

Awareness and Perception of AI among Medical Students of District Swat: A Cross-Sectional Study

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ABSTRACT

Background: Artificial intelligence (AI) is rapidly influencing modern healthcare, yet limited data exist on medical students' awareness and perceptions of AI in Pakistan. Understanding students' views is essential to guide future integration of AI into medical education and clinical practice. **Objective:** To evaluate the awareness, perception, and concerns regarding Artificial Intelligence (AI) among medical students in District Swat, Pakistan. **Study Design:** A cross-sectional survey. **Settings:** Medical students from Saidu Medical College, Swat Medical College, and Saidu College of Dentistry in District Swat, Pakistan. **Duration:** From Jan 10 to Mar 10, 2025. **Methods:** A cross-sectional survey was conducted among 252 medical students from three institutions in Swat. A structured questionnaire assessed their AI awareness, understanding, perceived benefits, and associated concerns. Data were analyzed using SPSS for descriptive statistics, regression, and ANOVA tests. **Results:** The majority of students (95.3%) had prior awareness about AI; the awareness level was 28% (high), 33% (moderate), and 39% (low), though their understanding of AI research methods was moderate ($M=2.99$, $SD=1.01$). Most students believed AI would improve Healthcare ($M=3.75$, $SD=0.95$) and supported AI education in medical curricula ($M=3.69$, $SD=0.99$). Diagnosis (32.3%) and surgery (21.1%) were the most impacted areas. Concerns about AI replacing physicians were low ($M=2.69$, $SD=1.18$), though apprehensions about AI-assisted errors persisted ($M=3.27$, $SD=1.2$). ANOVA analysis showed no significant correlation between AI awareness and concerns about AI errors ($p=0.585$). **Conclusion:** Medical students in Swat acknowledge AI's role in medicine and express a strong interest in learning more about it. While they recognize AI's benefits in enhancing healthcare efficiency, concerns about AI-related risks remain. The findings highlight the need for AI-focused education in medical curricula to prepare future doctors for AI-integrated Healthcare.

Keywords: Artificial intelligence (AI), Medical students, Awareness, Perception.

INTRODUCTION

Artificial Intelligence (AI) has become an integral part of education and various other fields, including Healthcare, significantly impacting medical education and clinical practice. The growing role of AI in medical

education and Healthcare makes its understanding among the medical professionals necessary. Besides assessing perception and prejudice, awareness and perception are also necessary for the medical field to keep pace with its growing progress. With its growing progress, its handling and understanding become anew.

Several studies have assessed the awareness of the AI medical field, each highlighting its need and growing Interest among students and gaps in knowledge, particularly in developing countries such as Pakistan.

A cross-sectional study conducted among doctors and medical students in Pakistan in 2022 revealed that 74% had basic knowledge of AI, and only 27.3% were aware of its medical applications.¹ This knowledge gap clarifies the need for structured AI education in medical curricula. Similarly, another study found that medical students recognized the potential use of AI to assist in diagnosis and clinical decision-making. However, they also expressed concerns about AI replacing human judgment.² This fear was also noted in a study conducted in Ghana, where the students acknowledged AI's usefulness in the field and clinical settings but lacked formal training on how to implement it.³

International studies have further emphasized the importance of AI integration into medical education. Research in Germany and Saudi Arabia suggests early exposure to AI concepts can enhance medical students' ability to adapt to evolving healthcare technologies.⁴⁻⁷ However, a study in Jordan found that 66.2% of medical students felt their curriculum had not adequately covered AI despite significant Interest in learning about it.² In Pakistan, medical students' familiarity with AI remains limited, with many relying on informal sources such as the Internet rather than structured coursework.⁷

A study conducted in Peshawar, Pakistan, revealed that 61.7% of medical students had no prior knowledge of AI. While many were willing to learn, prejudiced concerns regarding AI's role in replacing medical professionals persisted.⁶ This underscores the necessity of introducing AI-related education in medical schools, particularly in regions like Swat, where AI adoption remains minuscule.

Given the increasing reliance on AI-assisted technologies in Healthcare, ranging from diagnostic imaging to predictive analytics, the awareness and preparedness of medical students in Swat require urgent assessment. This study aims to evaluate medical students' awareness of AI in Swat, their level of understanding perception, improve their level of understanding to provide better perception, eradicate AI-related concerns, and propose strategies for integrating AI education into medical curricula.

Future healthcare professionals can be better equipped to leverage AI for improved patient care while mitigating ethical and professional concerns by addressing these gaps.

