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Research article

Determining medical students' anxiety and readiness levels about artificial intelligence

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ABSTRACT

The aim of this study is to determine the levels of anxiety and readiness among medical students regarding artificial intelligence (AI) and examine the relationship between these factors. The research was conducted on medical students, and the data was collected through face-to-face and online surveys between April and June 2022. The study utilized a socio-demographic information form, an AI anxiety scale, and a medical AI readiness scale. The data collected from a total of 542 students were analyzed using the Statistical Program for Social Sciences (SPSS) version 25. Cronbach's α coefficient was used for reliability analysis. A path diagram was created using AMOS 24, and structural equation modelling (SEM) analysis was applied. The findings of the study indicate that medical students have a moderate level of readiness and a high level of anxiety regarding AI. Furthermore, an inverse relationship was found between AI readiness and AI anxiety. These results highlight the importance of increasing the preparedness of medical students for AI applications and reducing their anxieties. The study suggests the inclusion of AI in the medical curriculum and the development of a standardized curriculum to facilitate its teaching.

1. Introduction

Artificial Intelligence (AI) is one of the most popular technological achievements of recent times. Artificial intelligence and related applications are developing more and more every day and taking their place in both daily and professional fields. Health is an area where technological change is frequent and has a significant impact. It can be seen that the use of and interest in AI in this field has increased in recent years [1,2].

It is said that the history of artificial intelligence dates back to Aristotle. Alan Mathison Turing's "Can machines think?" question has started discussions in this field. However, the concept of artificial intelligence was first used by John McCarthy at a conference. McCarthy defined artificial intelligence as "the science and engineering of making intelligent machines, especially intelligent computer programs". It emerged in studies in the field of health in the 1970s [3].

Today, artificial intelligence is used in many stages from diagnosis to treatment in the field of health. Artificial intelligence applications are seen being used in disease diagnosis in many fields such as respiratory and digestive diseases, cancer, heart diseases, eye diseases, medical decision making, medical imaging, medical record keeping, drug development and many more areas. In the field of

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health, applications with various artificial intelligence technologies continue to be developed to avoid unnecessary treatments, to diagnose disease before it becomes critical, to correctly analyze various scans in a shorter time, to help doctors make the right decisions so that patients can manage their diseases [3–9]. Artificial intelligence in health is predicted to make a positive contribution to many applications from diagnosis to treatment in the future, and many doctors and healthcare professionals are expected to use AI technology [1,2,8].

Although AI is unlikely to replace doctors and nurses, it is widely recognized as a reliable tool for clinical decision-making [6]. Medical students who are future doctors are candidates to use this technology in their professional practice. It is inevitable for students to adapt to changes related to artificial intelligence [9]. Additionally, problem identification in AI is important to ensure its applicability to these applications [10]. In this regard, it is important to assess medical students' readiness for artificial intelligence technologies and their application in medicine, and to determine their level of anxiety. This study aims to determine the levels of anxiety and readiness of medical school students for artificial intelligence and to investigate the relationship between them.

2. Methods

The population of this research, which is planned as a relational screening model, consists of medical school students in Türkiye. The data of the research were collected face to face and through Google Forms between April and June 2022. The students were reached by sharing the research form by the administrators of the groups in which the students participated, via social media. While collecting data, a limitation has been imposed on the system so that each participant can send a response only once. Data is controlled by IP and cookies.

Socio-demographic Information Form: This form developed by the researchers for the current study includes socio-demographic questions such as gender, family type, income status, parental education level, frequency of computer use, and level of artificial intelligence knowledge.

Artificial Intelligence Anxiety Scale: The scale was developed by Wang and a Turkish validity and reliability study was conducted by Terzi. The scale consists of 4 sub-dimensions including learning at scale, job change, sociotechnical blindness, and artificial intelligence configuration and a total of 21 items. The scale is a 7-point Likert type. A minimum score of 21 and a maximum of 147 points can be obtained from the scale [11].

Medical Artificial Intelligence Readiness Scale: The scale was developed by Karaca et al. to measure the level of artificial intelligence readiness of medical school students. The scale is a 5-point Likert type, consisting of a total of 22 items. The scale has 5 subdimensions: cognitive factor, skill factor, anticipation factor, ethical factor and medical artificial intelligence readiness. A high score on the scale indicates high readiness for medical AI [1].

