ETHICAL AND MEDICOLEGAL PERSPECTIVES REGARDING AI ADOPTION IN HEALTHCARE: A CROSS-SECTIONAL ONLINE SURVEY AMONG EGYPTIAN PHYSICIANS

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ABSTRACT

Background: Artificial intelligence (AI) holds promises for enhancing healthcare efficiency. As AI's applications grow, ethical and medicolegal concerns arise**. Objectives:** This study aimed to assess the perspectives of Egyptian physicians toward AI integration in healthcare, with special emphasis on its ethical and medicolegal implications. **Methodology:** A cross-sectional study using an anonymous electronic questionnaire was conducted on a convenience sample of Egyptian physicians. The questionnaire included three sections: personal and professional data of participants, perspectives and attitudes of physicians toward AI adoption in healthcare, and ethical and medicolegal implications. **Results**: Responses were received from 177 physicians. Only 37.3% of participants started using AI tools in their medical practice. Improved diagnostic accuracy was determined by 53.7% of participants as the most beneficial AI application. Limited awareness of AI was the principal obstacle to AI adoption, highlighted by 65.5% of participants. 47.5% of physicians were concerned about accountability and medicolegal liability risks. More than half of the participants agreed that significant ethical issues and risks of breaching patient confidentiality are related to AI use. The majority agreed that the physician should ensure that AI-driven medical decisions align with the patient's best interests and that medical AI systems' unexplainable nature would limit patients' autonomy. 57.6% of the participants agreed that physicians should be transparent about using AI in healthcare.61.6% strongly agreed that the physician's judgment and expertise should guide the application of AI in healthcare. 78.0% of participants showed good scores for awareness of ethical and medicolegal issues. 85.9% of participants exhibited unfamiliarity with any legal regulations guiding AI applications in healthcare. 47.5% of participants identified physicians and healthcare institutions using AI as responsible for medical errors resulting from using AI. Physicians' age, medical specialty, job level, and affiliated healthcare institute significantly affected awareness scores regarding ethical and medicolegal issues, with P values of 0.004, 0.001, and < 0.001, respectively. **Conclusions:** The study revealed that Egyptian physicians generally recognized the importance of AI in medicine. Incorporating ethical and medicolegal considerations in developing AI systems could facilitate the successful adoption of AI in healthcare.

Keywords: Artificial intelligence; AI; Ethical; Medicolegal; Medicine; Egypt.

INTRODUCTION

Artificial intelligence (AI) is a broad field of computer-based technology systems that entails developing machines and software capable of performing tasks that could simulate human intelligence **(Chen and Decary 2020)**.

Artificial Intelligence is becoming increasingly common in healthcare, with a variety of promising applications, including enhanced diagnostic accuracy, reducing medical errors in diagnosis, and clinical risk prediction **(Topol 2019 and Loftus et al 2020b**). Additionally, AI has proved its capability to assist medical professionals with routine administrative tasks, with subsequently improved workflows (**Panch et al 2018**).

Due to its expanding potential, it has been argued that the implementation of AI tools could revolutionize healthcare **(Johnson et al., 2021)**. Since the launch of the Chat Generator Pre-Trained Transformer (ChatGPT), a publicly accessible AI platform (**Levin et al 2023**) in November 2022, it garnered significant interest from the medical community for its potential to enhance efficiency in clinical practice **(Jeblick et al 2024**).

While AI technologies have the potential to profoundly transform medical practice and patient care, their implementation in healthcare systems presents significant ethical and medicolegal challenges (**Jassar et al 2022**). The literature demonstrated significant concerns

regarding data privacy, accountability, bias, patient autonomy, transparency, and confidentiality. These ethical challenges associated with AI applications in healthcare should be thoroughly investigated to fully leverage AI technologies (**McKay et al 2022**).

The existing literature highlights the lack of cohesive legislation regarding the medicolegal liability of physicians utilizing AI. This uncertainty concerning responsibility obscures the ability to evaluate fault-based liability **(Bottomley and Thaldar 2023)**. Therefore, there is a need for new legal regulations concerning medical professional liability in relation to AI applications. The establishment of these legal regulations could encourage the responsible use of this emerging technology and foster active collaboration between machines and healthcare providers while ensuring the ethical and legal framework **(Sablone et al., 2024).**

Despite several studies in Middle Eastern countries (**AlZaabi et al 2023, Abuzaid et al 2022, Qurashi et al 2021, and Swed et al 2022**) and Western counties (**Maassen et al 2021, Blease et al 2019, and Lennartz et al 2021**) have investigated the attitudes of physicians toward AI adoption, studies are still scarce in Egypt (**khalf et al 2022**). Therefore, this study aimed to evaluate the current attitudes and perspectives of Egyptian physicians regarding the use of AI in healthcare, with a specific emphasis on its ethical and medico-legal considerations.

SUBJECTS AND METHODS

Sample Size

The current research is a cross-sectional questionnaire-based study. The sample size was calculated using Epi Info-7 software **(Dean et al 2000**) based on the intention of 87.2% of the surveyed physicians in a previous study **(Giavina-Bianchi et al 2024**) to use AI frequently/always in their medical practice. The minimum accepted sample size was 171 physicians to achieve 80% study power and a 95% confidence interval.

