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Original Article

Assessment of the Iranian Medical Students' Attitudes and Readiness Toward Artificial Intelligence: A Cross-Sectional Study

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ABSTRACT

Background: Artificial Intelligence (AI) is increasingly reshaping healthcare through advancements in diagnosis, therapeutic decision-making, and patient care management. This study designed to evaluate the attitudes and readiness of medical science students toward AI, to inform and improve AI-related educational programs.

Methods: This cross-sectional study was carried out at Mazandaran University of Medical Sciences (MAZUMS), Iran, between December 2023 and March 2024. A total of 637 students enrolled in medical and health sciences programs were recruited through convenience sampling via online platforms. Data were collected using a 31-item online questionnaire captured demographic information, exposure to AI-related education, and readiness for AI. The study utilized the validated Persian version of the Medical Artificial Intelligence Readiness Scale for Medical Students (MAIRS-MS). Statistical analyses were performed using SPSS version 22, with a significance threshold set at $p < 0.05$.

Results: In total, 637 Iranian medical sciences students participated. Of these, 54.2% were in preclinical training and 45.8% were in clinical phases. Most participants (80.7%) reported gaining knowledge about AI primarily through media sources. Radiology, general surgery, and diagnostic decision-making were identified as the disciplines most influenced by AI. According to MAIRS-MS results, students demonstrated the highest readiness in ethical aspects and the lowest in cognitive domains. The mean overall readiness score was 63.19±12.86 (out of 100). Participants with previous AI-related education achieved significantly higher readiness scores compared with those without such training ($\beta = 6.36$, $p < 0.001$).

Conclusion: Iranian medical students showed substantial interest in AI, although their levels of readiness varied, with stronger ethical understanding and weaker cognitive competencies. Exposure to prior AI education was linked to higher readiness scores, emphasizing the necessity of incorporating structured AI instruction into medical curricula. Overall, these results underscore the importance of targeted curriculum development to equip future healthcare professionals with the skills required for effective AI integration.

Keywords: Artificial Intelligence; Students; Medical; Attitude; Readiness; Cross-Sectional Studies

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Introduction

Artificial Intelligence (AI) is an overarching term that enable computer systems and software to simulate human cognitive functions and achieve performance comparable to human capabilities (1). AI-based technologies have been applied across multiple domains, including computer engineering, finance, legal practice, and industrial manufacturing (2).

AI is rapidly becoming a key component of healthcare delivery (3). AI applications in areas such as disease pattern analysis, medical imaging diagnosis, and treatment recommendations, have the potential to improve diagnostic accuracy, treatment outcomes, and health system efficiency (4). However, successfully integrating AI into clinical care requires the understanding and readiness of healthcare providers, including physicians and nurses (5).

Intelligent algorithms can analyze large datasets to support clinical decision-making, perform repetitive tasks to free up clinician time, and suggest new personalized treatment plans. However, the integration of AI has also raised valid concerns regarding the loss of human oversight, privacy, and job security (6). AI has become increasingly integrated into the education and training of healthcare professionals. For instance, computer-assisted learning platforms have been designed to support healthcare students in developing diagnostic competencies. These systems utilize machine learning algorithms trained on diverse clinical datasets to enhance learners' diagnostic decision-making skills (7). Understanding how future healthcare professionals perceive such emerging technologies is therefore crucial. Nonetheless, limited research has examined AI readiness—particularly in terms of knowledge and skills—alongside attitudes toward AI (2, 8). The Iranian medical education system, with its seven-year training structure and limited resources, provides a distinctive setting for examining AI education. Accordingly, we hypothesized that students who have prior exposure to AI training or a strong interest in the field are more likely to exhibit higher levels of readiness (9, 10).

Despite the growing significance of AI, limited research has examined the level of knowledge, attitudes, and preparedness of medical students across different specialties regarding the integration of AI technologies into future clinical practice (11).

This study aimed to assess the attitudes and readiness of medical students from various disciplines toward adopting AI in their future professional careers. Such an evaluation is critical for informing curriculum designers, policymakers, and healthcare leaders about existing educational gaps and the interventions needed to develop a workforce that is both competent and confident in using AI-based technologies (12).

Although AI technologies are rapidly advancing and becoming more integrated into healthcare systems, a substantial gap persists in understanding medical students' readiness and perspectives toward AI, particularly in resource-constrained educational contexts such as Iran. Addressing this gap is crucial for informing effective curriculum planning and policy development. Accordingly, this cross-sectional study was conducted among medical sciences students in Sari, Iran, including those from medicine, nursing, pharmacy, and other health-related disciplines, to assess their attitudes toward AI and their level of preparedness for integrating AI technologies into their future professional practice.

Methods

Study Design and Setting

This cross-sectional study aimed to assess the attitudes and readiness of medical students toward AI at Mazandaran University of Medical Sciences (MAZUMS), Sari, Iran, from December 2023 to March 2024. Sari, a major city in northern Iran, was selected as the study setting due to its role as an important educational center in Mazandaran Province, encompassing a heterogeneous student body that reflects the broader medical academic environment of the region.

Participants and Sampling

Following extensive outreach on social networks and within student communities, a total of 637 students and residents participated in the study. Eligible participants were individuals affiliated with MAZUMS across diverse healthcare-related disciplines and educational levels, without any age limitations. Participants were required to provide informed consent and possess sufficient proficiency in Persian to complete the questionnaires accurately. Exclusion criteria included students from other countries, respondents who submitted incomplete questionnaires, individuals unable to provide informed consent, and those who could not access the online survey because of technical difficulties.

Participants were stratified into four groups. The first group consisted of medical and pharmacy residents. The second group included undergraduate medical students (years 1–7), pharmacy students, and dentistry students (years 1–6). Notably, within Iran's seven-year medical education program, students in the sixth and seventh years are required to undertake night shifts. The third group comprised undergraduate and postgraduate students in nursing and midwifery. The fourth group included undergraduate and postgraduate students from other medical sciences disciplines, categorized as "Others" in the survey. This group encompassed programs such as Radiology Technology, Medical Laboratory Sciences, Optometry, Anesthesiology, Occupational Therapy, Surgical Technology, Environmental Health, Biotechnology, and Health Information Technology.