Sample Size: The sample for this study was determined by power analysis. According to the calculation made using G*power 3.1 program; A sample size of at least 476 was determined with an effect size of 0.15, a margin of error of 0.05, a confidence level of 0.95, and a representativeness of the population of 0.95 [12]. Cohen (1988) suggests that a sample size should be achieved that calculates power values between 0.90 and 0.99 [13].

2.1. Ethical aspects of research

Malatya Turgut Özal University has obtained approval from the Non-Interventional Ethics Committee (No:2022/34) for the study; Permission was obtained from the scale owners and consent was obtained from the participants. The students participating in the research were informed about the study and it was stated that the data would only be used within the scope of the research. Informed consent was obtained.

2.2. Limitations of the research

Collecting research data online and not being able to reach all medical school students are the limitations of the research.

2.3. Statistical analysis

The data included in the study were analyzed using the SPSS (Statistical Program for Social Sciences) 25 program. Cronbach's α coefficient was used for reliability analysis. A path diagram was constructed using AMOS 24 and structural equation modeling (SEM) analysis was applied.

For multiple normal distribution control, 26 of 568 questionnaires collected using Mahalanobis Distance were excluded from the study [14]. The multiple normal distribution skewness value of the model was calculated as 6.558, and since it was less than 8, multiple normal distribution was achieved [15].

The most important difference between SEM and classical regression analysis is that more than one relationship can be tested simultaneously. Researchers can test the relationships between observed and unobserved variables through their analysis. BAIT; measurement errors and the co-variances between these errors are included in the model. SEM, which allows the analysis of direct and indirect relationships between variables, also provides a visual representation of the analysis to researchers [16,17].

3. Results

A total of 542 students participated in the study. 63.7% (n = 345) of students were female and 36.3% (n = 197) were male. The mean age is 20.62 ± 2.04. 46.1% of students were in the first grade, 13.3% in the second grade, 17% in the third grade, 11.4% in the fourth grade, 3.7% in the fifth grade, and 8.5% in the sixth grade. 90.8% of the students have a nuclear family structure, 86.3% have a moderate family income level, 36.2% of their mothers are secondary school graduates and 43.4% of their fathers have completed a bachelor's degree. 68.8% of students have average knowledge about computers, 53.7% have little use of the computers, 97.8% have heard about artificial intelligence before, but only 9.4% have sufficient knowledge about artificial intelligence and stated that it was adequate (Table 1).

The average of the artificial intelligence readiness score of the students who participated in the study was 61 ± 15.58; The mean score on the AI anxiety scale is 74.55 ± 26.03. The mean scores according to the sub-dimensions of the scales are presented in Table 2.

3.1. Modelling of the relationship between scales with SEM

In order to model the relationship between the "Medical Artificial Intelligence Readiness" and "Artificial Intelligence Anxiety" scales used in the study, a path diagram was established and the model was analyzed. The path diagram of the model, in which the "Artificial Intelligence Anxiety" scale was taken as the dependent variable and the "Medical Artificial Intelligence Readiness" scale as the independent variable, is given in Fig. 1.

The statistical significance of the regression coefficients in the arrows is checked when interpreting the relationships between the scales. Information about regression coefficients and significance values in the model is presented in Table 3.

The model fit indices were $\chi 2$ 118,252, df 19, $\chi 2/df$ 6.224, CFI 0.966, GFI 0.949, NFI 0.959, IFI 0.966 and RMSEA 0.098 (Table 3). Since the calculated goodness-of-fit indices were at the desired level, improvements were made using modification factors. For modification, error covariances were drawn between e1-e4 residual terms and the newly formed diagram is given in Fig. 2.

The regression coefficients of the model and the significance values of the coefficients are given in Table 4..

Table 1
Demographic information of participants.