Data collection tool

An anonymous electronic questionnaire was formulated using the Microsoft Forms platform after a comprehensive review of published literature **(Sablone et al 2024, Gerke et al 2020, Prakash et al 2022, and Siala and Wang 2022**). Firstly, two Egyptian experts in AI and medical ethics were asked to assess the relevance of the questionnaire items to the study's objective. After that, a pilot study involving 20 Egyptian physicians was conducted to ensure the questionnaire was well-formulated and understandable.

The questionnaire was distributed by sending the Microsoft Form link via social media. Physicians from different clinical specialties in Egypt were invited to participate in the study over two months (September and October 2024). A convenient sampling technique was used (non-probability sampling). Participation was voluntary, and the questionnaire's preface informed participants about the survey's goal.

The survey comprises 20 questions assigned into 3 main domains. The first domain (7 questions) involved the personal and professional characteristics of participants, including age, gender, medical specialty, experience duration, job level, highest academic degree, and affiliated healthcare institute. The second domain (4 questions) comprised questions assessing physicians' attitudes and perspectives toward the adoption of AI in healthcare. The third domain (9 questions) evaluated the participants' knowledge regarding ethical and medicolegal issues related to AI use in healthcare. The survey included three different question forms: a single correct answer per question, numerous correct answers per question, and a four-point Likert scale question.

Ethical considerations

Before the study commencement, approval was obtained from the Research Ethics Committee of the Faculty of Medicine, Alexandria University (IRB Number: 00012098, FWA Number: 00018699, Approval Serial Number: 0306518). The authors guarantee the confidentiality of participant data.

Statistical analysis of the data

Data analysis was done using the IBM SPSS software package version 20 **(**Armonk, NY: IBM Corp, released 2011**)**. Categorical variables were summarized by frequency and percentages. Quantitative data were expressed as a range (minimum and maximum), mean, standard deviation, and median. The Kolmogorov-Smirnov test was used to confirm the normality of data distribution. The chi-square test was applied to study the association between categorical variables. Fisher's exact test was used when more than 20% of the total expected cell counts were less than 5. For normally distributed quantitative variables, the

student t-test was used to compare two groups, while the F-test (ANOVA) was used to compare more than two groups. The significance of the results obtained was judged at a 0.05 significance level.

RESULTS

1-Personal and professional characteristics of participating physicians

The present work included the responses of 177 physicians from 11 Egyptian governorates. Table 1 shows the personal and professional characteristics of study participants. The majority of participants were females (59.3 %). Over half of respondents (53.7 %) were aged between 31 and 40 years. The involved physicians represented a variety of specialties, including internal medicine (18.6%), pediatrics (11.9%), general surgery (11.4 %), clinical toxicology (7.3%), ophthalmology (6.8%), neuropsychiatry (5.6%), clinical pathology (5.6%), family medicine (5.1%), obstetrics and gynecology (4.0%), radiology (4.0%), dermatology (2.8%), orthopedics (2.8%), and critical care (2.8%). The less represented medical specialties (< 2 %) were grouped and categorized as "Other".

Regarding the job level of respondents, consultants constituted 55.9 % of the participants, followed by specialists (28.8%) and residents (15.3%). Concerning the highest academic degree, more than half of the participants (52.5%) obtained a doctorate, followed by 28.2% with a master's degree. Considering affiliated healthcare institutes, more than half of the participants (57.1%) were employed in university hospitals, while 32.8% were affiliated with Ministry of Health hospitals. In terms of professional experience, 34% have experience lasting more than ten years and less than 15 years, followed by those with experience lasting more than 20 years (22.6%) (Table 1).

2-Perspectives and attitudes of participating physicians regarding AI adoption in healthcare

Table 2 presents the survey results regarding participating physicians' perspectives and attitudes toward using AI in healthcare. A considerable portion of participants (43.5 %) declared that they started using AI tools outside medical professional settings. However, only 37.3% of participants exhibited a positive attitude towards AI use in medicine and declared that they began using AI tools in medical practice, while 62.7% have never utilized any AI tool in their medical profession.

The participants were asked to identify the beneficial applications of AI in healthcare. Improved diagnostic accuracy was determined by 53.7% of participants as the most useful application of AI in healthcare. Also, medical imaging analysis and automation of administrative tasks were mentioned by (44.6%) and (42.9%) respondents, respectively. Besides, 35%, 34.5%, and 31.6% of the participants mentioned enhanced treatment planning, virtual assistants and chatbots, and clinical risk prediction as the most beneficial application of AI in healthcare, respectively (Table 2).

In addition, the participants were asked to recognize the principal obstacles to AI adoption in healthcare. Limited awareness of AI technologies was highlighted by 65.5% of participants as the principal obstacle. On the other hand, 47.5% of physicians were concerned about possible accountability and medicolegal liability implications, and fear of job displacement were the primary concerns mentioned by 44.1%, 42.4%, and 22 % of participants, respectively (Table 2).