The sample size was calculated to estimate the population mean score of the Medical Artificial Intelligence Readiness Scale for Medical Students (MAIRS-MS) with sufficient precision. Based on a Standard Deviation (SD) of 14.8 reported in a previous study (13), and a 95% confidence level ($\alpha = 0.05$), the required sample size was determined using the following formula:

$$n = \frac{(z_{1-\frac{\alpha}{2}})^2 SD^2}{E^2}$$

where E represents the absolute margin of error for the mean estimate. Setting the margin of error at approximately 1.15 points on the 0–100 MAIRS-MS scale yielded an estimated required sample size of 637.

A total of 1,095 individuals accessed the survey link. Data collection continued until 645 questionnaires were fully completed, with an average completion time of 10 minutes. Given the voluntary and web-based nature of the study, a convenience sampling method was employed, although all eligible students were invited to participate. Despite all questions were mandatory, eight participants were excluded from the analysis as the respondents provided unreasonable or irrelevant responses to required open-ended items, such as those related to academic year or age. These incorrect responses were considered as missing data and 637 were finally analyzed. The participant recruitment and inclusion process is illustrated in Figure 1.

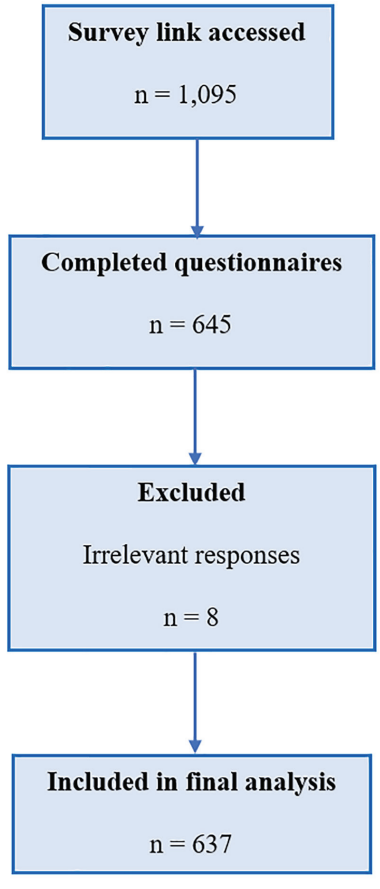

Figure 1: Flow Diagram of Participant Recruitment and Inclusion in the Study

Tools / Instruments

The final survey utilized in this study included 31 items organized into three primary sections. The first section included five questions aimed at collecting participants' demographic characteristics, including age, gender, field of study, educational level, and year of enrollment. The second section featured five questions—comprising Yes/No, multiple-choice, and short-answer formats—partly adapted from a survey by Liu and colleagues (14), with some minor changes to assess the participants' medical education. These items addressed exposure to AI-related education, familiarity with AI concepts, medical specialties most influenced by AI, preferred AI-related topics, and the amount of time participants wished to allocate monthly to learning about AI. The survey's third section included 20 multiple-choice items rated on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), adapted from the Persian version of the "Medical MAIRS-MS to evaluate AI readiness among Iranian medical science students. For each item, the Mean score and SD were calculated across the total sample.

Validity and Reliability - The MAIRS-MS scale is a validated and reliable instrument (Cronbach's alpha = 0.87) initially developed by Karaca and colleagues (15) to evaluate the perspectives and preparedness of medical students regarding AI technologies and their applications in healthcare. The original scale consists of 22 items across four domains: cognition, ability, vision, and ethics. The Persian version of the MAIRS-MS employed in this study was translated and validated by Rezazadeh and colleagues (10), demonstrating strong psychometric properties, including a Cronbach's alpha of 0.94 for the overall scale, a Content Validity Index (CVI) of 0.92, and a Content Validity Ratio (CVR) of 0.75. Two items with CVR values below 0.70 were excluded due to redundancy or ambiguity ("I can explain the AI applications used in healthcare services to patients" and "I can explain the limitations of AI technology").

In addition, the questionnaire included an optional open-ended section allowing participants to share further comments on AI. These responses were manually analyzed and categorized into four themes. Participants were permitted to review and modify their responses using a back button; however, all questions were mandatory except the final open-ended item. To maintain anonymity, no identifying information was collected, and access to the data was limited to two researchers to ensure confidentiality and data integrity.

Reliability in the present study was assessed using Cronbach's alpha, yielding an overall coefficient of 0.84, with values exceeding 0.78 for each quantitative item, indicating very good reliability. For the practice section, face validity was evaluated using impact scores, while content validity was assessed through CVI and CVR measures. Items with an impact score greater than 1.5 were considered to demonstrate acceptable face validity.

Data Collection

Data collection was conducted over a three-week period. Medical sciences students and residents at MAZUMS completed the study by responding to an electronic questionnaire distributed through a unique survey link shared via email and social media platforms, including Telegram and WhatsApp with a mean completion time of 10 minutes. To avoid duplicate entries, each participant was assigned a unique response ID, and attempts to access the survey link again from the same device triggered a notification indicating that the survey had already been submitted. A reminder email was sent one week after the initial distribution to encourage participation.

Data Analysis

Incomplete surveys (n = 8) were excluded from the analysis. Data visualization was performed in Excel software, and statistical analyses were conducted using SPSS version 22. Qualitative variables were reported as frequencies and percentages, while quantitative variables were expressed as Mean ± SD. The normality of MAIRS-MS

scores was assessed using the Kolmogorov–Smirnov test. If the assumption of normality was met, independent two-sample t-tests were applied to compare mean readiness scores between two groups (e.g., male vs. female, preclinical vs. clinical students, students with vs. without prior AI education). One-way Analysis of Variance (ANOVA) was used to compare mean scores across more than two groups (e.g., year of study, different fields of education). If normality was not established, the non-parametric equivalents (Mann–Whitney U test and Kruskal–Wallis test) were used. Variables with $p < 0.20$ in univariate analyses were entered into the multivariable linear regression model to adjust for potential confounders and identify independent predictors of AI readiness. Subgroup comparisons across gender, faculty, and year of study were conducted descriptively to explore variations in readiness. Statistical significance was set at $p < 0.05$ for all tests.

