination of individual needs, and planning and preparation for the future. Considering the rapid advancements in the field of medical artificial intelligence, it is believed that artificial intelligence will become a significant part of medical education in the coming years (13). Therefore, evaluating the readiness status of medical students for medical artificial intelligence is crucial, as it will guide educational design and development.

Upon reviewing the relevant literature, a study conducted by Gencer and Gencer (14) aimed at evaluating the readiness status of medical students for medical artificial intelligence revealed that the readiness levels of students were low. A study conducted by Abdullah et al. (15) in Pakistan, aimed at examining the awareness and knowledge levels of general practitioners regarding artificial intelligence, revealed that the majority of participants (54.8%) had low awareness. A study conducted by Pinto et al. (16) aimed at evaluating the attitudes of medical students towards artificial intelligence revealed that the participants exhibited positive attitudes towards artificial intelligence. A study conducted by Abid et al. (17) aimed at evaluating the attitudes of medical students towards artificial intelligence in the Peshawar region of Pakistan revealed that the majority of students (61.7%) lacked knowledge about artificial intelligence. A study conducted by Emir et al. (18) revealed that medical students had high levels of readiness and awareness regarding medical

artificial intelligence. A study conducted by Öcal et al. (19) aimed at determining medical students' thoughts on artificial intelligence in medicine reported that the majority of students (59.2%) lacked knowledge of artificial intelligence but were willing to use it in their professional careers.

In the literature review, although studies have been conducted to determine the readiness level of medical artificial intelligence technologies for medical faculty students in the field of health, there are not enough studies in the national literature. In this context, the aim of this study is to evaluate the readiness of medical faculty students for medical artificial intelligence and to determine whether it varies according to demographic characteristics. In line with this aim, this study contributes to filling the gap in the literature and provides practical insights for the development of a new curriculum in medical education. On the basis of the literature review, the research hypotheses are formulated as follows.

Hypothesis 1. Medical faculty students have a high level of readiness for medical artificial intelligence.

Hypothesis 2a. Medical artificial intelligence readiness levels and sub dimensions of medical faculty students significantly differ according to gender.

Hypothesis 2b. Medical artificial intelligence readiness levels and sub dimensions of medical faculty students significantly differ according to the age group variable.

Hypothesis 2c. Medical artificial intelligence readiness levels and sub dimensions of medical faculty students significantly differ according to the class variable.

MATERIALS AND METHODS

Research Design and Sample

This cross-sectional study was conducted with quantitative research method. The research population consists of 2175 medical faculty students. The sample size representing the research population was determined as at least 326 according to the sample size determination formula developed by Özdamar (20) and simple random sampling method was used. Inclusion criteria included being an active medical faculty student during the study period and volunteering to participate in the research. Exclusion criteria were incomplete or invalid survey responses. In this study, online survey technique was used and data was collected from 368 students who volunteered to participate in the study. Ethics committee approval dated 24.05.2024 and numbered 99868 was obtained from Kayseri University ethics committee. STROBE checklist was used in the study.

Data Collection Tools

Two different measurement tools were used in the study. The first one is the "Medical Artificial Intelligence Readiness Scale" developed by Karaca et al. (11), which consists of 22 statements. The scale has cognitive sub dimension (8 statements), skill sub dimension (8 statements), foresight sub dimension (3 statements) and ethical sub dimension (3 statements). The scale is a 5-point Likert scale (strongly disagree (1)-disagree (2)-neither agree nor disagree (3)-agree (4)-strongly agree (5). The second is a measurement tool to determine sociodemographic characteristics, consisting of three statements (gender, age group and class). Karaca et al. (11) found Cronbach's Alpha (CA) coefficient to be 0.87. There are no reverse coded statements in the scale. It is evaluated that the increase in the scores obtained from the scale will increase the level of readiness for artificial intelligence in medicine, and the decrease in the scores will decrease. The average threshold value is 3.

Statistical Evaluation of Data

The SPSS 22 package program was used in the statistical analysis of the data obtained. The Cronbach’s alpha value of the Medical Artificial Intelligence Readiness Scale was measured at 0.953. The Cronbach’s alpha values for the sub dimensions of the scale were measured as follows: 0.865 for the cognitive sub dimension, 0.867 for the skills sub dimension, 0.860 for the foresight sub dimension, and 0.809 for the ethical sub dimension. Accordingly, the Medical Artificial Intelligence Readiness Scale can be considered highly reliable. Since the skewness and kurtosis values of the data were within the ±1.5 range and showed a normal distribution, parametric tests were used. Descriptive statistics, correlation analysis, t tests and ANOVA (post hoc analyses to analyze differences) were used to analyze the data obtained. Statistically, significance level was accepted as ($p<0.05$).