The present study revealed a significant association between the positive attitude toward using AI in medical practice and affiliated healthcare institutes (P=0.003), where physicians affiliated with university hospitals constitute 72.7% of participants who started using AI in medical practice. However, no significant relationship exists between using AI in medical practice and respondents' gender, age, medical specialty, job level, highest academic degree, and experience duration, with P values 0.715, 0.106, 0.679, 0.211, 0.174, and 0.380, respectively (Table 3).

3-Ethical and medicolegal issues related to AI use in healthcare

Concerning the ethical and medicolegal implications of using AI in healthcare, more than half of the participants (58.8%) agreed that serious ethical issues are associated with using AI in healthcare, while 22.6% of respondents disagreed. In addition, 63.8% of the participants expressed their agreement with the potential risks of breaching patient confidentiality associated with using AI to collect healthcare data. Conversely, 38 respondents (21.5%) disagreed with this perspective. Furthermore, a significant percentage of participants (59.3%) agreed that the physician should ensure that AI-driven medical decisions align with the patient's

best interests. Conversely, only 2 respondents (1.1%) disagreed, making it the least prevalent viewpoint (Table 4).

Out of the total respondents, 134 participants (75.7%) agreed that medical AI systems' unexplainable nature would limit patients' autonomy, while 16.4% of respondents disagreed. Concerning transparency about using AI, 57.6% of the participants agreed that physicians should be transparent about using AI in healthcare. In contrast, only 22 respondents (12.4%) disagreed with this notion. The study also included a question about physicians' role in applying AI in healthcare. A considerable portion of the participants (61.6%) strongly agreed that the physician's judgment and expertise should guide the application of AI in healthcare. On the other hand, only 5 respondents (2.8%) disagreed with this perspective (Table 4).

Participants' awareness of ethical and medicolegal issues related to AI use in healthcare risks. The unreliability and trustworthiness of AI technologies, ethical

was quantified. Each question was given 4 points based on the response, with 4 points for the "strongly agree" response, 3 points for the "agree" response, 2 points for "disagree", and 1 point for the "strongly disagree". Thus, the maximum possible score is 24. The participants' awareness scores ranged from 11 to 24, with a mean of 19.72 ± 3.05 and a median of 20. The awareness score was divided into three tertiles; the first tertile represented poor, the second tertile denoted fair, and the third tertile represented good knowledge. Most participants (78.0%) showed good scores for awareness of ethical and medicolegal issues related to AI use in healthcare.

The participants were asked to identify the World Health Organization (WHO) consensus on ethical principles for using AI in healthcare. The majority of participants (71.8%) identified promoting human well-being, safety, and the public interest as an element of the WHO ethical principles, whereas 66.1% identified ensuring transparency, "explainability," and intelligibility. Only 56.5% identified the protection of autonomy as an element of the WHO ethical principles. Respondents were less likely to identify the other three elements. Almost a quarter of participants (24.9%) identified all six elements of the WHO ethical principles (Table 4). Regarding legislation guiding AI use in healthcare, most participants (85.9%) exhibited unfamiliarity with any existing legal regulations guiding AI applications in healthcare, while only 14.1% acknowledged their familiarity with existing legal regulations (Table 4).

When asked about the responsibility for medical errors resulting from using AI software in clinical context, a considerable portion of participants (47.5%) identified physicians and healthcare institutions using AI as the primary responsible entity. In contrast, only 25.4% of respondents highlighted creators of AI algorithms as responsible for such errors. More than a quarter of participants (27.1%) declared that establishing accountability is debatable. Notably, patients who gave consent for AI use weren't mentioned by any participants as responsible for such errors (Table 4).

4-Associations between awareness regarding ethical and medicolegal issues of AI and

($p = 0.006$) was observed, with almost half (49.3%) of physicians with good awareness scores being consultants, followed by specialists (34.1%). Moreover, there was a significant association between physicians' awareness and their affiliated healthcare institute ($p < 0.001$), with staff members affiliated with university hospitals constituting more than half (53.6%) of physicians with good awareness scores. However, there was no significant association between physicians' awareness and their highest academic degree, gender, and duration of experience, with p-values of 0.264, 0.678, and 0.564, respectively (Table 5).

physicians' personal and professional characteristics

The present study revealed a significant association between physicians' awareness scores regarding ethical and medicolegal issues and their age ($p = 0.004$), where 58% of physicians with good awareness scores were in the age group 31 to 40. In addition, medical specialty significantly affected the level of awareness, with 19 out of 20 surgeons (95%) participating in the study showing good awareness scores. Besides, 17 pediatricians out of 21 (80.0 %) participated in the survey, followed by 26 internists out of 33 (78.7%) who participated in the survey, showing good awareness scores (Table 5).

