

***Students' Perception Towards Applying Artificial Intelligence in Medical Field. A Cross-Sectional Study Among Medical Students, Cairo University***

***Eman Taher<sup>1</sup>, Mawada Hassanin Hegazy<sup>2</sup>, Marwan Mohammed Hegazy<sup>2</sup>, Maryam Mohamed Abomousa<sup>2</sup>, Nada Ahmed Osman<sup>2</sup>, Mahmoud Elsayed Mohamed<sup>2</sup>, Eman Elfar<sup>1</sup>***

<sup>1</sup> Public Health and Community Medicine Department, Faculty of Medicine, Cairo University

<sup>2</sup> Medical student, Cairo University

***Abstract***

Artificial Intelligence (AI) means making machines able to simulate intelligence by giving the computer human-like abilities. Despite the improvement of AI in medicine, its applications in medical practice are relatively limited, reflecting a resistance to change and possibly misperceptions with negative attitudes held by physicians and future doctors. There is a great need to assess the perceptions of medical students towards AI. The aim of this study was to explore the knowledge and perception of medical students in KasrAlainy, Cairo University, Egypt towards AI use in medical education and practice. The study is a cross-sectional study using a validated self-administered questionnaire. The questionnaire included sections: basic criteria of students, their knowledge regarding AI, their perception towards AI use in medical education, clinical practice, and possible influence on patients. A convenient sample of 309 undergraduate medical students distributed through all academic levels. Cluster analysis was used to identify shared patterns within students' responses. Nearly four fifths of the students (80.6 %) showed either moderate or high knowledge score category. Total perception score mean and SD were 68.5 %  $\pm$  12.10. Receiving any AI courses was associated with higher knowledge and perception scores (P value < 0.001 and 0.01 respectively). Students belonging to cluster 2 scored higher knowledge and perception scores were living in urban areas, had highly educated fathers, and received AI courses. In conclusion, students of higher socioeconomic and educational levels who receive any AI courses were associated with higher knowledge and positive perception among undergraduate medical students.

**Key words:**

Artificial intelligence, medical students, knowledge, perception.

***Introduction***

Artificial Intelligence (AI) means making machines able to simulate intelligence by giving the computer human-like abilities, such as understanding, reasoning, and problem-solving. This computer interprets external data, learns from it, and uses this learning to reach specific goals and tasks. After all, it helps humanity and simplifies some operations rather than replacing human positions. AI is

spreading worldwide in many sectors including economics, transportation, manufacturing, education, and even healthcare (*Buabbas et al., 2023*).

Considering the spreading of AI integration with health care, it is found to be used in a variety of medical aspects. Starting from radiology, which provides a direct pathway for AI by providing digitally coded images that can be transformed into computer language. Moreover ophthalmology, particularly in diabetic retinopathy, age-related macular degeneration, and retinopathy of prematurity. Cardiology can also benefit from AI to diagnose patients at risk of rapid coronary plaque progression or predict the chance of a heart attack. Even in drug design, such as de novo design of chemical compounds and peptide or synthesis planning (*Chen et al., 2022*).

This deep integration of AI and medicine must have its impact, as it can spare time for busy doctors, help in remote diagnosis of patients, and allow the spread of medical services into rural regions. It can also reduce some of the drawbacks of traditional methods of diagnosis and treatment. But besides these advantages there are many concerns such as the ethical implications regarding privacy and data security. as well as the possibility for bias in the algorithms used and the risk that AI may replace physicians, leading to the loss of humanity and empathy in medical practice (*Chen et al., 2022*).

Despite the improvement of AI in medicine, the use of its applications in medical practice is relatively limited, reflecting a resistance to change and possibly misperceptions with negative attitudes held by physicians and future doctors (*Swed et al., 2022*). This limited AI exposure during study and practice has been found to induce anxiety in undergraduate medical students, influencing their future career decision-making (*Teng et al., 2022*).

As mentioned by the futurist doctor Eric Topol “Nearly every clinician in the future; from specialist physicians to paramedics, will be using artificial intelligence technology and especially deep learning.” (*Topol, 2019*). All this makes introducing AI to medical students in their early life important but to make it right an assessment of medical students’ knowledge and attitude toward AI must be conducted to identify the challenges and limitations in the future of AI-based medical education and practice (*Topol, 2019*).

Studies on the knowledge and attitude of medical students are still limited in Africa, especially in Egypt where limited AI applications in the curriculum and practice which can lead to a broad knowledge gap of misconceptions. So, there is a great need to assess the perceptions of medical students towards AI. The aim of this study was to explore the perception of medical students in KasrAlainy, Cairo University, Egypt towards AI use in medical education and practice.

## **Students and Methods**

### **Methods**

#### **Study design and setting**

This cross-sectional study was conducted in KasrAlainy School of Medicine, Cairo University throughout the period from December 2023 till June 2024.

#### **Study participants**

Undergraduate students at Cairo University, Kasr Al Ainy School of Medicine who agreed to participate in the study. All academic levels were eligible to participate in the study.

**Sample size and type**

By using EPI-INFO Software for sample size calculation (Version 7.2.5.0) available at [www.openepi.com](http://www.openepi.com), setting the total population of 10,000 undergraduate medical students, confidence level at 95%, margin of error  $\pm 0.05$  and after reviewing previous study results (*Buabbas et al., 2023*) showing that the percentage of medical students believed in the importance of artificial intelligence was (73.7%); Based on that a sample size of at least 289 undergraduate medical students were required.

A convenient sample of 309 students were enrolled

**Data collection tool**

The questionnaire is derived from a valid questionnaire used by *Buabbas et al., (2023) and Khater et al., 2023*. The face and content validity of the questionnaire was assured by three public health experts who revised the questions for their relevance, completeness, and comprehensibility. A pilot study on 30 students who were not included in the analysis preceded actual data collection to check the clarity of questions and reliability of the questionnaire.