RESULTS

Table 1 presents the percentages and frequency distributions of the demographic characteristics of the medical faculty students who participated in the study.

Table 1. Demographic characteristics of the students (n=368)

Variables	n	%
Gender		
Female	165	44.8
Male	203	55.2
Age group		
Under 20	95	25.8
21-24	129	35.1
25 and above	144	39.1
Class		
1st	65	17.7
2nd	68	18.5
3rd	39	10.6
4th	56	15.2
5th	57	15.5
6th	83	22.6
Total	368	100

Table 1 shows that 55.2% of the medical faculty students who participated in the study were male, 39.1% were 25 years and over, 22.6% were sixth-year students, and the average age of the participants was approximately 24 years. In this study, no missing data were observed as all survey responses were complete and valid.

Table 2 presents the descriptive statistics and correlation analysis of medical faculty students' readiness for medical artificial intelligence. The analysis of the obtained data revealed that the overall average readiness of students for medical artificial intelligence is ($\bar{x}$=3.12), with a cognitive sub dimension of ($\bar{x}$=2.81), a skill sub dimension of ($\bar{x}$=3.33), a foresight sub dimension of ($\bar{x}$=3.31), and an ethical sub dimension of ($\bar{x}$=3.18).

In line with these findings, medical faculty students' medical artificial intelligence readiness, skill, foresight and ethics sub dimensions are high above the average threshold value ($\bar{x}$=3), whereas the cognitive sub dimension is low below the threshold value ($\bar{x}$=3). Accordingly, Hypothesis 1 was accepted.

Table 2. Findings on medical artificial intelligence readiness

Variables	$\bar{x}$	S.D.	1	2	3	4
Medical AI Readiness	3.12	0.638				
1. Cognitive Sub dimension	2.81	0.708	1			
2. Skill Sub dimension	3.33	0.584	0.882**	1		
3. Foresight Sub dimension	3.31	0.780	0.831**	0.789**	1	
4. Ethics Sub dimension	3.18	0.769	0.859**	0.816**	0.597**	1

n=368; ** p<0.01; Pearson correlation

Correlation analysis revealed a high level of positive relationships between the sub dimensions of readiness for artificial intelligence in medicine.

In Table 3, a t test was conducted to determine whether the medical artificial intelligence readiness of medical faculty students and its sub dimensions differ according to gender. The overall medical artificial intelligence readiness, cognitive sub dimension, skill sub dimension, and ethical sub dimension of medical faculty students differ significantly according to sex (p=0.000), whereas the foresight sub dimension does not significantly differ (p=0.955).

The average scores for overall medical artificial intelligence readiness, the cognitive sub dimension, the skill sub dimension, and the ethical sub dimension of female medical faculty students ($\bar{x}$=3.32; $\bar{x}$=2.98; $\bar{x}$=3.58; $\bar{x}$=3.58) were found to be higher than those of male medical faculty students ($\bar{x}$=2.95; $\bar{x}$=2.67; $\bar{x}$=3.13; $\bar{x}$=2.85). Accordingly, Hypothesis 2a was partially accepted.

Table 3. t test results for medical artificial intelligence readiness according to the gender variable

Variables	Gender	x̄	S.D.	t	p
Medical AI Readiness	Female	3.32	0.513	6.040	**<0.001***
	Male	2.95	0.680		
Cognitive Sub dimension	Female	2.98	0.599	4.318	**<0.001***
	Male	2.67	0.760		
Skill Sub dimension	Female	3.58	0.336	8.509	**<0.001***
	Male	3.13	0.659		
Foresight Sub dimension	Female	3.30	0.661	0.057	0.955
	Male	3.31	0.867		
Ethics Sub dimension	Female	3.58	0.772	10.141	**<0.001***
	Male	2.85	0.586		

n=368; *p<0.05; Independent sample t test

In Table 4, a one-way analysis of variance (ANOVA) was conducted to determine whether medical artificial intelligence readiness and its sub dimensions differ according to age group. Initially, Levene's test was performed to assess the homogeneity of variances, and it was found that the variances were distributed homogeneously (p>0.05). The overall medical artificial intelligence readiness, cognitive sub dimension, skill sub dimension, foresight sub dimension, and ethical sub dimension of medical faculty students significantly differed according to the age group variable (p=0.000; p<0.05). Accordingly, Hypothesis 2b was accepted.