METHODS

The questionnaire was developed specifically for this study after reviewing prior surveys on AI awareness

among medical students and healthcare professionals. It included sections on demographics, awareness, knowledge, understanding, perceived benefits, concerns, and attitudes toward AI. Since no pre-validated instrument was available for this setting, we designed the tool and assessed its reliability, which showed good internal consistency (Cronbach's alpha = 0.796).

An ERB certificate was obtained from the Ethical Review Board of Saidu Medical College, Swat (Ref no. 176-ERB/SMC/024). Only those medical students who volunteered were included in the study, and anonymity was maintained. The study population consisted of medical students from two medical and one dental college in the district of Swat. A convenience (voluntary response) sampling strategy was used for selecting participants from three medical colleges. Inclusion criteria were medical students willing to participate and who belonged to the three medical colleges; those who were unwilling and non-medical students were excluded. A structured questionnaire was designed, which contained demographics, awareness of AI in the medical field, knowledge, understanding, fear, and attitude associated with AI. The sample size was calculated to be 236 for a 75% response rate using the Raosoft calculator; overall, 252 responses were submitted. The data was analyzed using SPSS (version 30). We ran tests for descriptive analysis (means, percentages, and standard deviations), regression, and inferential analysis (ANOVA) was used to explore the relationship between variables.

RESULTS

A total of 252 students participated in the study. Table 1 shows the demographic data of participants.

Table 1: Demographic data of the participants

Sample size	N=252	Percentage
Gender (males)	115	(45.6%)
Gender (females)	137	(54.3%)
Mean Age	20.83(1.38)	
SMC	143	(56.7%)
SCD	46	(18.2%)
STMC	63	(25%)
First Year	94	(37.3%)
Second Year	95	(37.6%)
Third Year	46	(18.2%)
Fourth Year	7	(2.7%)
Final Year	10	(4%)

Table 2: Awareness level of individuals

Awareness level	Individuals	Percentages	Scale
High	71	28.17	13-17
Moderate	83	32.94	11-12
Low	98	38.9	≥10

The table shows the number of individuals with high, moderate, and low levels of awareness about AI. The 17-point scale was based on four questions, three of which were about understanding, and one was about some prior knowledge about AI. Each question was assigned a score; the sum of scores was 17. Based on the number of individuals on the scale, they were assigned to levels.

Table 3: Mean, SD, and p-value of Likert scale questions regarding improvements, associated fears, understanding, and concerns

	Question	Mean	SD	P-Value
Improvements	AI Applications have improved medicine	3.45	0.94	0
	AI will improve medicine in the future	3.75	0.95	0
	AI applications in medicine will become common in the future	4.01	0.91	0
	AI will optimize physicians/surgeons' work.	3.31	1.01	0
	AI will cause more benefits than harm	3.29	1.02	0
	AI applications will be cost-effective	3.45	0.95	0
Associated Fears	My area of Interest will be particularly affected by AI.	3.27	1.01	
	The development of AI in medicine frightens me	3.11	1.13	0.12
	AI will replace some or all the Physicians/Surgeons	2.69	1.18	0
	There is much hype about AI in medicine, but it will soon be over	2.83	0.95	0.0058
Understanding	Understand AI research methods	2.99	1.01	0.9
	I feel like my learning opportunities about AI in the medical field are adequate	2.93	1.08	.293
	Idea of Artificial intelligence applications in the medical field, research, machine learning, and NN	3.07	0.99	0.25
	I will need to understand and use AI during my medical career	3.73	0.91	0
	AI should be taught in medical schools	3.69	0.99	0
	Given the chance, I would like to learn more about AI.	3.98	0.90	0
	concern about AI-assisted errors in surgery, treatment, diagnosis, and prescription in the medical field	3.275	1.2	0

Table 3 shows the mean, SD, and p-value of Likert scale questions. Each question's total minimum and maximum scores ranged from 1—strongly disagree to 5—strongly Agree.

Awareness and Understanding: The students showed a moderate understanding of AI, with a mean score of 3.07 (SD = 0.99) for awareness of AI applications, machine learning, and neural networks. While many students agreed that AI would improve medicine in the future (mean = 3.75, SD = 0.95), their understanding of AI research methods was lower (mean = 2.99, SD = 1.01). A majority (mean = 3.98, SD = 0.90) expressed Interest in learning more about AI.