Variable	Groups	Frequency	Percent
Gender	**Female**	345	63,7
	Male	197	36,3
Family Type	**Nuclear**	492	90,8
	Large	38	7
	Separate	12	2,2
Income Status	**Bad**	34	6,3
	Middle	468	86,3
	Good	40	7,4
Mother's Education Status	**Illiterate**	35	6,5
	Primary education	148	27,3
	Secondary education	196	36,2
	Bachelor's degree	144	26,6
	Master degree	19	3,5
Father's Education Status	**Primary Education**	84	15,5
	Secondary Education	159	29,3
	Bachelor's degree	235	43,4
	Master degree	64	11,8
Computer Knowledge Level	**Bad**	53	9,8
	Middle	373	68,8
	Good	116	21,4
Hearing Artificial Intelligence Before	**Yes**	530	97,8
	No	12	2,2
Artificial Intelligence Knowledge Level	**Insufficient**	240	44,3
	Partially Sufficient	251	46,3
	Sufficient	51	9,4
Computer Usage Frequency	**Never use**	11	2
	He uses little	291	53,7
	Constantly using	240	44,3
Class	**1**	250	46,1
	2	72	13,3
	3	92	17
	4	62	11,4
	5	20	3,7
	6	46	8,5
Total		542	100
Variable		**Mean ± ss**	**Min - Max**
Age		20,62 ± 2,04	18–28

Table 2
Descriptive statistics of scale scores.

Scale Scores	Mean ± sd	(Min - Max)	Cronbach alfa
Cognitive	18,56 ± 5,31	8–33	0,933
Skill	23,8 ± 7,67	8–38	
Anticipation	8,58 ± 2,94	3–15	
Ethic	10,05 ± 2,9	3–15	
Artificial Intelligence Readiness	61 ± 15,58	22–96	
Learning	21,27 ± 9,42	8–54	0,943
Job Change	24,72 ± 11,05	6–42	
Sociotechnical Blindness	17,82 ± 6,71	4–28	
AI Configuration	10,75 ± 5,89	3–21	
AI Anxiety	74,55 ± 26,03	21–145	

sd; standard deviation.
Cronbach's α coefficients for scales greater than 0.90 indicate high scale reliability [18].

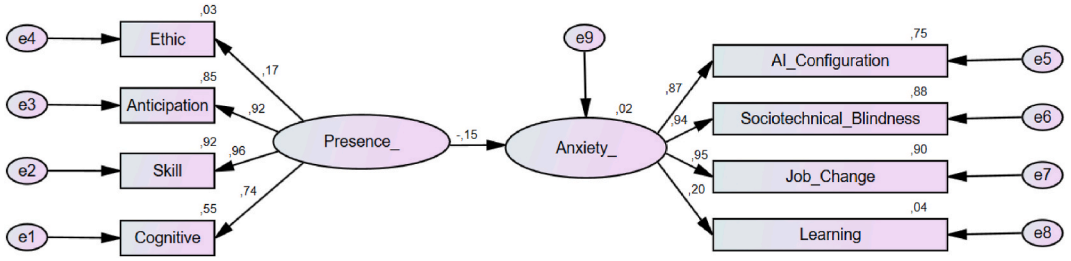

Fig. 1. SEM diagram of the relationship between "medical AI readiness" and "artificial intelligence anxiety" scales.

Table 3
Regression coefficients and significance values obtained by SEM.

Independent Variables	Dependent Variables	β_1	β_2	p
Presence	**Anxiety**	−0,146	−0,189	0,001*
Cognitive	**Presence**	0,743	1	0,001*
Skill		0,961	1,868	0,001*
Anticipation		0,92	0,685	0,001*
Ethic		0,167	0,123	0,001*
AI_Configuration	**Anxiety**	0,868	1	0,001*
Sociotechnical_Blindness		0,939	1,232	0,001*
Job_Change		0,95	2,053	0,001*
Learning		0,198	0,365	0,001*

β_1; Standardized regression coefficients, β_2; non-standardized regression coefficients, *p < 0.05; *t*-test result for the significance of the regression coefficients.

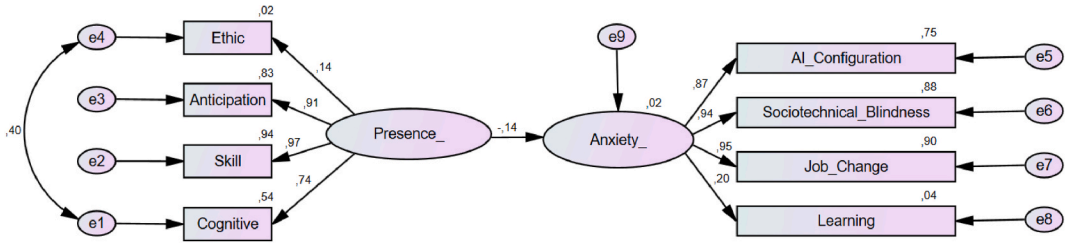

Fig. 2. Modification model of the relationship between "medical AI readiness" and "artificial intelligence anxiety" scales.