Furthermore, a significant association between physicians' awareness and their job level

Table (1): Personal and professional characteristics of participating physicians (n = 177)

Q	Personal and professional data	Number	(%)
1	**Gender** [a]		
	Male	72	(40.7%)
	Female	105	(59.3%)
2	**Age (years)** [a]		
	25 – 30	13	(7.3%)
	31 – 40	95	(53.7%)
	41 – 50	35	(19.8%)
	50 – 60	18	(10.2%)
	>60	16	(9.0%)
3	**Medical Specialty** [a]		
	Internal medicine	33	(18.6%)
	Pediatrics	21	(11.9%)
	General Surgery	20	(11.4%)
	Clinical Toxicology	13	(7.3%)
	Ophthalmology	12	(6.8%)
	Neuropsychiatry	10	(5.6%)
	Clinical pathology	10	(5.6 %)
	Family medicine	9	(5.1%)
	Obstetrics and Gynecology	7	(4.0%)
	Radiology	7	(4.0%)
	Dermatology	5	(2.8%)
	Orthopedics	5	(2.8%)
	ENT	5	(2.8%)
	Critical and Emergency care	5	(2.8%)
	Others	15	(8.5%)
4	**Job level** [a]		
	Resident	27	(15.3%)
	Specialist	51	(28.8%)
	Consultant	99	(55.9%)
5	**Highest Academic degree** [a]		
	Bachelor	20	(11.4%)
	Master	50	(28.2%)
	Doctorate	93	(52.5%)
	Diploma	10	(5.6%)
	Egyptian fellowship or Egyptian board	4	(2.3%)
6	**Affiliated healthcare institute** [a]		
	University Hospital	101	(57.1%)
	Ministry of Health Hospital	58	(32.8%)
	Private sector	18	(10.1%)
7	**Duration of professional experience (year)**[a]		
	<5 years	19	(10.7%)
	5 – <10 years	33	(18.6%)
	10 – <15 years	60	(34%)
	15 – <20 years	25	(14.1%)
	≥20 years	40	(22.6%)

[a] Single correct answer per question

Table (2): Distribution of the participants according to perspectives and attitudes toward AI adoption in healthcare (n = 177)

Q	Perspectives and attitudes toward AI adoption in healthcare	No.	(%)
8	**Have you ever used any AI tool outside medical professional settings?** [a]		
	Yes	77	(43.5%)
	No	100	(56.5%)
9	**Have you ever used any AI tool (ChatGPT or other tools) in your medical practice?** [a]		
	Yes	66	(37.3%)
	No	111	(62.7%)
10	**According to your point of view, what are the most beneficial applications of AI in healthcare?** [b]		
	Improved diagnostic accuracy	95	(53.7%)
	Medical Imaging analysis	79	(44.6%)
	Automation of administrative tasks	76	(42.9%)
	Enhanced treatment planning	62	(35.0%)
	Virtual Assistants and Chatbots	61	(34.5%)
	Clinical Risk Prediction	56	(31.6%)
11	**According to your point of view, what are the principal obstacles to AI adoption in healthcare?** [b]		
	Limited awareness of AI technologies	116	(65.5%)
	Accountability and medicolegal liability risks	84	(47.5%)
	Unreliability and trustworthiness of AI technologies	78	(44.1%)
	Ethical implications	75	(42.4%)
	Fear of job displacement	39	(22.0%)

a Single correct answer per question b Multiple correct answers per question

Table (3): Association between physicians' attitudes toward using AI in medicine and their personal and professional data (n = 177)

	Personal and professional data	Q9. Have you ever used any AI tool (ChatGPT or other tools) in your medical practice?		Test of Sig.	p
		No (n = 111)	Yes (n = 66)		
1	**Gender**				
	Male	44 (39.6%)	28 (42.4%)	χ^2= 0.133	0.715
	Female	67 (60.4%)	38 (57.6%)		
2	**Age**				
	25 – 30	7 (6.3%)	6 (9.1%)		
	31 – 40	67 (60.4%)	28 (42.4%)		
	41 – 50	18 (16.2%)	17 (25.8%)	χ^2= 7.641	0.106
	50 – 60	8 (7.2%)	10 (15.2%)		
	>60	11 (9.9%)	5 (7.6%)		
3	**Medical Specialty**				
	Internal medicine	18 (16.2%)	15 (22.7%)		
	Pediatrics	14 (12.6%)	7 (10.6%)		
	General Surgery	14 (12.6%)	6 (9.1%)		
	Clinical Toxicology	8 (7.2%)	5 (7.6%)		
	Ophthalmology	9 (8.1%)	3 (4.5%)		
	Neuropsychiatry	5 (4.5%)	5 (7.6%)		
	Clinical pathology	5 (4.5%)	5 (7.6%)		
	Family medicine	6 (5.4%)	3 (4.5%)	FET= 11.284	0.679
	Obstetrics and Gynecology	4 (3.6%)	3 (4.5%)		
	Radiology	5 (4.5%)	2 (3.0%)		
	Dermatology	5 (4.5%)	0 (0.0%)		
	Orthopedics	3 (2.7%)	2 (3.0%)		
	ENT	1 (0.9%)	4 (6.1%)		
	Critical and Emergency care	4 (3.6%)	1 (1.5%)		
	Others	10 (9.0%)	5 (7.6%)		
4	**Job level**				
	Resident/ demonstrator	21 (18.9%)	6 (9.1%)	χ^2=	0.211