Ethics **-** This study received approval from the Ethical Committee of MAZUMS. Informed consent was obtained electronically at the beginning of the online survey and only those who agreed to participate completed the survey. Participants were provided with detailed information about the study's purpose, procedures, and confidentiality. Besides, they were informed and reassured that their answers would remain confidential and be utilized only for scientific and research purposes.

Results

Demographic Characteristics

A total of 637 medical science students from MAZUMS participated in this study. Table 1 presents the demographic and academic characteristics of medical science students and residents at this university. The proportions for gender, field of study, and educational level are calculated based on the total sample size. Age is reported as Mean ± SD. Percentages for residency program (PGY1–PGY4) are calculated within the subgroup of residents. Undergraduate medical students are further categorized into preclinical (Years 1–3) and clinical (Years 4–7) stages. The categories "Bachelor" and "Master" refer to students in nursing, midwifery, and other allied health disciplines, while the "Medical, Dental, and Pharmacy student" refers to those enrolled in professional degree programs.

Table 1: Demographic characteristics of the respondents

Demographic details	Frequency (%) / Mean±SD*
Age	23.14±4.34
Gender	
Male	264 (41.4)
Female	373 (58.6)
Field	
Medicine	365 (57.3)
Dentistry	50 (7.8)
Midwifery	10 (1.6)
Pharmacy	48 (7.5)
Nursing	65 (10.2)
Other	99 (15.5)
Educational level	
Bachelor's degree	138 (21.7)
Master's degree	39 (6.1)
Medical, dental and pharmacy students	414 (65.0)
Medical and Pharmacy residents	46 (7.2)
Stage of study (undergraduates)	
Year 1	89 (15.1)
Year 2	150 (25.4)
Year 3	131 (22.2)
Year 4	97 (16.4)
Year 5	41 (6.9)
Year 6	42 (7.1)
Year 7	41 (6.9)
Residency program	
PGY 1	4 (8.7)
PGY 2	16 (34.8)
PGY 3	13 (28.3)
PGY 4	13 (28.3)
Medical student	
Preclinical years	180 (54.2)
Clinical years	152 (45.8)

*Frequency (%) is reported for qualitative variables and Mean±SD is reported for quantitative variables; PGY: Post-Graduate Year; SD: Standard Deviation.

According to Table 1, all participants were Iranian. The mean age of the sample was 23.14±4.3423.14±4.34 years. Regarding

gender distribution, 58.6% of participants were female. Most participants were medical students, comprising 57.3% of the total. Among these students, 54.2% were in the preclinical phase, while 45.8% were in the clinical phase of their training. Based on the classification of medical sciences education, 7.2% of the participants were residents in medicine or pharmacy programs. Overall, 65% of participants were students in medicine, dentistry, or pharmacy. Additionally, 79.3% indicated that they had not received any prior education related to AI. On average, participants expressed a preference to spend 2.92 ± 1.90 hours per month learning about AI-related topics.

Attitudes and Interests Toward AI

The survey evaluated the overall perspective of medical science students toward AI (Table 2). Most students (80.7%) chose media sources in response to "How did you become familiar with AI?" Other commonly cited sources of familiarity included family or friends, student scientific associations, academic articles, and conferences.

When asked about their specific interests in AI, most participants selected topics such as the application of AI in their professional practice, the aspects of healthcare staff duties that could potentially be replaced by AI, and the global health implications of AI. Students were also requested to identify the medical careers within their respective fields that they believed would be most influenced by AI. The responses to this item were presented descriptively, indicating the possibility of overlapping answers; however, attempts were made to reduce redundancy.

Among the specialties, radiology, general surgery, and diagnostic fields were most frequently identified as those likely to be significantly affected by AI in the future (Figure 2).

AI Readiness

As noted previously, participants' preparedness in AI was evaluated using the mean score of the Persian version of the MAIRS-MS scale. As shown in Figures 3–6, this instrument was used to determine the self-reported AI readiness of MAZUMS students. The MAIRS-MS scale measures readiness across four domains: cognitive, ability, vision, and ethics. The findings presented in the figures indicate that participants perceived themselves as most prepared in the ethics domain and least prepared in the cognitive domain.

Table 2: Exposure of students to artificial intelligence

Subject	Frequency (%) / Mean±SD*
History of AI related education	
No	505 (79.3)
Yes	132 (20.7)
How did you become familiar with AI? (Yes)	
Media	514 (80.7)
Scientific student groups	114 (17.9)
Articles	68 (10.7)
Conferences	63 (9.9)
Research projects	46 (7.2)
Books	35 (5.5)
Family/friends	145 (22.8)
None	36 (5.7)
Interested AI topics (Yes)	
Weakness/strength in medical sciences	193 (30.3)
AI application in your work	315 (49.5)
AI fundamental concepts	137 (21.5)
AI models	156 (24.5)
Ethics of AI	130 (20.4)
What aspects of a Treatment staff's job can be replaced with AI? (yes)	251 (39.2)
Global health implications of AI	243 (38.1)
Effects of AI on health inequalities	145 (22.8)
Other	3 (0.5)
The maximum amount of time I would like to spend exploring the topic of AI in medicine per month (Hour)	2.92±1.90

*Frequency (%) is reported for qualitative variables and Mean±SD is reported for quantitative variables; AI: Artificial Intelligence; SD: Standard Deviation.