Perceived Benefits of AI in Medicine: Most students believed AI would optimize physicians' work (mean = 3.31, SD = 1.01) and be cost-effective (mean = 3.45, SD = 0.95). AI was perceived as an inevitable part of future medicine (mean = 4.01, SD = 0.91), with students supporting AI education in medical schools (mean = 3.69, SD = 0.99).

Concerns and Fears: Some students feared AI-assisted errors in surgery, diagnosis, and prescription (mean = 3.27, SD = 1.2). A notable concern was AI's potential impact on medical careers, with 3.27 (SD = 1.01) indicating anxiety about AI affecting their specialty. While concerns about AI replacing doctors were present (mean = 2.69, SD = 1.18), they were not as strong as other apprehensions.

Table 4: The perceived area of healthcare mostly affected according to medical students

Area of Healthcare, do you think AI will have an impact on the most	No. of times selected	%
Diagnosis	81	32.3
Surgery	53	21.1
Teaching	36	14.3
Overall Treatment	32	12.7
Prescribing	29	11.5
Examination	20	7.9

Perceived Impact of AI on Healthcare Fields: The highest perceived impact was on diagnosis (32.3%), followed by surgery (21.1%), teaching (14.3%), and overall treatment (12.7%). Regression analysis indicated that students who feared AI replacing doctors were significantly less likely to believe it would impact diagnosis ($p < 0.001$). At the same time, concerns about AI affecting their specialty were significantly associated with the perception that AI would impact treatment ($p = 0.014$).

Table 5: Multiple logistic regression analysis for the healthcare area and the fears associated with AI

Healthcare Area	Predictor	Coefficient	Std. error	z-value	p-value	Interpretation
Diagnosis	Concerned about the AI-assisted Risks (Q25)	-0.58	0.323	-1.79	0.073	Not significant
	AI development is frightening (Q14)	0.29	0.261	1.11	0.265	Not significant
	(2) Specialty of my Interest will be Affected (Q13)	-2.62	0.531	-4.94	<0.001	Significant
	(1) Doctors will be replaced by AI (Q15)	-4.07	0.734	-5.47	<0.001	Significant
Surgery	Concerned about the AI-assisted Risks (Q25)	-0.009	0.139	-0.06	0.949	Not significant
	AI development is frightening (Q14)	-0.04	0.114	-0.37	0.949	Not significant
	The specialty of my Interest will be Affected (Q13)	0.03	0.175	0.17	0.708	Not Significant
	Doctors will be replaced by AI (Q15)	0.2	0.231	1.12	0.868	Not Significant
Treatment	Concerned about the AI-assisted Risks (Q25)	-0.19	0.148	-1.29	0.149	Not Significant
	AI development is frightening (Q14)	-0.19	0.120	-1.6	0.101	Not significant
	(3) Specialty of my Interest will be Affected (Q13)	0.48	0.195	2.47	0.014	Significant
	Doctors will be replaced by AI (Q15)	0.02	0.25	0.08	0.938	Not Significant
Examination	Concerned about the AI-assisted Risks (Q25)	0.04	0.186	0.27	0.783	Not significant
	AI development is frightening (Q14)	-0.06	0.142	0.40	0.688	Not significant
	The specialty of my Interest will be Affected (Q13)	0.37	0.189	1.93	0.053	Weakly significant
	Doctors will be replaced by AI (Q15)	0.27	0.260	1.06	0.29	Not significant
Other (Teaching, Research, Public Health)	Concerned about the AI-assisted Risks (Q25)	-0.05	0.167	-0.31	0.758	Not significant
	AI development is frightening (Q14)	-0.12	0.138	-0.85	0.394	Not significant
	The specialty of my Interest will be affected (Q13)	-0.13	0.193	-0.67	0.500	Not significant
	(4) Doctors will be replaced by AI (Q15)	0.66	0.266	2.50	0.013	Significant

The above table (5) shows the multiple logistic regression analysis for the healthcare area and the fears associated with AI, such as replacing doctors, concerns about risks, its development being frightening, and the specific specialty I am interested in will be affected.

Interpretations: Students who feared AI would replace doctors were significantly less likely to perceive diagnosis as the most affected area ($\beta = -4.07, p < 0.001$), suggesting that these students might downplay AI's diagnostic role due to fear of replacement. However, they were likelier to perceive AI as impacting non-clinical areas like teaching or research ($\beta = 0.66, p = 0.013$).