	Specialist	31 (27.9%)	20 (30.3%)	3.113	
	Consultant	59 (53.2%)	40 (60.6%)		
5	**Highest Academic degree**				
	Bachelor	15 (13.5%)	5 (7.6%)	FET= 6.145	0.174
	Master	32 (28.8%)	18 (27.3%)		
	Doctorate	52 (46.8%)	41 (62.1%)		
	Diploma	8 (7.2%)	2 (3.0%)		
	Egyptian fellowship or Egyptian board	4 (3.6%)	0 (0.0%)		
6	**Affiliated healthcare institute**				
	University Hospital	53 (47.7%)	48 (72.7%)	χ^2= 11.480*	0.003*
	Ministry of Health Hospital	46 (41.4%)	12 (18.2%)		
	Private sector	12 (10.8%)	6 (9.1%)		
7	**Duration of professional experience (year)**				
	<5 years	13 (11.7%)	6 (9.1%)	χ^2= 4.194	0.380
	5 – <10 years	19 (17.1%)	14 (21.2%)		
	10 – <15 years	43 (38.7%)	17 (25.8%)		
	15 – <20 years	14 (12.6%)	11 (16.7%)		
	≥20 years	22 (19.8%)	18 (27.3%)		

χ^2: **Chi-square test** FET: **Fisher Exact test**
p: p-value for associations between **physicians' attitudes toward using AI in medicine and personal and professional data**
*: Statistically significant at $p \leq 0.05$

Table (4): Distribution of the participants according to ethical and medicolegal issues related to AI use in healthcare (n = 177)

Q	Ethical and medicolegal issues related to AI use in healthcare	No. (%)
12	**There are serious ethical issues associated with the use of AI in Healthcare** [a]	
	Strongly disagree	3 (1.7%)
	Disagree	40 (22.6%)
	Agree	104 (58.8%)
	Strongly agree	30 (16.9%)
13	**There are potential risks of breaching patient confidentiality associated with using AI in collecting healthcare data** [a]	
	Strongly disagree	1 (0.6%)
	Disagree	38 (21.5%)
	Agree	113 (63.8%)
	Strongly agree	25 (14.1%)
14	**The physician should ensure that AI-driven medical decisions align with the patient's best interests** [a]	
	Strongly disagree	3 (1.7%)
	Disagree	2 (1.1%)
	Agree	105 (59.3%)
	Strongly agree	67 (37.9%)
15	**The unexplainability nature of medical AI systems would limit the patient's autonomy** [a]	
	Strongly disagree	0 (0.0%)
	Disagree	29 (16.4%)
	Agree	134 (75.7%)
	Strongly agree	14 (7.9%)
16	**The physician should be transparent regarding the use of AI in healthcare** [a]	
	Strongly disagree	2 (1.1%)
	Disagree	22 (12.4%)
	Agree	102 (57.6%)
	Strongly agree	51 (28.8%)
17	**The application of AI in healthcare should be guided by the physician's judgment and expertise**[a]	
	Strongly disagree	1 (0.6%)
	Disagree	5 (2.8%)
	Agree	62 (35.0%)
	Strongly agree	109 (61.6%)
18	**WHO Consensus on ethical principles for the use of AI for health** [b]	

	Protection of autonomy	100 (56.5%)
	Promoting human well-being, human safety, and the public interest	127 (71.8%)
	Ensuring transparency, "explainability," and intelligibility	117 (66.1%)
	Fostering responsibility and accountability	74 (41.8%)
	Ensuring inclusiveness and equity	75 (42.4%)
	Promoting AI that is responsive and sustainable	84 (47.5%)
19	**Are you aware of any existing legal regulations guiding AI use in healthcare?** [a]	
	Yes	25 (14.1%)
	No	152 (85.9%)
20	**Who is responsible for medical errors resulting from using AI software in the clinical context?**[a]	
	Physicians and healthcare institutions using AI	84 (47.5%)
	Creators of AI algorithms	45 (25.4%)
	Patient who gave consent for AI use	0 (0.0%)
	Establishing accountability is a matter of debate	48 (27.1%)

SD: **Standard deviation**

a Single correct answer per question b Multiple correct answers per question

Table (5): Associations between awareness scores of ethical and medicolegal issues related to AI use in healthcare and personal and professional data (n = 177)