4. Discussion

In this study, we tried to determine the level of knowledge and readiness of medical students about artificial intelligence. It was found as a result of the established path diagram that the relationship between the "Artificial Intelligence Anxiety" and "Medical Artificial Intelligence Readiness" scales was at a low level in the negative direction and was confirmed by the calculated goodness of fit

Table 4
Regression coefficients and significance values obtained with modified SEM.

Independent Variables	Dependent Variables	β_1	β_2	p	R^2
Presence	**Anxiety**	−0,141	−0,184	0,002*	0,020
Cognitive	**Presence**	0,737	1	0,001*	
Skill		0,97	1,9	0,001*	
Anticipation		0,912	0,685	0,001*	
Ethic		0,14	0,104	0,001*	
AI Configuration	**Anxiety**	0,868	1	0,001*	
Sociotechnical Blindness		0,939	1,232	0,001*	
Job Exchange		0,95	2,053	0,001*	
Learning		0,198	0,365	0,001*	

β_1; Standardized regression coefficients, β_2; non-standardized regression coefficients, *$p < 0.05$; *t*-test result for significance of regression coefficients, R^2; Explanatory Coefficient.
0020% of the variation in the "Artificial Intelligence Anxiety" score is explained by the "Medical Artificial Intelligence Readiness" scale score (R2 = 0.020). A statistically significant negative correlation was found between the "Medical Artificial Intelligence Readiness" and "Artificial Intelligence Anxiety" scales. A student's score of 1 on the Medical AI Readiness scale will reduce the score on the AI Anxiety scale by −0.184 points (β2 = 0.184; p = 0.002 < 0.05). The calculated fit indices of the model are presented in Table 5.

Table 5
Goodness of fit index values calculated by SEM.

Fit Index	First Model	Modified Model	Acceptable Fit	Perfect Fit
CMIN	118,252	30,091	The model with the smallest value is more compatible.	
χ^2/sd	6,224[a]	1,672	3–5	≤3
IFI	0,966	0,996	0,90–0,95	≥0,95
NFI	0,959	0,990	0,90–0,95	≥0,95
CFI	0,966	0,996	0,90–0,95	≥0,95
GFI	0,949	0,986	0,90–0,95	≥0,95
RMSEA	0,098[a]	0,035	0,05–0,08	≤0,05

Goodness of fit index values in the modified model was calculated as χ2 30,091, df 18, χ2/df 1.672. The decrease in the value of χ2 and the value of χ2/df below 3 show that the fit of the model is very good. The fact that the RMSEA value, which is the index showing the adequacy of the sample number, is 0.035 (RMSEA>0.80), shows that the sample size is at a very good level for the model used. GFI 0.986, CFI and IFI 0.996 and NFI 0.990. The fit of the model and data prepared for the "Artificial Intelligence Anxiety" and "Medical Artificial Intelligence Readiness" scales was found to be very good [19].

[a] The values found are not sufficient for model fit. χ2; Chi-Square Goodness of Fit, NFI; Normed Fit Index, IFI; Incremental Fit Index, CFI; Compretive Fit Index, RMSEA; Root Mean Square Error of Approximation, GFI; Goodness of Fit Index, GFI.

indices. χ2/df, RMSEA, GFI, CFI, IFI and NFI goodness-of-fit index values were used for the model. In SEM analysis, more than one fit indices are evaluated together to test the model fit and accuracy [20,21].

Current research shows that multivariate analysis methods are not used due to difficulties encountered in the application and interpretation process, and univariate analysis methods are often preferred [22]. A statement issued by the American Academy of Health's Task Force on Health Behavior on Postdoctoral Studies; emphasized that in order to present quality research, existing relationships between study variables should be presented using multivariate analysis methods rather than a single one [23].