Students concerned that their specialty might be affected by AI were also significantly less likely to believe AI would impact diagnosis ($\beta = -2.62, p < 0.001$) but more likely to think it would affect treatment practices ($\beta = 0.48, p = 0.014$), possibly reflecting anxiety about AI influencing core clinical decisions in their future field.

Anova Test: Awareness level vs. Concern level of individuals OR High awareness level among medical students causes higher concern regarding risks of AI.

Table 6-8: Groups A, B, and C indicate the groups with low, moderate, and high awareness, respectively

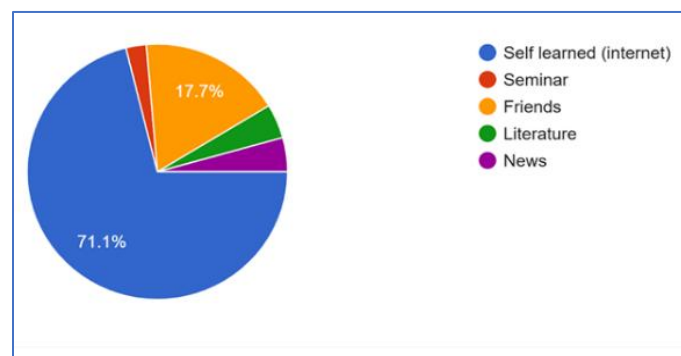
Descriptives								
						95% CI for mean		
	Groups	N	Mean	Std deviation	Std Error	Lower bound	Upper bound	Max/Min
Concern	A	96	3.36	1.28	0.13	3.10	3.62	5/1
	B	112	3.21	1.14	0.11	3.00	3.43	5/1
	C	40	3.18	1.20	0.19	2.79	3.56	5/1
	Total	248	3.27	1.20	0.8	3.12	3.42	5/1

Anova						
Concern		Sum of squares	Df	Mean square	F	Sig.
	Between Groups	1.56	2	0.78	0.54	.585
	Within groups	356.87	245	1.46		
	Total	358.44	247			

Multiple Comparisons (Concerns)							
Turkey HSD	I Family	J Family	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
	A	B	0.15	0.17	.644	-0.25	0.55
		C	0.19	0.23	.682	-0.35	0.73
	B	A	-0.15	0.17	.644	-0.55	0.25
		C	0.4	0.22	.983	-0.48	0.56
	C	A	-0.19	0.23	.682	-0.73	0.35
		B	-0.4	0.22	.983	-0.56	0.48

The following are the 3 tables for the ANOVA test, which we ran to test the hypothesis that students with more awareness and understanding of AI are more concerned about AI-assisted errors. (Table 6-8)

Awareness vs. Concern: The ANOVA test revealed no statistically significant correlation between AI awareness and concerns about AI-assisted errors ($p = 0.585$). This suggests that higher AI awareness does not necessarily indicate higher concern among medical students.

Figure 1: The learning sources of AI among students

DISCUSSION

Artificial Intelligence is revolutionizing the healthcare system by introducing new diagnostic techniques and

treatment methods and improving administrative efficiency.⁸ In developing countries like Pakistan, integrating AI into the healthcare system is challenging due to limited resources, inadequate training for healthcare providers, and infrastructural limitations. As future healthcare professionals, medical students play a vital role in the potential integration of AI into clinical practice. Therefore, this study explored the awareness and perception of AI among medical students in District Swat, Khyber Pakhtunkhwa, focusing on their knowledge, attitudes, and practices regarding AI in medicine.

The findings revealed that although many students had heard of AI, a significant portion had low levels of awareness regarding its application in the medical field. This contrasts with a previous study conducted in Peshawar, where fewer students reported prior AI knowledge.⁶ Similarly, in a German study, while many students were aware of AI, their understanding of its applications was still limited.⁹ These differences may be due to the earlier timeframes of those studies, as awareness and exposure to AI have increased significantly in recent years.

The participants in our study generally viewed AI positively regarding its contribution to medical advancements and future potential. This perception is

supported by prior studies where many participants expressed optimism regarding AI's role in diagnostics and the Healthcare system.^{10,11} Participants in our study believed AI would enhance, rather than replace, the capabilities of healthcare professionals, aligning with findings from Lebanon and Kuwait.^{12,13}

Participants also expressed moderate concerns regarding AI's impact on their future specialties. While the fear of AI completely replacing physicians was low, concerns about errors in AI-assisted diagnosis, surgery, and prescriptions were present. These concerns echo findings from other studies where participants were uncertain about AI's reliability and potential implications on the doctor-patient relationship.^{14,15} Despite these apprehensions, there was strong support for integrating AI education into medical school curricula and a clear interest in learning more about it.