	Personal and professional data	**Level of Ethical and medicolegal issues related to AI use in healthcare**			**FET**	**p**
		Poor (6 – 11) (n = 1)	**Fair (12 – 17) (n = 38)**	**Good (18 – 24) (n = 138)**		
1	**Gender**					
	Male	1 (100.0%)	15 (39.5%)	56 (40.6%)	1.410	0.678
	Female	0 (0.0%)	23 (60.5%)	82 (59.4%)		
2	**Age**					
	25 – 30	0 (0.0%)	1 (2.6%)	12 (8.7%)		
	31 – 40	0 (0.0%)	15 (39.5%)	80 (58.0%)		
	41 – 50	0 (0.0%)	15 (39.5%)	20 (14.5%)	19.789*	0.004*
	50 – 60	1 (100.0%)	2 (5.3%)	15 (10.9%)		
	>60	0 (0.0%)	5 (13.2%)	11 (8.0%)		
3	**Medical Specialty**					
	Internal medicine	0 (0.0%)	7 (18.4%)	26 (18.8%)		
	General Surgery	0 (0.0%)	1 (2.6%)	19 (13.8%)		
	Pediatrics	0 (0.0%)	4 (10.5%)	17 (12.3%)		
	Clinical Toxicology	0 (0.0%)	2 (5.3%)	11 (8.0%)		
	Ophthalmology	0 (0.0%)	3 (7.9%)	9 (6.5%)		
	Neuropsychiatry	0 (0.0%)	7 (18.4%)	3 (2.2%)		
	Clinical pathology	0 (0.0%)	3 (7.9%)	7 (5.1%)		
	Family medicine	0 (0.0%)	1 (2.6%)	8 (5.8%)	χ^2 = 59.181*	0.001*
	Obstetrics and Gynecology	0 (0.0%)	3 (7.9%)	4 (2.9%)		
	Radiology	0 (0.0%)	1 (2.6%)	6 (4.3%)		
	Dermatology	0 (0.0%)	0 (0.0%)	5 (3.6%)		
	Orthopedics	0 (0.0%)	0 (0.0%)	5 (3.6%)		
	ENT	1 (100.0%)	1 (2.6%)	3 (2.2%)		
	Critical and Emergency care	0 (0.0%)	2 (5.3%)	3 (2.2%)		
	Others	0 (0.0%)	3 (7.9%)	12 (8.7%)		
4	**Job level**					
	Resident/ demonstrator	0 (0.0%)	4 (10.5%)	23 (16.7%)		
	Specialist	0 (0.0%)	4 (10.5%)	47 (34.1%)	12.587*	0.006*
	Consultant	1 (100.0%)	30 (78.9%)	68 (49.3%)		
5	**Highest Academic degree**					
	Bachelor	0 (0.0%)	3 (7.9%)	17 (12.3%)		
	Master	0 (0.0%)	8 (21.1%)	42 (30.4%)		
	Doctorate	1 (100.0%)	26 (68.4%)	66 (47.8%)	11.092	0.264
	Diploma	0 (0.0%)	0 (0.0%)	10 (7.2%)		
	Egyptian fellowship or Egyptian board	0 (0.0%)	1 (2.6%)	3 (2.2%)		
6	**Affiliated healthcare institute**					

	University Hospital	0 (0.0%)	27 (71.1%)	74 (53.6%)		
	Ministry of Health Hospital	0 (0.0%)	4 (10.5%)	54 (39.1%)	18.647*	<0.001*
	Private sector	1 (100.0%)	7 (18.4%)	10 (7.2%)		
7	**Duration of professional experience (year)**					
	<5 years	0 (0.0%)	4 (10.5%)	15 (10.9%)		
	5 – <10 years	0 (0.0%)	6 (15.8%)	27 (19.6%)		
	10 – <15 years	0 (0.0%)	10 (26.3%)	50 (36.2%)	7.206	0.564
	15 – <20 years	0 (0.0%)	8 (21.1%)	17 (12.3%)		
	≥20 years	1 (100.0%)	10 (26.3%)	29 (21.0%)		

FET: Fisher Exact test
p: p-value for **awareness scores of ethical and medicolegal issues related to AI use in healthcare and personal and professional data**
*: Statistically significant at $p \leq 0.05$

DISCUSSION

Despite the growing usage of AI worldwide and the accumulating evidence about its promising impact on healthcare, significant ethical and medicolegal challenges persist (**Gerke et al 2020**, **Jassar et al 2022**). Also, evaluating current physicians' perspectives and attitudes is critical for identifying potential obstacles and supporting future AI integration in healthcare (**Laï et al 2020**). Therefore, the present study was conducted to explore Egyptian physicians' current attitudes regarding the use of AI in healthcare and its ethical and medicolegal considerations.

The present study revealed that more than half of the participants have never utilized any AI tool in their medical profession. Only 37.3% of participants exhibited a positive attitude towards AI use in medicine and acknowledged starting to use AI tools in medical practice. This denotes that AI has started to acquire reasonable recognition and awareness among Egyptian medical professionals. This is consistent with similar studies stating that physicians demonstrated a positive attitude about integrating AI into their practice (**Coppola et al 2021, Mosch et al 2022, and Pecqueux et al 2022**). Notably, ChatGPT's emergence could have attracted a lot of interest from medical professionals as a means of enhancing efficiency in healthcare (**Dave et al 2023**). However, this cohort's adoption of AI in medicine is still in its nascent stages.

The present study revealed a significant association between a positive attitude toward using AI in medical practice and affiliated healthcare institutes, with physicians affiliated with university hospitals composing the vast majority of participants who started using AI in medicine. This could be explained by the fact that continuous scientific updates and research work are crucial for physicians affiliated with university hospitals as necessary elements of their continued professional development.

Concerning physicians' awareness of AI's applications in medicine, improved diagnostic accuracy was determined by a majority of participants as the most useful application of AI. Also, a high proportion of respondents mentioned medical imaging analysis and automation of administrative tasks. To date, AI can uncover vital findings that could be inaccessible even to skilled physicians. Consequently, AI integration could support clinical decision-making, possibly reducing misdiagnoses in human practice. Moreover, the use of AI in clinical practice can considerably alleviate the burden of routine tasks, allowing for increased focus on patient care and quality enhancement (**Stanfill and Marc 2019**).