**The Questionnaire included the following sections:**

- Sociodemographic data as age, sex, education, and occupation of both parents, and residency.
- Education system, education level, and academic performance in last year.
- General knowledge about AI includes 8 questions about basic information regarding AI. Responses include correct, incorrect or I do not know. The total percent score by correct answers was calculated after reversing the code for 3 questions. The main source of knowledge has been investigated.
- Perceptions towards AI and its application in medical education. This section consisted of 8 questions measured on 5 Likert scales (strongly agree, agree, neutral, disagree, and strongly disagree) and coded from 0-4. Total percent score was calculated for this section. Cronbach's alpha for this section was 0.786.
- Perception towards AI application in clinical practice: it included 8 questions measured on a 5 Likert scale (strongly agree, agree, neutral, disagree, and strongly disagree) and coded from 0-4. The total percent score was calculated for this section. Cronbach's alpha for this section was 0.810
- Perception towards AI effects on patients: it included 7 questions measured on a 5 Likert scale (strongly agree, agree, neutral, disagree, and strongly disagree) and coded from 0-4. The total percent score was calculated for this section. Cronbach's alpha for this section was 0.609
- Total perceptive score was calculated from the 3 domains of perception including 23 questions. Cronbach's alpha for this section was 0.876

**Data collection**

A web-based self-administrated anonymous questionnaire was conducted using Google Forms. No duplication was ensured to allow one response from each participant. The questionnaire link was distributed through emails and social media platforms, targeting students from 1<sup>st</sup> to 5<sup>th</sup> year to provide a representative sample of both preclinical and clinical phases. Study participation was voluntary, and students were assured of the confidentiality and anonymity of their responses. Throughout the study period, reminders were sent to complete the questionnaire.

**Ethical consideration**

All procedures for data collection were treated with confidentiality according to the Declaration of Helsinki. Participants were informed that this was an anonymous survey and participation was

voluntary. The research ethics committee of KasrAlainy, Cairo University approved this study (**N-501-2023**). An amendment was requested and approved (N-55-2024)

### **Statistical analysis**

All the data was revised for completeness and logical consistency. Pre-coded data was entered on the computer using Microsoft Office Excel software program for Windows, 2010. Data was then transferred to the statistical package of social science software program (SPSS), version 25 to be statistically analyzed. After data cleaning, quantitative data was checked for normality using Kolmogorov–Smirnov test (non-significant test indicates normality setting P value at 0.05). Quantitative data was presented using mean and standard deviation while qualitative data was presented by frequency and percent. The knowledge percent score was classified as high (100% to less than 80%), moderate (80% to 60 %) and low (less than 60%) according to Bloom's cutoff categories (**Chand et al., 2022**).

Bivariate analysis was performed to detect the association between different variables and percent scores of both the knowledge and total perception using Mann Whitney U test, Kruskal Wallis test and Chi square test as appropriate. Correlation was performed using Spearman test.

### **Cluster analysis**

K-means cluster analyses were performed to find the patterns of students' knowledge and perceptions and to see which participants have which kind of perspectives. The optimal number of clusters was determined using the silhouette score which determines the optimal number of clusters for each analysis. The higher the score, the better fit the cluster analysis. We performed 3 rounds of K-means cluster analysis involving the knowledge score. A higher silhouette score (0.592) indicated two clusters as the optimal choice in all three of our cluster analyses. The iteration history indicated convergence after 2 iterations. The final cluster canters demonstrated 2 distinct groups. Cluster 1 was characterized by a knowledge score equal 44.38 %, while cluster 2 showed a higher knowledge score which equal 76.1 %. ANOVA results indicated a significant difference between clusters ( $F(307) = 381.2$ ,  $p < 0.001$ ).

## **Results**

Three hundred and nine (309) medical students at Cairo University participated in the study. Their age ranged from 17 to 28 years with mean and standard deviation of ( $20.6 \pm 1.58$ ). Most of them were Egyptians (94.5%), living in urban areas (86.7 %). Nearly equal percentages of both genders participated in the study. The majority of their parents were highly educated (93.5%, 89.6% of fathers and mothers respectively). Nearly two-thirds of their fathers (63.1 %) and one-third of their mothers (34.3%) were professionals. Most students (94.2%)were mainstream students. Students were nearly equally distributed to preclinical academic years (1<sup>st</sup> to 3<sup>rd</sup>) and clinical academic years (4<sup>th</sup> and 5<sup>th</sup>) (50.5 % and 49.5 % respectively). Nearly two-thirds of them (68.9%) reported excellent grades in the previous academic year. Nearly half (49.8%) of the students received any courses about artificial intelligence. (Table 1)

The total knowledge score percentage ranged from zero to 100 with mean and SD of 69.9  $\pm$ 16.89 percent. It was further categorized into low, moderate, and high. Nearly four-fifths of the studied

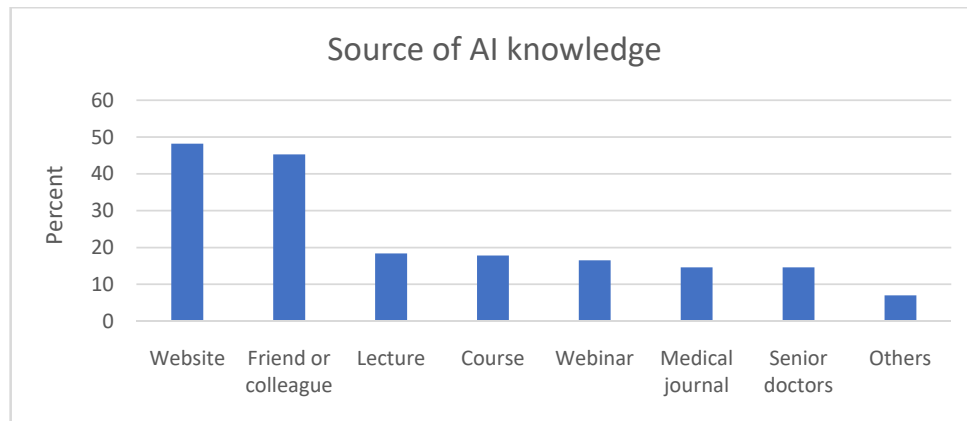
sample of students showed either moderate or high knowledge score category. The total perception score ranged from zero to 100 percent with a mean and SD of (68.5 %±12.10) (Table 1).