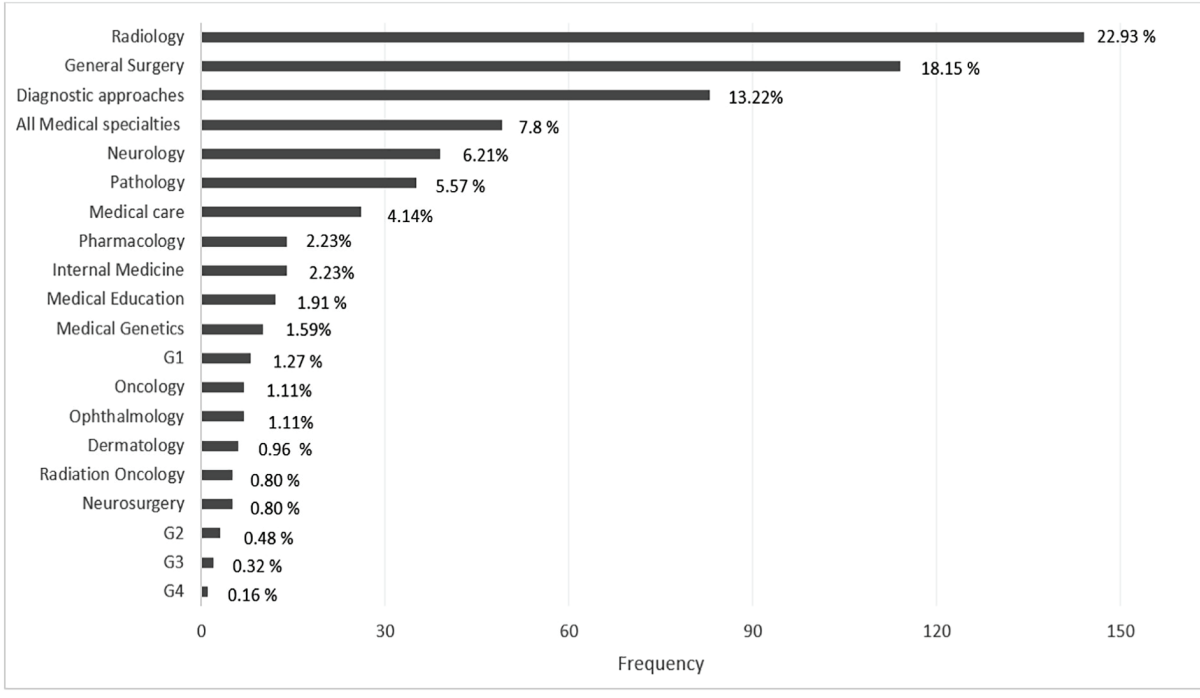

Figure 2: Specialties most influenced by artificial intelligence.
G1 (frequency=8): Clinical Pharmacy, Cardiology, and Psychiatry. G2 (frequency=3): Biotechnology, Medical Statistics, Regenerative Medicine, Anesthesiology, and Obstetrics & Gynecology. G3 (frequency=2): Nuclear Medicine, Physiotherapy, and Epidemiology. G4 (frequency=1): Pediatrics, Robotic Surgery, Prosthodontics, Social Medicine, Orthopedic Surgery, Health Information Technology, Rehabilitation, Bioinformatics, Pharmaceutics, Forensic medicine, Emergency Medicine, Plastic Surgery, and Immunotherapy.

As mentioned earlier, each item on the MAIRS-MS is rated on a scale from 1 to 5 points, ("strongly disagree" to "strongly agree"). The participants in this study achieved a Mean ±SD of 22.71 ± 5.99 out of a maximum of 40 points for the cognition factor (Table 3). For the ability factor, the participants had a mean score of 23.26±5.63 out of a total of 35. The mean score for the vision factor was 6.46 ± 1.75, from a total of 10. The mean score for the ethics factor was 10.75±2.42, from a total of 15. Overall, the respondents achieved a total mean MAIRS-MS score of 63.19 ± 12.86 out of 100.

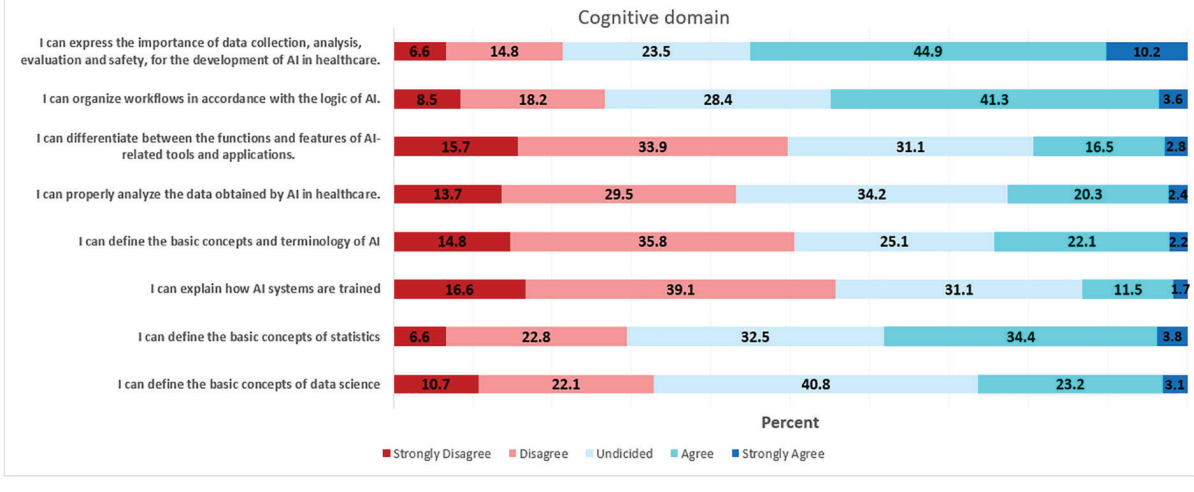

Figure 3: Cognitive domain of the MAIRS-MS scale. MAIRS-MS: Medical Artificial Intelligence Readiness Scale for Medical Students