Our study found that students perceived diagnosis as the area most likely influenced by AI, followed by surgery, education, and prescribing. These findings are consistent with research showing AI's high diagnostic accuracy in areas such as skin and breast cancer.^{17,18} Surgical procedures involving robotic systems have also shown significant benefits, including reduced complications and shorter hospital stays.¹⁹ Additionally, AI has proven useful in medical education through simulation and prescription safety by reducing medication errors.^{20,21}

Interestingly, students who feared AI replacing doctors were significantly less likely to believe it would positively impact diagnostic processes. At the same time, these concerns increased AI's perceived impact in treatment and education. This indicates that fear may shift the perceived utility of AI from core clinical roles to supplementary or academic domains.

Our analysis did not find a statistically significant relationship between students' awareness of AI and their concerns regarding AI-related risks. This suggests that simply being aware of AI does not necessarily lead to greater concern about its impact.

Given the low levels of understanding among students, there is a need to arrange awareness seminars and workshops to improve foundational knowledge. Enhancing exposure to AI and its practical applications can help students develop more balanced and informed perspectives.

CONCLUSION

The findings highlight that medical students in District Swat recognize the growing role of AI in medicine and also expressed a strong willingness to learn about it, provided the opportunity. While they acknowledge the benefits AI brings to medical practice, including

improved efficiency and cost-effectiveness, they also harbor concerns about AI-assisted errors and potential disruptions to their careers.

Despite some fears, the results suggest that students do not overwhelmingly believe AI will replace physicians but rather assist them in their journey and profession. The study underscores the need for AI-focused education in medical curricula to enhance understanding, address misconceptions, and prepare future doctors for AI-integrated Healthcare.

Overall, the study provides valuable insights into medical students' current awareness and perception of AI, laying the groundwork for future AI literacy programs in medical education.

LIMITATIONS

This study has several limitations. Firstly, the data was self-reported, introducing the possibility of response bias. Secondly, although the sample included students from three medical colleges, the findings may not be generalizable to all medical students nationwide. Thirdly, the cross-sectional design restricts the ability to conclude causality or track changes in awareness and perceptions over time. Finally, the study focused solely on medical students and thus does not reflect students' perceptions in other healthcare disciplines, such as nursing or pharmacy.

SUGGESTIONS / RECOMMENDATIONS

Based on our findings, several strategies can be introduced to strengthen AI knowledge and reduce concerns among medical students. First, integrating structured AI modules into the medical curriculum would provide students with formal and reliable knowledge rather than relying on informal sources. Second, workshops and seminars led by healthcare and computer science experts could help clear misconceptions, especially fears of errors or job replacement. Third, collaborations with computer science departments may give students hands-on exposure to AI tools, research methods, and ethical issues. Finally, student-led projects and elective courses on AI in healthcare could promote innovation and confident use of AI in future practice. These steps together would improve understanding, address concerns, and better prepare students for AI-integrated healthcare.

CONFLICT OF INTEREST / DISCLOSURE

The authors declare no conflict of Interest.