Also, there is a statistically significant positive correlation between the total knowledge and total perception scores. (Spearman's rho correlation coefficient 0.196, p value 0.001).

**Table 1:**  
Basic criteria of the study population (total = 309)

Variable		No.	%
Age (in years)	Mean ± SD	20.6 ± 1.58	
Gender	Male	162	52.4
	Female	147	47.6
Nationality	Egyptian	292	94.5
	Non-Egyptian	17	5.5
Residency	Urban	268	86.7
	Rural	41	13.3
Father education	Illiterate/read and write	7	2.3
	Preparatory/Secondary	13	4.2
	Higher education	289	93.5
Mother education	Illiterate/read and write	17	5.5
	Preparatory/Secondary	15	4.9
	Higher education	277	89.6
Father occupation	Professional work	195	63.1
	Employee	68	22.0
	Retired	42	13.6
	Not working	4	1.3
Mother occupation	Professional work	106	34.3
	Employee	59	19.1
	Retired	23	7.4
	Not working	121	39.2
Educational system	Mainstream	291	94.2
	IPKA	18	5.8
Educational level	Preclinical (1 <sup>st</sup> , 2 <sup>nd</sup> , 3 <sup>rd</sup> )	156	50.5
	Clinical (4 <sup>th</sup> , 5 <sup>th</sup> )	153	49.5
Academic achievement in last year	Accepted	8	2.6
	Good	27	8.7
	Very good	61	19.7
	Excellent	213	68.9
Received any courses about artificial intelligence	Yes	154	49.8
	No	155	50.2
AI Knowledge levels	Low	60	19.4
	Moderate	173	56.0
	High	76	24.6
Total knowledge score (percent)	Mean ± SD	69.9 ±16.89	
Total perception score (percent)	Mean ± SD	68.5 ±12.10	

IPKA: Integrated Program of Kasr Alainy



**Figure 1:**

Source of students' knowledge regarding AI

The main sources of students' knowledge regarding AI were extracurricular as websites followed by friends or colleagues (48.2 % and 45.3% respectively) (figure 1).

No statistically significant difference was found in total knowledge score or total perception score except for higher knowledge and perception score among students who received any courses about artificial intelligence (P value < 0.001 and 0.01 respectively) (Table 2).

Table 3 showed that statistically significant higher percentages of students in cluster 2 were living in urban areas, having highly educated fathers, achieving higher academic grades, and had been taught about AI than students in cluster 1 (p value 0.033, 0.035, <0.001, 0.047 respectively).

More than 90% of students were found to know that AI algorithms analyze data to perform specific tasks, and that AI uses computers and technology to simulate intelligent behavior. While nearly half of them correctly identified that Machine learning is one of the most common tools of artificial intelligence in the medical field, Python and Java are both languages that are widely used for AI, and the most serious drawback to AI in the medical field is violating data privacy and security (57.9, 52.4 and 50.5 percent respectively). Statistically significantly higher percentages of cluster 2 students responded correctly to all knowledge items (p value < 0.001). Additionally, cluster 2 students showed a statistically significant higher knowledge score than cluster 1 students (p value < 0.001) (Table 4).

**Table 2:**  
Bivariate analysis of the total knowledge and total perception scores (total = 309)

Variable		Knowledge score		P value	Total Perception score		P value
		Mean	SD		Mean	SD	
Gender	Male	69.52	17.78	0.896	69.01	11.43	0.708
	Female	70.41	15.90		67.94	12.81	
Nationality	Egyptian	69.86	16.94	0.779	68.47	12.13	0.635
	Non-Egyptian	71.32	16.40		69.00	11.92	
Residency	Urban	70.62	16.57	0.073	69.00	11.98	0.115
	Rural	65.55	18.49		65.22	12.51	
Father education	Illiterate/read and write	67.86	21.48	0.082	69.69	12.69	0.409
	Preparatory/Secondary	60.58	17.56		72.41	7.77	
	Higher education	70.42	16.68		68.30	12.25	
Mother education	Illiterate/read and write	66.91	16.50	0.071	71.71	8.87	0.068
	Preparatory/Secondary	61.67	14.54		73.66	11.96	
	higher education	70.58	16.95		68.02	12.22	
Father's occupation	Professional work	70.13	16.85	0.793	68.60	12.44	0.704
	Employee	68.20	19.84		67.54	11.44	
	Retired	72.02	11.97		69.93	11.93	
	Not working	68.75	7.22		64.92	9.79	
Mother's occupation	Professional work	71.11	16.22	0.511	68.27	13.56	0.617
	Employee	71.40	16.58		67.82	11.71	
	Retired	70.11	17.97		66.66	7.44	
	Not working	68.18	17.46		69.38	11.70	
Educational system	Mainstream	69.67	16.89	0.221	68.84	11.97	0.066
	IPKA	74.31	16.86		63.01	13.20	
Academic achievement in last year	Accepted	71.88	12.94	0.088	68.55	8.48	0.516
	Good	70.37	17.04		66.35	10.69	
	Very good	64.75	22.42		67.34	12.92	
	Excellent	71.30	14.88		69.10	12.16	
Received any courses about artificial intelligence	Yes	73.38	16.21	<0.001	70.10	11.52	0.010
	No	66.53	16.91		66.91	12.49	
Education grade	preclinical	69.95	17.89	0.995	68.10	12.90	0.719
	clinical	69.93	15.87		68.91	11.26	