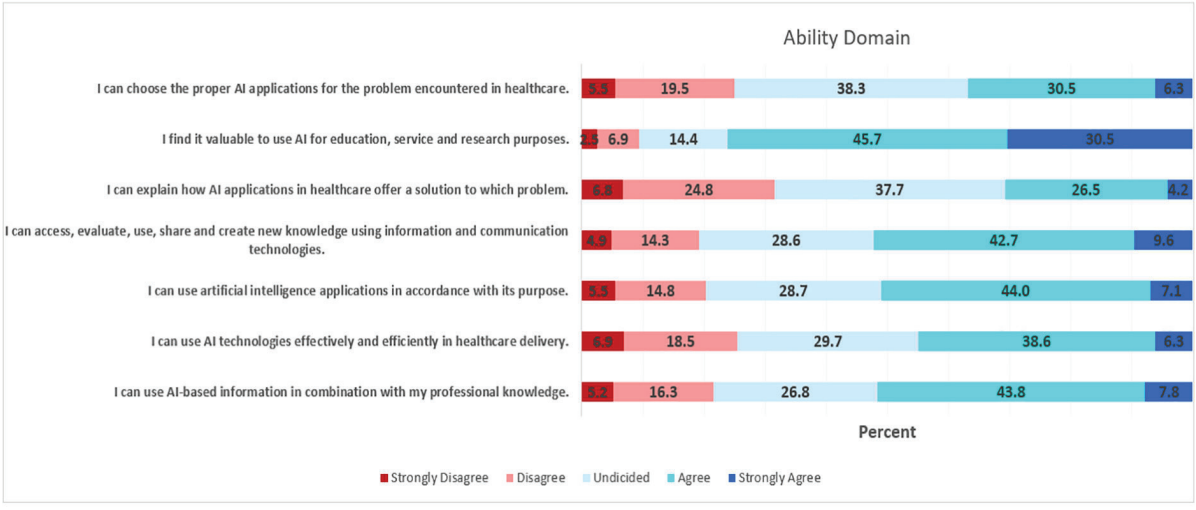

Figure 4: Ability domain the MAIRS-MS scale. MAIRS-MS: Medical Artificial Intelligence Readiness Scale for Medical Students

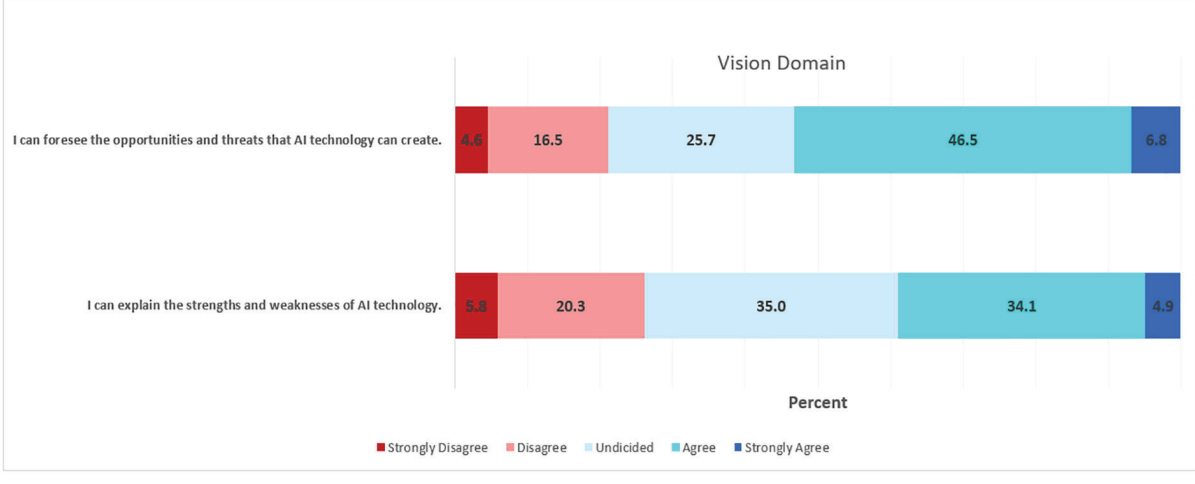

Figure 5: Vision domain of the MAIRS-MS scale. MAIRS-MS: Medical Artificial Intelligence Readiness Scale for Medical Students

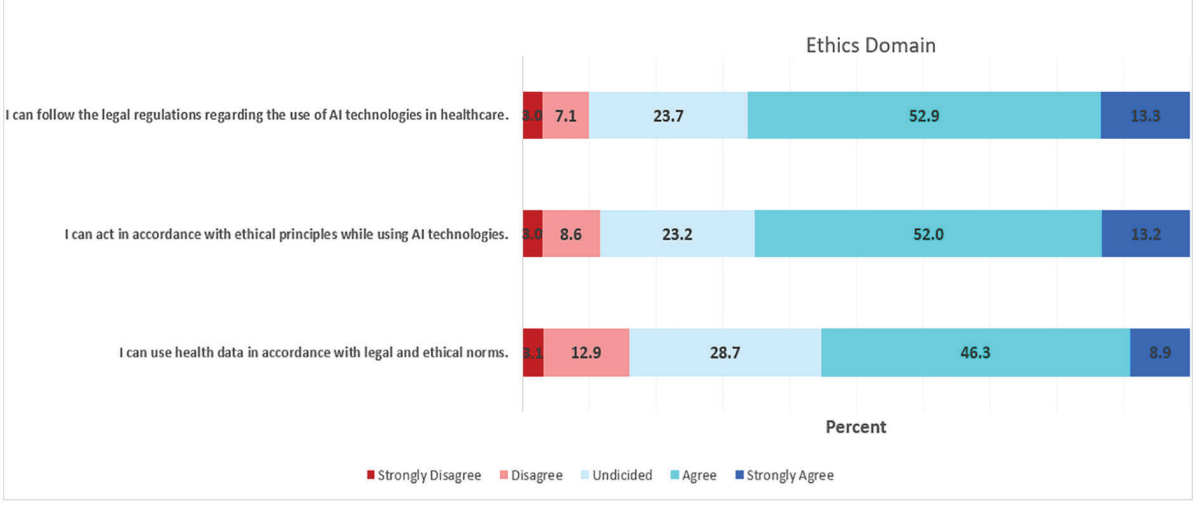

Figure 6: Ethics domain of the MAIRS-MS scale. MAIRS-MS: Medical Artificial Intelligence Readiness Scale for Medical Students

Table 3: Mean scores of the respondents

Domain	Mean±SD
Cognitive	22.71±05.99
Ability	23.26±05.63
Vision	6.46±01.75
Ethics	10.75±02.42
Total	63.19±12.86

SD: Standard Deviation

Table 4: Comparison of the mean MAIRS-MS scores across student groups

Group	Category	Mean±SD	p-value
Medical students	Preclinical years	63.78±12.03	0.692
	Clinical years	63.21±14.07	
Year of Study	Year 1	60.40±13.00	0.150
	Year 2	63.87±13.70	
	Year 3	65.85±12.90	
	Year 4	61.40±12.60	
	Year 5	62.09±15.0	
	Year 6	62.26±15.00	
	Year 7	66.90±15.00	
	Total	63.52±13.30	
Medical	Student	63.52±12.99	0.303
	Resident	60.93±02.98	
Pharmacy	Student	61.70±10.49	0.089
	Resident	68.47±16.22	

MAIRS-MS: Medical Artificial Intelligence Readiness Scale for Medical Students; SD: Standard Deviation.