Noteworthy, AI-assisted analysis of radiological images has been postulated as the most promising application of AI in medicine **(Yu et al 2018**). Interestingly, McKinney et al., implied that AI could surpass radiologists in detecting breast cancer in mammograms (**McKinney et al 2020**). Moreover, in a previous study, radiologists showed a greater willingness to integrate AI into their clinical practice than other medical specialties (**Pedro et al 2023**).

In the current work, the highest percentage of participants highlighted limited awareness of AI technologies as the principal obstacle to AI adoption in healthcare. In addition, a great majority of physicians were concerned about possible accountability and medicolegal liability risks. This finding is consistent with similar studies that reported that ethical and medicolegal issues concerning liability are one of the greatest challenges associated with AI adoption in healthcare **(O'Sullivan et al 2019, Loftus et al 2020a, and Pecqueux et al 2022**).

It has been argued that the uncertainty and fear of legal consequences for relying on AI

recommendations may restrain medical professionals from successfully integrating AI into their medical practice (**Bottomley and Thaldar 2023, and Jaremko et al 2019**).

agreed with this notion in the current study. This indicates a recognition of the critical role that physicians play in the responsible and effective implementation of AI technologies in healthcare (**Panch et al 2018**) .

The present study revealed that middle-aged consultants affiliated with university hospitals have significantly better awareness scores regarding ethical and medicolegal issues associated with AI adoption in medicine. A possible explanation could be the higher tendency of middle-aged physicians to adopt digital and new technological advancements. Hence, they tend to have better awareness of new digital technologies.

Concerning the World Health Organization (WHO) consensus on ethical principles for using AI in healthcare, almost a quarter of participants identified all six elements of the WHO ethical principles. In 2021, the WHO published comprehensive regulations on the ethics governing AI applications for health. These ethics encompass the protection of autonomy, promoting human well-being, and human safety, ensuring transparency, "explainability", promotion of responsibility and accountability, ensuring inclusiveness and equity, and promoting responsive AI. These principles should guide the applications of AI in healthcare in an ethical framework (**WHO 2021**).

Regarding legislation guiding AI use in healthcare, most participants exhibited unfamiliarity with any existing legal regulations guiding AI applications in healthcare.

Concerning the responsibility for medical errors resulting from using AI software in the clinical context, a considerable portion of participants identified physicians and healthcare institutions utilizing AI as the primary responsible parties. More than a quarter of the participants expressed that the issue of accountability is debatable. In contrast, only 25.4% of respondents pointed to the creators of AI algorithms being responsible for these errors. Of note, no participants mentioned patients who consented to AI use as being responsible for such errors. Similarly, a previous survey in Germany (**Maassen et al 2021**)

However, current regulations postulate that physicians are protected from medicolegal liability as long as they utilize AI in accordance with the standard of care (**Amann et al 2020, and Price et al 2019**).

Concerning the ethical and medicolegal implications of using AI in healthcare, most participants showed good awareness scores. Most physicians agreed that significant ethical issues and potential risks of breaching patient confidentiality are associated with using AI in healthcare. It is well-known that AI developers need access to enormous training datasets for creating accurate AI algorithms. Hence, there is a great concern that the usage of data could conflict with the patient's rights to confidentiality. Consequently, the implementation of AI-specific security measures is crucial for securing data sharing and guarding against the breach of patients' sensitive data (**Grant et al 2020**).

In addition, more than half of the respondents agreed that the physician should be transparent regarding AI use and ensure that AI-driven medical decisions align with the patient's best interests.

Moreover, the vast majority of participants agreed that medical AI systems' unexplainable nature would limit patients' autonomy. It is universally established that patient autonomy and informed consent are foundational ethical principles within the healthcare field that uphold patients' rights to make informed decisions regarding their medical care based on adequate information (**Sakellari 2003)**.

It is worth mentioning that the complexity of AI algorithms could render their operations opaque to humans, which is called a "black box" problem (**He et al 2019**). In this context, Sakamoto et al., 2020 postulated that the black box problem of AI algorithms could adversely influence the doctor-patient relationship as physicians may be unable to explain recommendations made by AI algorithms to their patients, with further mitigation of patients' autonomy (**Sakamoto et al 2020**). In response to this issue, some creators have attempted to develop interpretable forms of AI to ensure transparency and fulfill the requirements of informed consent. Subsequently, this could prompt the establishment of better evidence for resolving medicolegal liability (**Ali et al 2023**).

The importance of physicians' role in the application and evaluation of AI in the medical

field is emphasized by the majority of respondents who reported physicians' controversial responses to legal liability issues, denoting worldwide uncertainty among physicians concerning medicolegal liability issues.

Regarding international regulations on the liability of AI in healthcare, the European Commission has proposed the Artificial Intelligence Act, which is considered one of the first laws specifically addressing AI. This liability regime separates high-risk AI systems from low-risk AI systems using established legal regulations and a risk-based methodology, where strict liability applies to the high-risk AI systems (**Cancela-Outeda 2024**).