IPKA: Integrated Program of Kasr Alainy

**Table 3:**  
Cluster analysis of students' basic criteria

		Cluster Number of Case				P value
		Cluster 1 (60)		Cluster 2 (249)		
		No	%	No	%	
Gender	Male	37	61.7	125	50.2	0.110
	Female	23	38.3	124	49.8	
Nationality	Egyptian	57	95.0	235	94.4	0.573
	Non-Egyptian	3	5.0	14	5.6	
Residency	Urban	47	78.3	221	88.8	0.033
	Rural	13	21.7	28	11.2	
Father education	Illiterate/read and write	2	3.3	5	2.0	0.035
	Preparatory/Secondary	6	10.0	7	2.8	
	Higher education	52	86.7	237	95.2	
Mother education	Illiterate/read and write	5	8.3	12	4.8	0.195
	Preparatory/Secondary	5	8.3	10	4.0	
	Higher education	50	83.3	227	91.2	
Father's occupation	Professional work	39	65.0	156	62.7	0.354
	Employee	16	26.7	52	20.9	
	Retired	5	8.3	37	14.9	
	Not working	0	0.0	4	1.6	
Mother's occupation	Professional work	19	31.7	87	34.9	0.780
	Employee	10	16.7	49	19.7	
	Retired	4	6.7	19	7.6	
	Not working	27	45.0	94	37.8	
Educational system	Mainstream	57	95.0	234	94.0	0.524
	IPKA	3	5.0	15	6.0	
Academic achievement in last year	Accepted	0	0.0	8	3.2	<0.001
	Good	4	6.7	23	9.2	
	Very good	25	41.7	36	14.5	
	Excellent	31	51.7	182	73.1	
Received any courses about artificial intelligence	Yes	23	38.3	131	52.6	0.047
	No	37	61.7	118	47.4	
Education grade	Preclinical	29	48.3	127	51.0	0.710
	Clinical	31	51.7	122	49.0	

IPKA: Integrated Program of KasrAlainy



**Table 4:**  
Cluster analysis of students' knowledge regarding AI

		Total sample (309)		Cluster Number of Case				P value
				Cluster 1 (60)		Cluster 2 (249)		
		No.	%	No.	%	No.	%	
1- Artificial Intelligence (AI) is a hardware program*	Correct answer	227	73.5	26	43.3	201	80.7	<0.001
	Incorrect answer	35	11.3	9	15.0	26	10.4	
	I do not know	47	15.2	25	41.7	22	8.8	
2- AI uses computers and technology to simulate intelligent behavior and critical thinking comparable to human being	Correct answer	278	90.0	44	73.3	234	94.0	<0.001
	Incorrect answer	24	7.8	11	18.3	13	5.2	
	I do not know	7	2.2	5	8.3	2	0.8	
3- AI algorithms analyze your data to perform specific tasks and solve problems in a matter of seconds	Correct answer	289	93.5	44	73.3	245	98.4	<0.001
	Incorrect answer	9	2.9	5	8.3	4	1.6	
	I do not know	11	3.6	11	18.3	0	0.0	
4- Python and Java are both languages that are widely used for AI Strongly agree	Correct answer	162	52.4	13	21.7	149	59.8	<0.001
	Incorrect answer	13	4.2	3	5.0	10	4.0	
	I do not know	134	43.4	44	73.3	90	36.1	
5- Machine learning is one of the most common tools of artificial intelligence in medical field	Correct answer	179	57.9	16	26.7	163	65.5	<0.001
	In correct answer	24	7.8	10	16.7	14	5.6	
	I do not know	106	34.3	34	56.7	72	28.9	
6- AI will replace medical professionals being capable of make precise decisions about medications and treatments*	Correct answer	212	68.6	30	50.0	182	73.1	0.002
	Incorrect answer	60	19.4	18	30.0	42	16.9	
	I do not know	37	12.0	12	20.0	25	10.0	
7- The most serious drawback to AI in medical field is violating data privacy and security	Correct answer	156	50.5	13	21.7	143	57.4	<0.001
	Incorrect answer	78	25.2	21	35.0	57	22.9	
	I do not know	75	24.3	26	43.3	49	19.7	
8- AI cannot be used in managing medical records*	Correct answer	226	73.1	27	45.0	199	79.9	<0.001
	Incorrect answer	59	19.1	22	36.7	37	14.9	
	I do not know	24	7.8	11	18.3	13	5.2	
Total knowledge score	Mean ± SD	69.9 ±16.89		44.4 ± 9.04		76.1 ±11.77		<0.001

\*Negative statements were reverse coded

Regarding the perception of students towards the application of AI in medical teaching. Almost three-fourths of medical students agreed or strongly agreed that medical students should receive AI teaching, Incorporating AI systems in medical education would ease the learning process, and that it is important for universities to integrate AI technologies into their medical education (73.8, 75.4 and 74.8 % respectively). The importance of teaching students about the ethical implications of AI by universities was agreed by 87.7 percent of students. Subtotal perception towards AI application in medical teaching score percentage was calculated with a mean of 69.4 $\pm$  15.91 percent. No statistically significant difference was found between 2 clusters of students either in individual statements or subtotal score (Table 5).