Table 4 presents the mean scores of medical science students and residents. Scores are compared across different categories, including stage of study (preclinical vs. clinical years), year of study (Years 1–7), and type of program (medical vs. pharmacy students and residents).

The p-values presented in Table 4 reflect whether the observed differences among subgroups reached statistical significance. In general, preclinical and clinical medical students demonstrated comparable scores, with no statistically significant difference between them. Although mean scores showed slight variation across academic years—peaking in Year 7—these differences were not statistically significant. Additionally, medical students achieved slightly higher scores than medical residents, whereas pharmacy residents outperformed pharmacy students.

To further investigate the determinants of medical students' readiness for AI, both univariate and multivariable linear regression analyses were performed. In the univariate analysis, each demographic and educational characteristic, along with sources of AI exposure and areas of interest, was assessed individually to explore its association with MAIRS-MS scores. Variables demonstrating statistical significance or borderline significance were subsequently included in the multivariable regression model to control for potential confounders and to identify independent predictors of AI readiness.

Table 5 summarizes the findings of these analyses, presenting crude and adjusted coefficients, corresponding confidence intervals, and p-values. Both unstandardized coefficients (B) and standardized coefficients (β) are provided to facilitate interpretation of absolute differences in scores as well as relative effect sizes (Table 5).

Table 5: Linear regression analysis of factors associated with MAIRS-MS scores across respondents

Variable	Crude	
	Coefficient (95% CI)	P-value
Age	0.08 (-0.15, 0.31)	0.481
Gender		
Male	1.23 (-0.8, 3.26)	0.234
Female	Reference category	-
Field		
Dentistry	-1.15 (-4.94, 2.64)	0.553
Midwifery	4.95 (-3.17, 13.01)	0.228
Pharmacy	0.46 (-3.40, 4.32)	0.814
Nursing	-0.82 (-4.2, 2.56)	0.633
Other	-0.63 (-3.48, 2.22)	0.664
Medical	Reference category	-
Education		
Bachelor's degree	-0.50 (-4.81, 3.80)	0.819
Master's degree	0.58 (-4.93, 6.09)	0.835
Medicine, dental and pharmacy students	-0.20 (-4.13, 3.73)	0.920
Medical and pharmacy residents	Reference category	.
Graduation		
Under graduate	-0.54 (-3.49, 2.40)	0.717
Post graduate	Reference category	-
History of education for AI (yes)	8.18 (5.80, 10.56)	<0.001
How did you get familiar with AI? (Yes)		
Media	1.77 (-0.75, 4.30)	0.168
Scientific student groups	4.45 (1.87, 7.03)	0.001
Articles	8.73 (5.57, 11.89)	<0.001
Conferences	6.98 (3.68, 10.28)	<0.001
Research projects	13.01 (9.29, 16.73)	<0.001
Books	8.63 (4.30, 12.98)	<0.001
Family/ friends	4.07 (1.71, 6.43)	0.001
None	Reference category	-
Interested AI topics (Yes)		
Weakness/ strength in medical sciences	1.77 (-0.40, 3.93)	0.110
AI application in your work	2.21 (0.23, 4.20)	0.029
AI fundamental concepts	3.22 (0.80, 6.82)	0.009
AI models	5.03 (2.74, 7.32)	<0001
Ethics of AI	0.45 (-2.03, 2.93)	0.722
"What aspects of a Treatment staff's job can be replaced with AI?"(Yes)	0.19 (-1.86, 2.24)	0.855
Global health implications of AI	1.44 (-0.61, 3.50)	0.167
Effects of AI on health inequalities	2.06 (-0.31, 4.43)	0.089
Other	Reference category	-
The maximum amount of time I would like to spend exploring the topic of AI in medicine per month (hour)	1.40 (0.88, 1.91)	<0.001

Variable	Adjusted		
	Unstandardized Coefficient (95% CI)	P-value	Standardized beta coefficients
History of education for AI (Yes)	6.36 (3.81, 8.91)	<0.001	0.194

How did you get familiar with AI? (Yes)			
Media	2.93 (0.49, 5.36)	0.018	0.103
Scientific student groups	-0.80 (-3.53, 1.92)	0.564	-0.025
Articles	3.70 (0.28, 7.11)	0.034	0.087
Conferences	-0.51 (-3.99, 2.97)	0.722	-0.006
Research projects	7.36 (3.23, 11.49)	<0.001	0.158
Books	0.99 (-3.41, 5.38)	0.660	0.018
Family/ friends	3.43 (1.19, 5.77)	0.003	0.119
None	Reference category	-	-
Interested AI topics (Yes)			
Weakness/ strength in medical sciences	0.56 (-1.52, 2.64)	0.600	0.016
AI application in your work	0.85 (-1.02, 2.72)	0.375	0.027
AI fundamental concepts	-1.27 (-3.74, 1.20)	0.313	-0.035
AI models	2.50 (0.11, 4.89)	0.040	0.081
Global health implications of AI	0.26 (-1.75, 2.28)	0.800	0.006
Effects of AI on health inequalities	0.22 (-2.14, 2.59)	0.854	0.117
Other	Reference category	-	
The maximum amount of time I would like to spend exploring the topic of AI in medicine per month (Hour)	0.85 (0.35, 1.36)	0.001	0.124

R-squared=0.44; AI: Artificial Intelligence; MAIRS-MS: Medical Artificial Intelligence Readiness Scale for Medical Students; CI: Confidence Interval.

In the univariate linear regression analyses, multiple variables demonstrated statistically significant relationships with MAIRS-MS scores and were subsequently included in the multivariable model. These variables comprised prior exposure to AI education; sources of familiarity with AI (such as scientific student groups, academic articles, conferences, research activities, books, media, and personal networks); areas of interest in AI (including practical applications in one's field, foundational concepts, and AI models); as well as the maximum monthly time students were willing to dedicate to learning about AI.