CONCLUSIONS

The survey results provide valuable insights into Egyptian physicians' perceptions and attitudes regarding AI integration in healthcare. The present study revealed that AI use among Egyptian physicians is still in its earliest stages. Improved diagnostic accuracy, imaging analysis, and administrative work were selected by physicians as the most promising AI applications in healthcare. In addition, limited awareness of AI technology was the principal obstacle mentioned by the respondents. Noteworthy, fear of medicolegal liability risks was a major concern among the participants.

RECOMMENDATIONS

It is recommended to increase awareness of AI technology's potential among Egyptian physicians. In addition, addressing physicians' accountability and medicolegal concerns related to AI integration could contribute to the widespread acceptance and effective integration of AI technologies in the medical domain. Further surveys on a larger scale could better emphasize the differences in attitudes of Egyptian physicians in diverse medical specialties.

CONFLICT OF INTEREST

The authors declare no conflict of interest in this research.

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الملخص العربي

وجهات نظر أخلاقية وقانونية طبية بشأن اعتماد الذكاء الاصطناعي في الرعاية الصحية: استطلاع رأي مقطعي عبر الإنترنت بين الأطباء المصريين

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يحمل الذكاء الاصطناعي وعودًا بتعزيز كفاءة الرعاية الصحية. ومع نمو تطبيقات الذكاء الاصطناعي، تنشأ المخاوف الأخلاقية والطبية القانونية. **الهدف من هذه الدراسة:** هدفت هذه الدراسة إلى تقييم وجهات نظر الأطباء المصريين تجاه دمج الذكاء الاصطناعي في الرعاية الصحية، مع التركيز بشكل خاص على آثاره الأخلاقية والطبية القانونية. . **طريقة الدراسة:** اجريت دراسة مقطعية باستخدام استبيان إلكتروني على عينة ملائمة من الأطباء المصريين. وتضمن الاستبيان ثلاثة أقسام: البيانات الشخصية والمهنية للمشاركين، ووجهات نظر ومواقف الأطباء تجاه تبني الذكاء الاصطناعي في الرعاية الصحية، والآثار الأخلاقية والطبية القانونية. **النتائج**: تم تلقي ردود من 177 طبيبًا. بدأ 37.3٪ فقط من المشاركين بدأوا في استخدام أدوات الذكاء الاصطناعي في ممارستهم الطبية. حدد 53.7٪ من المشاركين التحسن في دقة التشخيص باعتبارها تطبيق الذكاء الاصطناعي الأكثر فائدة. كان الوعي المحدود بالذكاء الاصطناعي هو العقبة الرئيسية أمام تبني الذكاء الاصطناعي والتي أبرزها 65.5٪ من المشاركين. كان 47.5٪ من الأطباء قلقين بشأن مخاطر المساءلة والمسؤولية الطبية القانونية. اتفق أكثر من نصف المشاركين على أن القضايا الأخلاقية المهمة ومخاطر انتهاك سرية المريض مرتبطة باستخدام الذكاء الاصطناعي. واتفقت الأغلبية على أن الطبيب يجب أن يضمن أن القرارات الطبية التي يقودها الذكاء الاصطناعي تتوافق مع مصالح المريض وأن الطبيعة غير القابلة للتفسير لأنظمة الذكاء الاصطناعي الطبية من شأنها أن تحد من استقلالية المرضى. واتفق 57.6٪ من المشاركين على أن الأطباء يجب أن يكونوا شفافين بشأن استخدام الذكاء الاصطناعي في الرعاية الصحية. ووافق 61.6٪ بشدة على أن حكم الطبيب وخبرته يجب أن يوجه تطبيق الذكاء الاصطناعي في الرعاية الصحية. وأظهر 78.0٪ من المشاركين درجات جيدة في الوعي بالقضايا الأخلاقية والطبية القانونية. وأظهر 85.9٪ من المشاركين عدم إلمامهم بأي لوائح قانونية توجه تطبيقات الذكاء الاصطناعي في الرعاية الصحية. وحدد 47.5٪ من المشاركين الأطباء ومؤسسات الرعاية الصحية التي تستخدم الذكاء الاصطناعي كمسؤولين عن الأخطاء الطبية الناتجة عن استخدام الذكاء الاصطناعي. أثر عمر الأطباء والتخصص الطبي ومستوى الوظيفة والمؤسسة الصحية التابعة لهم بشكل كبير على درجات الوعي فيما يتعلق بالقضايا الأخلاقية والطبية القانونية،**الخلاصة**: كشفت الدراسة أن الأطباء المصريين يدركون عمومًا أهمية الذكاء الاصطناعي في الطب. إن دمج الاعتبارات الأخلاقية والطبية القانونية في تطوير أنظمة الذكاء الاصطناعي يمكن أن يسهل التبني الناجح للذكاء الاصطناعي في الرعاية الصحية

الكلمات المفتاحية: الذكاء الاصطناعي؛ مصر؛ أخلاقي؛ طبية شرعية؛ الطب