**Table 5:**  
Cluster analysis by students' perception towards AI application in medical teaching

		Total sample (309)		Cluster Number of Case				P value
				Cluster 1 (60)		Cluster 2 (249)		
		No.	%	No.	%	No.	%	
1- Medical students should receive AI teaching	Strongly disagree/ disagree	23	7.4	7	11.7	16	6.4	0.309
	Neutral	58	18.8	9	15.0	49	19.7	
	Strongly agree/ agree	228	73.8	44	73.3	184	73.9	
2- Incorporating AI systems in medical education would ease your learning process	Strongly disagree/ disagree	21	6.8	3	5.0	18	7.2	0.412
	Neutral	55	17.8	14	23.3	41	16.5	
	Strongly agree/ agree	233	75.4	43	71.7	190	76.3	
3- AI will prepare you for real clinical practice	Strongly disagree/ disagree	86	27.8	18	30.0	68	27.3	0.882
	Neutral	86	27.8	17	28.3	69	27.7	
	Strongly agree/ agree	137	44.3	25	41.7	112	45.0	
4- I am confident in my ability to use AI technologies for learning purposes	Strongly disagree/ disagree	35	11.3	6	10.0	29	11.6	0.176
	Neutral	93	30.1	24	40.0	69	27.7	
	Strongly agree/ agree	181	58.6	30	50.0	151	60.6	
5- It is important for universities to integrate AI technologies into their medical education	Strongly disagree/ disagree	17	5.5	3	5.0	14	5.6	0.521
	Neutral	61	19.7	15	25.0	46	18.5	
	Strongly agree/ agree	231	74.8	42	70.0	189	75.9	
6- It is important for universities to teach students about the ethical implications of AI	Strongly disagree/ disagree	10	3.2	2	3.3	8	3.2	0.072
	Neutral	28	9.1	10	16.7	18	7.2	
	Strongly agree/ agree	271	87.7	48	80.0	223	89.6	
7- AI can replace traditional teaching methods	Strongly disagree/ disagree	104	33.7	16	26.7	88	35.3	0.443
	Neutral	65	21.0	14	23.3	51	20.5	
	Strongly agree/ agree	140	45.3	30	50.0	110	44.2	
8- AI can be useful in grading your academic performance	Strongly disagree/ disagree	36	11.7	8	13.3	28	11.2	0.888
	Neutral	55	17.8	10	16.7	45	18.1	
	Strongly agree/ agree	218	70.6	42	70.0	176	70.7	
Subtotal perception score towards AI application in medical teaching		Mean ± SD		66.9 ±16.77		70.0 ±15.68		0.238

Regarding the perception of students towards AI use in clinical practice, nearly one-third (37.9%) of students disagreed that AI would replace some specialties in health care. Most of them agreed that AI can aid in medical research and that AI facilitates physicians' access to information (93.2% and 91.3% respectively). Seven out of ten students reported their willingness to use AI in their future medical practice (71.5%). Cluster 2 students showed a statistically significant higher positive perception than cluster one students in some statements; AI facilitates physicians' access to information, AI enables the physician to make more accurate decisions, and AI can aid in medical research (p value <0.001, 0.039 and 0.004 respectively). The subtotal perception score percentage towards AI application in clinical practice was calculated with a mean and standard deviation of 73.2  $\pm$ 14.87 percent. Cluster 2 students scored statistically significantly higher than cluster 1 students (p value 0.023) (Table 6).

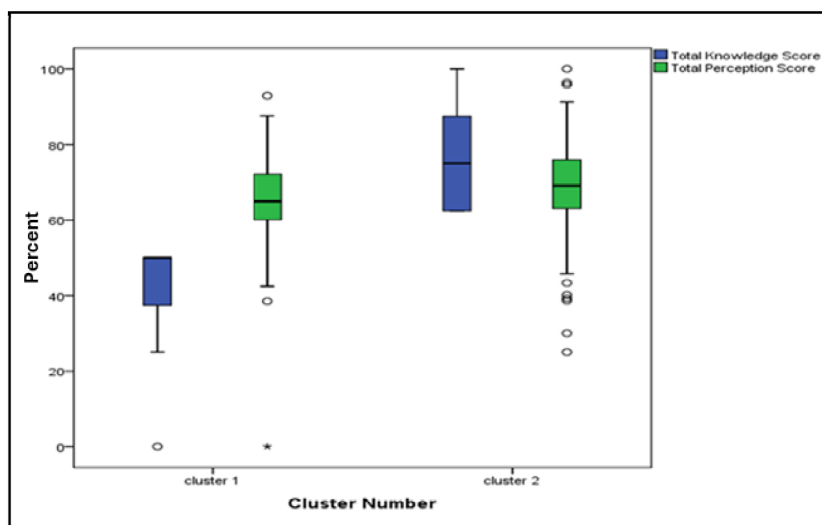
**Table 6:**  
cluster analysis by students' perception towards AI application in clinical practice