In the adjusted multivariable model (R^2 = 0.44), prior AI education remained a significant predictor. Students with any form of AI-related training achieved, on average, 6.36 points higher on the MAIRS-MS compared to those without such experience (95% CI: 3.81–8.91; $p < 0.001$; $\beta = 0.194$). Among sources of familiarity, exposure through research projects (B = 7.36; 95% CI: 3.23–11.49; $p<0.001$; $\beta = 0.158$), media (B = 2.93; 95% CI: 0.49–5.36; $p = 0.018$; $\beta = 0.103$), scientific articles (B = 3.70; 95% CI: 0.28–7.11; $p = 0.034$; $\beta = 0.087$), and family/friends (B = 3.43; 95% CI: 1.19–5.77; $p = 0.003$; $\beta = 0.119$) remained independently associated with higher AI readiness, compared with students who reported no exposure to AI.

Regarding specific AI topics, only an interest in AI models retained a significant association in the adjusted model (B = 2.50; 95% CI: 0.11–4.89; $p = 0.040$; $\beta = 0.081$), whereas interest in AI applications, weaknesses/strengths in medical sciences, fundamental concepts, ethics, global health implications, and health inequalities did not remain significant after adjustment. Finally, there was a clear dose–response pattern for time investment: for each additional hour per month that participants were willing to spend exploring AI in medicine, their MAIRS-MS score increased by 0.85 points on average (95% CI: 0.35–1.36; $p = 0.001$; $\beta = 0.124$), underscoring the importance of both prior AI education and ongoing engagement for higher AI readiness. Standardized coefficients (β) indicate the relative strength of predictors in the model. For instance, prior AI education ($\beta = 0.194$) had the strongest effect, followed by exposure through research projects ($\beta = 0.158$), highlighting their importance compared to other sources.

Open-ended section

A total of 38 open-ended responses were obtained and were organized into four primary categories (Supplementary file).

The first category consisted of participants who expressed a need for AI-focused courses or workshops within the university curriculum, or who inquired about basic AI principles (18 responses; for instance, several participants stressed the urgent integration of formal AI education into medical science programs).

The second category comprised students who raised concerns about the future implications and ethical challenges of AI within their disciplines (11 responses; e.g., some highlighted the potential of AI to reduce employment opportunities across various sectors).

The third category reflected a positive perspective toward the application of AI in medical fields (seven responses; e.g., respondents noted that AI can improve efficiency, accuracy, and ease of task performance).

The fourth category included two responses addressing perceived limitations of AI (e.g., the absence of a patient–therapist relationship was mentioned as a notable drawback).

Discussion

This cross-sectional investigation was carried out among students of medical sciences in Sari, Iran, including those enrolled in medicine, nursing, pharmacy, and other health-related programs to evaluate their attitudes toward AI and their preparedness for incorporating AI technologies into their future professional roles.

A key finding of this study was the substantial knowledge gap related to AI, as the majority of participants reported having no prior formal education or training in this area. This observation is consistent with previous research indicating limited and uneven incorporation of AI-related content within medical curricula globally (8, 16), underscoring a widespread educational shortfall rather than a context-specific issue.

The assessment of AI readiness via the MAIRS-MS scale offers a nuanced understanding of students' preparedness across various domains. Notably, the participants rated themselves highest in the ethics domain, suggesting a heightened awareness of the ethical considerations surrounding AI adoption in healthcare. This finding resonates with the increasing recognition of ethical implications, such as privacy concerns, potential biases, and the need for human oversight, as AI technologies become more prevalent in healthcare (3, 17). The lowest readiness in the cognition domain likely reflects minimal exposure to AI fundamentals in current curricula, whereas the elevated ethics score may reflect general awareness of AI-related concerns (e.g. privacy, bias) from public discourse rather than formal instruction.

The discrepancy between the students' enthusiasm for learning about AI applications and their low self-rated cognitive readiness highlights a crucial gap that must be addressed. While participants acknowledge the potential benefits of AI for their future professional practice, they may not possess the fundamental knowledge and conceptual understanding required to effectively adopt and apply these technologies (18, 19). This mismatch highlights the pressing need to integrate AI-related instruction into medical science curricula in order to bridge the divide between theoretical awareness and practical implementation (20).

Our findings revealed a statistically significant difference in MAIRS-MS scores, as students who had undergone AI training achieved mean scores that were 6.36 points higher than those who had not received such instruction. This outcome reinforces the importance of incorporating AI-focused education into medical curricula, given its potential to meaningfully enhance students' readiness and capacity to adopt AI technologies in their future clinical practice (21, 22).

Furthermore, our findings showed that several factors, including exposure to AI through research activities, academic

publications, family or friends, and media sources were linked to significantly higher MAIRS-MS scores. This implies that multiple forms of AI engagement, extending beyond structured academic instruction, may enhance medical students' preparedness in this field (23). Leveraging alternative pathways, such as promoting AI-related research projects, disseminating relevant literature, and fostering discussions within social networks, could complement formal educational efforts and further enhance students' AI literacy (12, 24).

Notably, our findings showed that students who expressed an interest in AI models obtained MAIRS-MS scores that were, on average, 2.5 points higher than their peers. This suggests that incorporating dedicated instruction on specific AI models and their clinical applications into medical curricula may better align with students' interests and, in turn, strengthen their preparedness for integrating AI into healthcare practice (7, 25).

A noteworthy finding of our study was the difference in MAIRS-MS scores among various fields of study. Although these differences were not statistically significant, midwifery students recorded the highest average score, while dental students had the lowest. Such variation may reflect distinctions in curricular design, levels of exposure to AI-related material, or differences in how relevant AI is perceived to be within specific medical specialties. Further research could explore the factors contributing to these disparities and inform the development of tailored educational approaches to address them (12, 22).

Furthermore, no statistically significant differences in MAIRS-MS scores were observed with respect to sex, age, or educational level (undergraduate versus postgraduate). This indicates that preparedness for AI integration may depend more on access to relevant knowledge and experiential learning opportunities than on demographic factors or level of academic training. However, the potential impact of the educational system's structure on these findings should also be taken into account (26, 27).