To identify which groups the differences exist between, a post hoc analysis was conducted using Tukey's test. According to this analysis, the average overall medical artificial intelligence readiness of medical faculty students aged 21-24 years (x̄=3.49) was found to be greater than that of students under 20 years (x̄=2.93) and those aged 25 years and above (x̄=2.90). The average scores for the cognitive sub dimension of medical faculty students aged 21-24 years (x̄=3.25) were found to be higher than those of students under 20 years (x̄=2.51) and those aged 25 years and above (x̄=2.58). The average scores for the skill sub dimension of medical faculty students aged 21-24 years (x̄=3.59) were found to be higher than those of students under 20 years (x̄=3.31) and those aged 25 years and above (x̄=3.11). Additionally, the average scores of students aged 25 years and above (x̄=3.11) were lower than those of students under 20 years (x̄=3.31). The average scores for the foresight sub dimension of medical faculty students aged 21-24 years (x̄=3.59) were found to be higher than those of students under 20 years (x̄=3.04) and those aged 25 years and above (x̄=3.22). The average scores for the foresight sub dimension of medical faculty students under 20 years of age (x̄=3.04) were lower than those of students aged 25 years and above (x̄=3.22). The average scores for the ethical sub dimension of medical faculty students aged 21-24 years (x̄=3.68) were found to be higher than those of students under 20 years (x̄=2.91) and those aged 25 years and above (x̄=2.90).

One-way analysis of variance (ANOVA) was conducted to determine whether medical artificial intelligence readiness and the sub dimensions of medical faculty students differ according to the class variable. Initially, Levene's test was performed to assess the homogeneity of variances, and it was found that the variances were distributed homogeneously (p>0.05). According to the obtained data, the overall medical AI readiness of medical school students, as well as the cognitive, skill, foresight, and ethical sub dimensions, significantly differed across classes (p<0.05). Accordingly, Hypothesis 2c was accepted.

To identify which groups the differences exist between, a post hoc analysis was conducted using Tukey's test. Accordingly, the mean overall medical AI readiness of 4th-year medical students (x̄=3.37) was greater than that of 1st-year (x̄=2.93) and 3rd-year students (x̄=2.91). Additionally, the mean cognitive sub dimension scores of the 4th-year medical students (x̄=3.13) were higher than those of the 1st-year (x̄=2.58), 2nd-year (x̄=2.77), and 3rd-year students (x̄=2.60). The mean skill sub dimension scores of the 4th-year medical students (x̄=3.47) were greater than those of the 3rd-year students (x̄=3.14).

The mean foresight sub dimension scores of the 6th-year medical students ($\bar{x}$=3.61) were higher than those of the 1st-year students ($\bar{x}$=3.04). Additionally, the mean ethical sub dimension scores of the 4th-year medical students ($\bar{x}$=3.81) were higher than those of the 1st-year ($\bar{x}$=2.98), 2nd-year ($\bar{x}$=3.16), 3rd-year ($\bar{x}$=2.85), 5th-year ($\bar{x}$=3.25), and 6th-year students ($\bar{x}$=3.03).

DISCUSSION

In today's rapidly evolving technological landscape, medical artificial intelligence has begun to play a significant role in various areas of healthcare and medical education. In particular, integrating medical AI applications into the medical education curriculum will provide medical students with new knowledge and skills in analyzing complex data, making accurate and rapid diagnoses, planning treatments, and delivering efficient, effective, and high-quality healthcare services. Thus, upon graduation, they will not face any issues adapting to medical AI technologies. Accordingly, this study was conducted to assess the medical AI readiness of medical students. The majority of the participating students were male (55.2%), aged 25 and over (39.1%), and in their 6th year (22.6%).

In this study, the medical AI readiness levels of medical students were found to be above the median value. Accordingly, it can be said that medical students are somewhat ready to use medical AI technologies. The findings of the study align with those of Karaca et al. (11), Emir et al. (18), and Moodi Ghalibaf et al. (21) in measuring the medical AI readiness of medical students. However, they do not align with the results of studies conducted by Gencer and Gencer (14), Abdullah et al. (15), Pinto et al. (16), Abid et al. (17), and Öcal et al. (19). Accordingly, Hypothesis 1 was accepted. The study examined whether medical AI readiness levels and sub dimensions differ significantly across medical students on the basis of certain demographic characteristics. The analyses revealed that the medical AI readiness levels and sub dimensions of medical students significantly differed according to sex, age group, and year of study. Accordingly, Hypothesis 2a, Hypothesis 2b, and Hypothesis 2c were accepted.