		Total sample (309)		Cluster Number of Case				P value
				Cluster 1 (60)		Cluster 2 (249)		
		No.	%	No.	%	No.	%	
1- AI will play an integral role in delivering health care services in the future	Strongly disagree/ disagree	29	9.4	9	15.0	20	8.0	0.242
	Neutral	51	16.5	10	16.7	41	16.5	
	Strongly agree/ agree	229	74.1	41	68.3	188	75.5	
2- AI will replace some specialties in health care	Strongly disagree/ disagree	117	37.9	21	35.0	96	38.6	0.405
	Neutral	63	20.4	16	26.7	47	18.9	
	Strongly agree/ agree	129	41.7	23	38.3	106	42.6	
3- It is important for medical professionals to understand how AI works	Strongly disagree/ disagree	12	3.9	5	8.3	7	2.8	0.051
	Neutral	28	9.1	8	13.3	20	8.0	
	Strongly agree/ agree	269	87.1	47	78.3	222	89.2	
4- AI facilitates physicians' access to information.	Strongly disagree/ disagree	8	2.6	7	11.7	1	0.4	<0.001
	Neutral	19	6.1	4	6.7	15	6.0	
	Strongly agree/ agree	282	91.3	49	81.7	233	93.6	
5- AI enables the physician to make more accurate decisions.	Strongly disagree/ disagree	29	9.4	10	16.7	19	7.6	0.039
	Neutral	73	23.6	17	28.3	56	22.5	
	Strongly agree/ agree	207	67.0	33	55.0	174	69.9	
6- AI reduces errors in medical practice.	Strongly disagree/ disagree	24	7.8	6	10.0	18	7.2	0.552
	Neutral	87	28.2	19	31.7	68	27.3	
	Strongly agree/ agree	198	64.1	35	58.3	163	65.5	
7- AI can aid in medical research	Strongly disagree/ disagree	4	1.3	3	5.0	1	0.4	0.004
	Neutral	17	5.5	6	10.0	11	4.4	
	Strongly agree/ agree	288	93.2	51	85.0	237	95.2	
8- I am willing to use AI in my future medical practice	Strongly disagree/ disagree	20	6.5	5	8.3	15	6.0	0.168
	Neutral	68	22.0	18	30.0	50	20.1	
	Strongly agree/ agree	221	71.5	37	61.7	184	73.9	
Subtotal perception score towards AI application in clinical practice	Mean ± SD	73.2 ±14.87		68.1 ±18.59		74.4 ±13.59		0.023

Table 7 shows students' perception towards the possible influence of AI on patients. Nearly half of students agreed that AI negatively affects the relationship of the physician with the patient and that Violations of patients' confidentiality may occur more (50.5 and 54.4 % respectively). While three-quarters of them (75.1%) perceived positively that AI facilitates patients' access to the service, with a higher percentage of cluster 2 students (79.9 %) than cluster 1 students (55 %) (p value <0.001). Subtotal perception towards the influence of AI on patient's percent score was calculated with mean and standard deviation of  $62.9 \pm 12.71$ . Cluster 2 students scored higher than cluster 1 students with statistically significant difference (p value 0.027). Also, the cluster 2 students perception score was statistically significantly higher than cluster 1 students' perception (p value 0.015).

**Table 7:**  
cluster analysis by students' perception regarding the possible influences of AI on patients

		Total sample (309)		Cluster Number of Case				P value
				Cluster 1 (60)		Cluster 2 (249)		
		No.	%	No.	%	No.	%	
1- AI can improve patient outcomes in Egypt	Strongly disagree/ disagree	39	12.6	8	13.3	31	12.4	0.982
	Neutral	68	22.0	13	21.7	55	22.1	
	Strongly agree/ agree	202	65.4	39	65.0	163	65.5	
2- AI facilitates patients' access to the service.	Strongly disagree/ disagree	16	5.2	6	10.0	10	4.0	<0.001
	Neutral	61	19.7	21	35.0	40	16.1	
	Strongly agree/ agree	232	75.1	33	55.0	199	79.9	
3- AI increases patients' confidence in medicine	Strongly disagree/ disagree	102	33.0	22	36.7	80	32.1	0.795
	Neutral	102	33.0	19	31.7	83	33.3	
	Strongly agree/ agree	105	34.0	19	31.7	86	34.5	
4- AI facilitates patient education	Strongly disagree/ disagree	41	13.3	9	15.0	32	12.9	0.082
	Neutral	72	23.3	20	33.3	52	20.9	
	Strongly agree/ agree	196	63.4	31	51.7	165	66.3	
5- AI negatively affects the relationship of the physician with the patient	Strongly disagree/ disagree	67	21.7	14	23.3	53	21.3	0.848
	Neutral	86	27.8	15	25.0	71	28.5	
	Strongly agree/ agree	156	50.5	31	51.7	125	50.2	
6- Violations of patients' confidentiality may occur more	Strongly disagree/ disagree	58	18.8	13	21.7	45	18.1	0.260
	Neutral	83	26.9	20	33.3	63	25.3	
	Strongly agree/ agree	168	54.4	27	45.0	141	56.6	
7- AI allows the patients to increase their control over their own health	Strongly disagree/ disagree	62	20.1	13	21.7	49	19.7	0.336
	Neutral	103	33.3	24	40.0	79	31.7	
	Strongly agree/ agree	144	46.6	23	38.3	121	48.6	
Subtotal perception score towards the possible influences of AI on patients	Mean ± SD	62.9 ± 12.71		59.3 ± 15.78		63.8 ±11.73		0.027
Total perception score	Mean ± SD	68.5 ± 12.10		64.8 ±14.02		69.4 ±11.44		0.015



**Figure 2:**

Total knowledge and total perception scores by cluster. (p value <0.001 and 0.015)

Figure 2 displays that belonging to cluster 2 was associated with statistically significant higher knowledge and total perception scores (P value <0.001 and 0.015).

## Discussion

The application of AI in medicine leads to rapid and continuous progress. Since it is an effectual program in different medical fields, its integration in medical education becomes pivotal (**Lee and Yoon, 2021**). This study aimed to assess the knowledge and perception of medical students towards AI. The mean age of participating students was  $20.6 \pm 1.5$  ranging from 17 to 28 years, of which 52.4% were male students while 47.6% were female students. Students in the pre-clinical phase represented 50.5% of the total participating students while in clinical phase they represented 49.5% and this equality is attributed to dissemination of questionnaire to different groups throughout different academic years with continuous ongoing encouragement to complete the survey in each group. Similarly, the study conducted by **Khater et al., (2023)** reported mean age of students was  $19.7 \pm 1.5$ , and 43.9% were male students. Students in the first and second years represented 75.3% of the total participating students and the percentage declined, reaching 2% for students in the final year. Moreover, **Al Saad et al., (2022)** reported that the mean age was  $21.3 \pm 2.4$ , male students represented (52.2%) in their survey about the knowledge regarding AI and participants from the final undergraduate year represented 31.8%.