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REFERENCES

1. Ahmed Z, Bhinder KK, Tariq A, Tahir MJ, Mehmood Q, Tabassum MS, et al. Knowledge, Attitude, and Practice of Artificial Intelligence Among Doctors and Medical Students in Pakistan: A Cross-Sectional Online Survey. *Ann Med Surg (Lond)*. 2022 Apr;76:103493.
2. Rjoop A, Al-Qudah M, Alkhasawneh R, Bataineh N, Abdaljalael M, Rjoub MA, et al. Awareness and Attitude Toward Artificial Intelligence Among Medical Students and Pathology Trainees: Survey Study. *JMIR Med Educ*. 2025 Jan;11(1):e62669.
3. Ankamah S, Gyesei K, Amponsah V. Awareness, Knowledge, and Attitude Towards Artificial Intelligence: Perspective of Medical Students in Ghana. *Inf Dev*. 2024;02666669241283790.
4. Al-Ghazali MA. Evaluation of Awareness, Perception and Opinions Toward Artificial Intelligence Among Pharmacy Students. *Hosp Pharm*. 2025 Mar;00185787251326227.
5. Moldt JA, Festl-Wietek T, Fuhl W, Zabel S, Claassen M, Wagner S, et al. Assessing AI Awareness and Identifying Essential Competencies: Insights From Key Stakeholders in Integrating AI Into Medical Education. *JMIR Med Educ*. 2024 Jun;10:e58355.
6. Abid S, Awan B, Ismail T, Sarwar N, Sarwar G, Tariq M, et al. Artificial Intelligence: Medical Students' Attitude in District Peshawar, Pakistan. *Pak J Public Health*. 2019 Jul;9(1):19-21.
7. Baseer S, Jamil B, Khan SA, Khan M, Syed A, Ali L. Readiness Towards Artificial Intelligence Among Medical and Dental Undergraduate Students in Peshawar, Pakistan: A Cross-Sectional Survey. *BMC Med Educ*. 2025 Apr;25(1):632.
8. Xiang Y, Zhao L, Liu Z, Wu X, Chen J, Long E, et al. Implementation of Artificial Intelligence in Medicine: Status Analysis and Development Suggestions. *Artif Intell Med*. 2020 Jan;102:101780.
9. Pinto dos Santos D, Giese D, Brodehl S, Chon SH, Staab W, Kleinert R, et al. Medical Students' Attitude Towards Artificial Intelligence: A Multicentre Survey. *Eur Radiol*. 2019 Apr;29:1640-6.
10. Castagno S, Khalifa M. Perceptions of Artificial Intelligence Among Healthcare Staff: A Qualitative Survey Study. *Front Artif Intell*. 2020 Oct;3:578983.
11. Sit C, Srinivasan R, Amlani A, Muthuswamy K, Azam A, Monzon L, et al. Attitudes and Perceptions of UK Medical Students Towards Artificial Intelligence and Radiology: A Multicentre Survey. *Insights Imaging*. 2020 Dec;11:1-6.
12. Doumat G, Daher D, Ghanem NN, Khater B. Knowledge and Attitudes of Medical Students in Lebanon Toward Artificial Intelligence: A National Survey Study. *Front Artif Intell*. 2022 Nov;5:1015418.
13. Buabbas AJ, Miskin B, Alnaqi AA, Ayed AK, Shehab AA, Syed-Abdul S, et al. Investigating Students' Perceptions Towards Artificial Intelligence in Medical Education. *Healthcare (Basel)*. 2023 May;11(9):1298.
14. Syed W, Al-Rawi MB. Assessment of Awareness, Perceptions, and Opinions Towards Artificial Intelligence Among Healthcare Students in Riyadh, Saudi Arabia. *Medicina (Kaunas)*. 2023 May;59(5):828.
15. Umer M, Naveed A, Maryam Q, Malik AR, Bashir N, Kandel K. Investigating Awareness of Artificial Intelligence in Healthcare Among Medical Students and Professionals in Pakistan: A Cross-Sectional Study. *Ann Med Surg (Lond)*. 2024 May;86(5):2606-11.
16. Wood EA, Ange BL, Miller DD. Are We Ready to Integrate Artificial Intelligence Literacy Into Medical School Curriculum: Students and Faculty Survey. *J Med Educ Curric Dev*. 2021;8:23821205211024078.
17. Esteva A, Kuprel B, Novoa RA, Ko J, Swetter SM, Blau HM, et al. Dermatologist-Level Classification of Skin Cancer With Deep Neural Networks. *Nature*. 2017 Feb;542(7639):115-8.
18. McKinney SM, Sieniek M, Godbole V, Godwin J, Antropova N, Ashrafian H, et al. International Evaluation of an AI System for Breast Cancer Screening. *Nature*. 2020 Jan;577(7788):89-94.
19. Sheetz KH, Nuliyalu U, Nathan H, Sonnenday CJ. Association of Surgeon Case Numbers of Pancreaticoduodenectomies vs Related Procedures With Patient Outcomes to Inform Volume-Based Credentialing. *JAMA Netw Open*. 2020 Apr;3(4):e203850.
20. Lohre R, Bois AJ, Pollock JW, Lapner P, McIlquham K, Athwal GS, et al. Effectiveness of Immersive Virtual Reality on Orthopedic Surgical Skills and Knowledge Acquisition Among Senior Surgical Residents: A Randomized Clinical Trial. *JAMA Netw Open*. 2020 Dec;3(12):e2031217.
21. Holmes MV, Richardson TG, Ference BA, Davies NM, Davey Smith G. Integrating Genomics With Biomarkers and Therapeutic Targets to Invigorate Cardiovascular Drug Development. *Nat Rev Cardiol*. 2021 Jun;18(6):435-53.