According to the results of the multivariate analysis methods in our study, it was found that the students' level of anxiety about artificial intelligence is moderate. Filiz et al. a study reported that health professionals have moderate concerns about the use of artificial intelligence in health [24]. Başer et al. In a study with family physicians, the average anxiety scale total score was found to be moderate [25]. Research conducted with doctors found that doctors were less concerned about AI than other healthcare professionals. Doctors are more knowledgeable about AI, some are using AI in their fields, and they are not worried about being replaced by AI [24,26]. AI users have a lower average AI anxiety than non-AI users. A study of senior medical university students found that participants had low AI anxiety [27].

We believe that the reason for students' anxiety is that they do not have enough knowledge about AI applications and have not yet encountered such technology24,26. Although most of the students in our study (97.8%) said they had heard about artificial intelligence before, only a few (9.4%) had a sufficient level of knowledge. Santos et al. a study of 263 students reported that students were aware of the debate about artificial intelligence in radiology, but 68% were unaware of the relevant technologies [28]. Only 6% Civaner et al. of students in the study say they are sufficiently competent to inform patients about the features and risks of artificial intelligence [29]. Grunhut et al. also suggested that medical students' knowledge of artificial intelligence is alarmingly low and insufficient [30]. Zabor et al. In a study conducted in Pakistan, it was reported that most medical students were positive about the application of artificial intelligence in the medical field and wanted to apply it, but lacked sufficient knowledge [31].

Research shows that the level of knowledge not only of students, but also of active healthcare workers is not sufficient. In a study conducted with radiologists and radiographers, it is seen that there is a lack of knowledge about artificial intelligence [32]. In a study on the use of artificial intelligence in breast diseases, it was seen that the majority of participating physicians had insufficient

knowledge about artificial intelligence [33].

The most important way to reduce anxiety is to increase their knowledge, awareness and preparation on the subject. In our study, it was observed that the level of knowledge of students about artificial intelligence was insufficient and the readiness of students was at a medium level. Some studies show that those who do not have knowledge about artificial intelligence have high levels of fear and anxiety [24–26]. Öcal et al. in the study, 93.6% (n:383) of students have heard about artificial intelligence; 59.4% (n:243) said that they are not interested in artificial intelligence [34]. In a study, a significant proportion of those who would not consider using AI applications in the health field said they were afraid [34]. For this reason, it is necessary to increase students' knowledge of the subject and ensure their readiness. Our research feed analysis supports this information. Increasing the level of knowledge about artificial intelligence will also reduce the level of anxiety.

According to the results of our study, while artificial intelligence applications in medicine become widespread, it is considered important to reduce the anxiety levels of medical students by increasing their readiness. As Sapci and Sapci stated in their systematic review, the integration of AI education into medical and health informatics curricula is an important future need [35]. In their study, Bisdalari et al. reported that the majority of students (85.6%) said that AI will be part of their medical education and they are willing (99%) to include AI in their future applications [36]. In a study of medical students in our country, 85% of the students stated their desire to utilize AI applications in their professional lives [34]. In a study conducted with nurses, it was revealed that there was a significant decrease in the anxiety levels of nurses before and after the implementation of training sessions on artificial intelligence [37]. Similarly, according to a study by Ramazan and Ahmed (2015), education reduces anxiety [38].

5. Conclusion

According to the results of our study, although the application of artificial intelligence in medicine is spreading, it is considered important to reduce the anxiety level of medical students by increasing their readiness. As a result, it is believed that artificial intelligence should be included in the medical curriculum. It is anticipated that research is needed to establish a framework of competencies that can facilitate the development and implementation of a standardized curriculum for the teaching of artificial intelligence at the undergraduate level.

At the same time, medical students should be made aware of the use, development and benefit of new technologies, artificial intelligence should be included in the course curricula, experts using artificial intelligence technology should explain this technology to other healthcare professionals in order to eliminate the anxiety and confusion on this issue, and to understand the concerns of healthcare professionals about artificial intelligence. More extensive studies should be conducted. With the increase in the number of samples and scales to be used, our findings and the analysis method we use will be guiding for different studies.

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Data availability statement

Data will be made available on request.

Additional information

No additional information is available for this paper.

CRediT authorship contribution statement

Gamze Özbek Güven: Writing – review & editing, Writing – original draft, Supervision, Resources, Methodology, Investigation, Data curation. **Şerife Yilmaz:** Writing – original draft, Supervision, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Feyza Inceoğlu:** Writing – original draft, Visualization, Validation, Methodology, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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