The current finding revealed that the knowledge level is high in 24.6% and moderate in 56% of the students, while the minority of them exhibited low level. This result is consistent with **Asmatahasin et al., (2021)** and **Jethlia et al., (2022)** who respectively reported that 89.3% and 72.5% of their students have proper knowledge, on the other hand other studies documented a lower level (**Brandes et al., 2020; Allam et al., 2024**). This discrepancy may be related to variation among different countries as well as the tool used in each study.

Although no significant association was detected between knowledge scores and different socioeconomic factors, higher scores were detected among students with higher social class as observed from the education and occupation of both parents, their urban residency as well as being student in IPKA program which is a paid credit program. Higher socioeconomic standards open the gate to be more familiar with new technology and reinforces the perceived value of AI (**Linrui and Keng , 2020**). Other studies reported the same findings (**Chen 2022; Swed 2022**). No association between knowledge score and educational grade may be attributable to the lack of integration of AI courses within the medical curriculum as mentioned by **Civaner et al., (2022)**. Cluster analysis revealed that two groups were identified, the larger one (249 students) appears to be from a higher social class as determined by their urban residency, educational level, and professional occupation of both parents which reached a significant level as regards residence and father education. Moreover, the larger group exhibited significantly higher scores regarding their academic achievement and significantly reported previous recognition of AI. Those findings are consistent with **Han et al., (2020)** who studied the impact of socioeconomic status on the use and trust AI and revealed that people with higher education and higher income were more familiar with technology and had a higher perceived value of AI.

The main source of knowledge among the participants was either websites, friends, or colleagues while only a small percentage (17.8%) gained their knowledge from specific courses. **Buabbas et al 2023** also reported that 16% had acquired their AI knowledge through training courses (**Buabbas et al., 2023**). Our results acknowledged the students' awareness as regards AI algorithms and language used in AI incorporating machine learning, Python and Java (93.5% and 53.1% respectively). A 2021 survey of medical students in Ontario showed that their respondents (83.3%) believed that they comprehended what AI meant; however, when asked about specific terminologies related to AI, such as machine learning or neural networks, students did not understand them (65.9% and 42.3% respectively) (**Mehta et al., 2021**). A small percentage expressed their concern about the possibility of AI replacing medical doctors. A similar finding is announced by **Swed et al., 2022** who reported that 21.5% of their participants were worried about the same issue.

Cluster two were significantly more knowledgeable than cluster one with a mean score  $76.1 \pm 11.8$  versus  $44.4 \pm 9.04$  respectively. This result is in line with the study conducted by Allam et al., 2024 who performed cluster analysis in their study and announced that the larger cluster was also more knowledgeable.

Perception is inevitably affected by what a student knows about AI from different sources (**Jha et al., 2022**). This study sheds light on the significant association between perspective score and previous knowledge regarding AI (p value 0.01). Most of the students in this study (73.8%) had a favorable perception towards the application of AI in medical teaching and nearly the same percentage of students strongly agreed or agreed on integrating AI into medical education. Additionally, three-fourths of them thought that AI would facilitate their learning process, and half of them acknowledged the usefulness of AI in the teaching process such as replacing old teaching methods and grading their academic performance. In tandem with this finding, **Buabbas et al., 2023** issued that the vast majority (nearly 90%) of their students were willing to integrate AI in medical education, and they expected that it would ease their learning process. Similar results were reported from UK and Germany (**Gong 2019; Sit 2020**). Despite the superiority of cluster two over cluster one regarding their perception towards the usefulness of AI in the medical field, still both clusters showed favorable perceptions. The same results

were published by **Allam et al., 2024** who observed that both clusters shared the viewpoint that AI education is essential and holds significant benefits for the future careers of medical students.

Regarding perception towards the application of AI in clinical practice, an encouraging score was observed in this study ( $73.2 \pm 14.87$ ). In consistency with current findings is the study conducted by **Alghamdi and Alashban, (2024)**. Three-fourths of our participants reported an agreement with the prominent role of AI in delivering health care services. Similar to this are the results of **Kansal et al., (2022) in India and Sit et al., 2020** in the UK who reported that the vast majority of their students recognized such a significant role of AI.

The most important role of AI in clinical practice is to enhance the efficiency of health care workers through facilitating access to information, making accurate diagnosis and reducing error without replacing human force (**Shuaibet al., 2020**). Most of the participants support this role. The same findings were reported from another study among UK medical students **Sit et al., 2020** as well as the study conducted by **Civaneret al., 2022** as the majority of their medical students perceived AI as a beneficial tool that could facilitate clinician's access to information (85.8%) and patients to healthcare services (76.7%) and lessen errors (70.5%). Cluster two revealed a predominantly favorable perception towards AI application in clinical practice as they showed stronger agreement towards the integral role of AI in health care services and the importance of educating medical professionals about how to use it. These findings align with **Allam et al., 2024** who declared that the larger knowledgeable cluster demonstrated a more positive perception towards working with AI and recognized its merits in clinical practice.

Incorporation of AI into health systems will foster the quality of care, including online consultation, prescription revision, requesting investigation, and much more (**Choudhury and Asan, 2020**). In June 2024, under the umbrella of Egypt Health Care Authority, a panel discussion titled artificial intelligence in health care was held. The President of Egypt Health Care Authority said that: "The modern Egyptian healthcare system focuses on three main pillars: technological health reform, the development of technological systems in the healthcare sector within the comprehensive insurance system and restoring citizens' trust in government health services through building a technologically driven and governance-based healthcare system." (**Eha.gov.eg, 2024**). Artificial intelligence is a double-edged sword. On one hand it can improve patients' care and outcome, on the other hand, it can permit access to patients' data and violate their confidentiality (**Yadav et al., 2023**). The effect of the widespread integration of AI in medicine on the doctor-patient relationship is questionable (Niel and Bastard, 2019). It is claimed that AI may dehumanize the practice of medicine (**Sparrow and Hatherley, 2020**).