Table 4. ANOVA results of medical artificial intelligence readiness according to age group and class variables

	Medical AI Readiness			**Cognitive Sub dimension**			**Skill Sub dimension**			**Foresight Sub dimension**			**Ethics Sub dimension**		
Age group	**$\bar{x}$**	**p**	**Diff.**	**$\bar{x}$**	**p**	**Diff.**	**$\bar{x}$**	**p**	**Diff.**	**$\bar{x}$**	**p**	**Diff.**	**$\bar{x}$**	**p**	**Diff.**
Under 20	2.93		**1<2**	2.51		**1<2**	3.31		**1<2**	3.04		**1<2**	2,91		**1<2**
21-24	3.49	<**0.001***	**3<2**	3.28	<**0.001***	**3<2**	3.59	<**0.001***	**3<2**	3.59	<**0.001***	**1<3**	3,68	<**0.001***	**3<2**
25	2.90			2.58			3.11		**3<1**	3.22		**3<2**	2,90		
Class															
1st	2.93			2.58			3.20			3.04			2,98		
2nd	3.13		**1<4**	2.77		**1<4**	3.43			3.28			3,16		**1<4**
3rd	2.91	**0.002***	**3<4**	2.60	<**0.001***	**2<4**	3.14	**0.028***	**3<4**	3.21	**0.001***	**1<6**	2,85 <	**0.001***	**2<4**
4th	3.37			3.13		**3<4**	3.47			3.26			3,81		**3<4**
5th	3.16			2.88			3.35			3.32			3,25		**5<4**
6th	3.15			2.84			3.32			3.61			3,03		**6<4**

n=368; *p<0.05; Diff.=Differences

Accordingly, compared with their male counterparts, female medical students were found to have significantly greater overall medical AI readiness, as well as higher cognitive, skill, and ethical sub dimension scores, with no significant difference observed in the foresight sub dimension. The higher readiness levels among female students may be attributed to various social, psychological, and educational factors. The higher readiness levels among female students can be attributed to their faster grasp of their cognitive abilities, greater emphasis on learning processes, increased effort, higher propensity for group work, and more sensitive and empathetic approach to ethical issues. These findings do not align with the results of studies conducted by Gencer and Gencer (14), Xuan et al. (22), and Jebreen et al. (23).

Significant differences were found between medical students' overall medical AI readiness and the cognitive, skill, foresight, and ethical sub dimensions across age groups. The mean levels of medical AI readiness and its sub dimensions were significantly greater among students aged 21-24 years than among those in other age groups (20 years and younger and 25 years and older). The higher medical AI readiness levels among students aged 21-24 years can be attributed to factors such as their advanced cognitive capacity, progress in education, familiarity with technology, and effective time management compared with those of students under 20 years, who are just beginning their education, and those over 25 years, who are nearing graduation. These findings are consistent with the results of the study conducted by Xuan et al. (22).

Significant differences were found between medical students' overall medical AI readiness and the cognitive, skill, foresight, and ethical sub dimensions based on class year. The overall medical AI readiness levels, as well as the cognitive, skill, and ethical sub dimension scores, were higher among 4th-year medical students than among those in other classes. Compared with students in other years, 4th-year medical students who have completed basic medical science education and advanced to clinical practice are considered better prepared in terms of cognitive competence, practical skills, and ethical behavior. Additionally, 6th-year students have higher foresight sub dimension scores than do students in other years. The greater degree of foresight among 6th-year students is due to their advanced clinical experiences and patient management skills. These findings do not align with the results of the study conducted by Gencer and Gencer (14).

The findings of high levels of medical AI skills, foresight, and ethical sub dimensions indicate that students possess practical competencies and ethical sensitivities regarding AI applications. These results are significant for the integration of AI applications into medical decision-making processes and for adhering to ethical standards in patient care. However, the low scores in the cognitive sub dimension suggest that students lack sufficient knowledge about the fundamental concepts and theoretical foundations of AI. This indicates that more emphasis needs to be placed on theoretical knowledge of artificial intelligence in medical education. Additionally, identifying differences on the basis of demographic factors (gender, age group, and class) suggests that AI education should be tailored to meet students' specific needs. Due to time and cost limitations, the study was limited to medical students in Kayseri province and the measurement tool used. Accordingly, it is difficult to generalize the findings obtained to all medical students. It should be taken into consideration that the data were collected in a certain time interval and different results may be obtained in studies conducted at different times.

CONCLUSION AND RECOMMENDATIONS

In conclusion, this study is expected to make significant contributions to the integration of medical education and artificial intelligence by evaluating medical students' readiness for medical AI. The study demonstrated that, overall, medical students possess a readiness level for medical AI that is above average. This finding indicates that students recognize the importance of AI in the medical field and are open to learning about it. In this context, to enhance knowledge, skills, and awareness regarding the use of medical AI, which is increasingly impacting medical practice, it is essential to include the topic comprehensively in the medical school curriculum and develop it according to needs. This includes strengthening theoretical training content and increasing opportunities for clinical practice. For more comprehensive results in future studies, similar research should be conducted with medical students in different regions. Comparing the results of such studies across various locations could reveal variations between studies. Additionally, long-term follow-up studies on the development of medical students' education in medical AI are considered highly beneficial.

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