Within Iran's medical education framework, students complete a seven-year curriculum, consisting of three years of preclinical training followed by four years of clinical clerkships. Our results indicated no significant difference in MAIRS-MS scores between preclinical and clinical students. This finding may be attributed to the lack of a structured AI curriculum within the current medical education program, leading to limited exposure to AI-related content during the preclinical years (8, 25).

On the other hand, evidence from Western settings, where AI has been more actively incorporated into medical curricula, may yield different results. For instance, Stewart and colleagues reported in a study from Western Australia that students in their clinical years demonstrated significantly higher levels of AI knowledge and preparedness than those in preclinical stages (2). This variation may reflect the earlier and more systematic inclusion of AI-related topics in Western medical programs, enabling students in clinical stages to expand on foundational concepts and gain applied experience during their rotations (20, 22).

Similar gaps are reported from studies on other Low- and Middle-Income Countries (LMICs). In Malaysia, medical students demonstrated only moderate AI readiness on the MAIRS-MS scale (13), while in Lebanon, most students reported acquiring AI knowledge primarily through media sources, reflecting limited formal curricular training (12). Additional challenges exist in Iran, including financial and infrastructural limitations, with recent evidence pointing to notable technological, economic, and organizational barriers (28). These constraints may delay the systematic implementation of AI in medical education, underscoring that Iranian students face distinct obstacles compared with both Western peers and students in other LMICs.

Addressing this issue requires Iranian medical institutions to systematically reassess their curricula and identify opportunities to incorporate AI education at an earlier stage.

Exposing students to AI concepts and their practical applications during the preclinical years could help build a strong foundation, equipping them to apply AI more effectively in clinical training and future medical practice (5, 26).

Furthermore, this study emphasizes the necessity of a thorough revision of medical curricula to make AI education a core component rather than an optional or supplementary element. This strategy reflects the growing acknowledgment of AI's widespread impact across medical specialties and its transformative potential in healthcare delivery (3, 5).

The open-ended responses revealed that medical students hold a nuanced view of AI readiness. Many underscored the pressing need to integrate formal AI education into medical programs, demonstrating a proactive interest in developing key competencies, despite the fact that AI is not yet included in medical curricula, often due to factors such as limited faculty expertise (29). Concurrently, ethical concerns and apprehensions about workforce implications reveal a critical awareness of AI's broader impact. Positive views on AI's potential to enhance medical practice coexist with caution about its limitations, particularly regarding the patient-provider relationship. These findings underscore the importance of developing comprehensive educational programs that balance technical proficiency with ethical and practical considerations in AI implementation. Similarly, the findings of a recent study underscore the importance of continuous training and development programs, robust ethical oversight, and strategic integration of AI to enhance productivity and innovation while supporting the workforce (30).

In summary, identifying the obstacles and enablers to integrating AI education in medical schools can help develop effective strategies for equipping medical students and practitioners with AI literacy. The combination of students' strong interest in AI applications for their future careers and their self-reported low readiness especially in cognitive skills, highlights the need for enhanced AI education. Addressing these educational gaps and fostering a clearer understanding of AI's capabilities and limitations in healthcare will better prepare future healthcare professionals to leverage AI in improving patient care and advancing medical science.

Limitations and Suggestions

The cross-sectional nature of this study should be acknowledged as a limitation, as data were gathered at a single point in time, which restricts the ability to assess the long-term effects of educational interventions. Longitudinal studies or follow-up assessments could offer deeper insight into the evolving attitudes and preparedness of students as they advance through their academic programs and become increasingly familiar with AI technologies.

Besides, this study employed a convenience sampling method, recruiting participants through social media platforms and student networks. Although this allowed for wide participation, it may have introduced selection bias, potentially overrepresenting students with a stronger interest in AI or higher digital engagement. Consequently, the findings may not be fully generalizable to all Iranian medical science students or to institutions with different educational settings.

While the MAIRS-MS scale demonstrated acceptable reliability, it is based on self-reported data and lacks objective measures of AI competence; therefore, future studies should include practical or simulation-based assessments.

Moreover, cultural and linguistic variations in the Persian adaptation may affect item interpretation compared to the original English version. In addition, responses related to ethical preparedness may have been influenced by social desirability bias. Future multi-center and longitudinal studies incorporating objective assessments are recommended to overcome these limitations and provide a more comprehensive understanding of AI readiness among medical students.

Conclusion

In this study, students demonstrated a strong interest in understanding AI applications relevant to their future careers. Their self-assessed readiness, particularly in the cognitive domain, highlights the need to reinforce AI education. Recognizing potential barriers and facilitating the incorporation of AI education in medical schools may help create effective strategies for training healthcare professionals and students in AI literacy. Addressing deficiencies in AI knowledge can foster a more comprehensive understanding of both the potential and limitations of AI in healthcare, thereby equipping future practitioners to utilize these technologies effectively in personalized patient care and the continued advancement of the health sciences.

Abbreviations

AI: Artificial Intelligence
LMICs: Low- and Middle-Income Countries
MAZUMS: Mazandaran University of Medical Sciences
MAIRS-MS: Medical Artificial Intelligence Readiness Scale for Medical Students

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Authors' Contribution

The study's concept and design were developed by PS, MR, ZN, and SE. Data were collected by PS, SE, and MG, while RN and SE handled data analysis and interpretation. The manuscript was drafted by PS, SE, and MG, with RN, MR, and ZN providing critical revisions for significant intellectual content. RN conducted the statistical analysis, and MR oversaw the overall study supervision. All authors reviewed and accepted the final version.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Ethical Considerations

This study was conducted in accordance with the Declaration of Helsinki. Ethical approval was granted by the Ethics Committee of Mazandaran University of Medical Sciences (reference number: IR.MAZUMS.REC.1402.631). All participants provided written informed consent before taking part. They received comprehensive information about the study's objectives, procedures, and measures to ensure confidentiality. Only individuals who agreed to participate completed the survey. Participants were assured that their responses would be kept confidential and used solely for research and scientific purposes.

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Availability of Data and Materials

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. Participants' responses in the optional open-ended section are categorized and included in the supplementary file.

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