Unfortunately, perception variation existed among participants of this study towards the role of AI in improving patient outcome in Egypt. Furthermore, according to fifty percent of participants, the role of AI is disrupting patient-doctor relationship as well as possibly violating patients' confidentiality. This finding can be attributed to the fact that those students have not yet been involved in hands-on medical practice unlike experienced physicians; especially considering the fact that half of them are still passing through the preclinical phase. Lack of prior training in AI as only 17% had received formal training negatively impacted their perception towards this domain. Cluster two excels over cluster one in sharing their positive perception towards the effect of AI on patients. This result may be due to the fact that 50% of cluster two have received prior AI training courses, however, both clusters exhibited lower scores in this perception domain rather than other domains.

### Limitations

This study was carried out at a single medical school, the findings may not be applicable to other medical students. Further research involving multiple medical schools is suggested to gain a more comprehensive understanding of students' knowledge and perceptions of AI. Additionally, the use of self-reported data might not fully reflect students' actual understanding of AI concepts. Employing qualitative methods in future studies could offer deeper insight into students' knowledge and perception regarding AI.

### Conclusion

In conclusion, the findings underscore the importance of medical schools adapting to technological advancements to prepare future physicians for the evolving landscape of healthcare. As AI becomes more integral to healthcare, medical curricula must be updated to provide students with a solid foundation in AI, covering its applications, potential, limitations, and ethical considerations. This preparation will enable future doctors to effectively utilize AI to enhance patient care, improve outcomes, and optimize health care efficiency. capabilities, not replace them, in both medical education and practice.

### Recommendation

Medical schools should work closely with AI experts and professionals from fields such as computer science and data analytics to create interdisciplinary courses that cover the fundamentals of AI, its applications in health care, and related ethical issues. They can also enhance learning by offering additional programs like workshops, seminars, and extracurricular activities to equip students with practical skills and experience in applying AI effectively.



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## تصور الطلاب تجاه تطبيق الذكاء الاصطناعي في المجال الطبي: دراسة مقطعية بين طلاب الطب في جامعة القاهرة

د. ايمان طاهر<sup>١</sup>، مودة حسنين<sup>٢</sup>، مروان حجازي<sup>٢</sup>، مريم ابوموسي<sup>٢</sup>  
ندي عثمان<sup>٢</sup>، محمود السيد<sup>٢</sup>، د. ايمان الفار<sup>١</sup>

<sup>١</sup> قسم الصحة العامة وطب المجتمع كلية الطب جامعة القاهرة  
<sup>٢</sup> طالب بكلية طب قصر العيني

### الملخص العربي

الذكاء الاصطناعي يعني جعل الآلات قادرة على محاكاة الذكاء من خلال منح الكمبيوتر قدرات شبيهة بالبشر. يؤثر دمج الذكاء الاصطناعي في الطب بعض المخاوف مثل التداعيات الأخلاقية المتعلقة بالخصوصية وأمن البيانات. وعلى الرغم من تطور الذكاء الاصطناعي في الطب، إلا أن تطبيقاته في الممارسة الطبية تظل محدودة نسبياً، مما يعكس مقاومة للتغيير وربما مفاهيم خاطئة ومواقف سلبية من قبل الأطباء وأطباء المستقبلين. هناك حاجة ملحة لتقييم تصورات طلاب الطب تجاه الذكاء الاصطناعي.

تهدف هذه الدراسة إلى استكشاف معرفة وتصور طلاب الطب في كلية الطب قصر العيني، جامعة القاهرة، مصر تجاه استخدام الذكاء الاصطناعي في التعليم الطبي والممارسة الطبية. كانت الدراسة مقطعية وقد اعتمدت على استخدام استبيان مُعتمد و موزع ذاتياً. تضمن الاستبيان أقساماً تغطي: البيانات الأساسية للطلاب، معرفتهم بالذكاء الاصطناعي، تصوراتهم تجاه استخدامه في التعليم الطبي، الممارسة السريرية، والتأثير المحتمل على المرضى.

شملت الدراسة عينة ملائمة من ٣٠٩ طالب طب موزعين عبر جميع المستويات الأكاديمية في جامعة القاهرة. تم استخدام تحليل العنقود لتحديد الأنماط المشتركة في استجابات الطلاب. بلغ متوسط درجة المعرفة والانحراف المعياري  $69.9 \pm 16.89$  بالمائة. أظهر ما يقرب من أربعة أخماس الطلاب (٨٠.٦%) درجة معرفة متوسطة أو مرتفعة. بلغ متوسط مجموع درجات التصور والانحراف المعياري  $68.5 \pm 12.10$  بالمائة. كان حضور أي دورات في الذكاء الاصطناعي مرتبطاً ارتباطاً ذا مغزى إحصائي بدرجات أعلى في المعرفة والتصور.

حقق الطلاب الذين ينتمون إلى العنقود الثاني من التحليل العنقودي درجات أعلى في المعرفة والتصور، وكانوا يعيشون في مناطق حضرية، ولديهم آباء ذوو تعليم عالٍ، وتلقوا دورات في الذكاء الاصطناعي.

**الخلاصة:** كان الطلاب ذوو المستويات الاجتماعية والاقتصادية والتعليمية الأعلى والذين تلقوا دورات في الذكاء الاصطناعي مرتبطون بمستوى معرفة وتصور إيجابي أعلى بين طلاب الطب الجامعيين.

**الكلمات المفتاحية:** الذكاء الاصطناعي، طلاب الطب، المعرفة، التصور.