

Knowledge, perception and use of artificial intelligence among clinical workers at the University of Uyo Teaching Hospital, Southern Nigeria

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ABSTRACT

Background: The global trend of Artificial Intelligence (AI) is rising, with applications across various fields including healthcare. Although AI offers significant medical benefits, it faces data security, job displacement concerns, and ethical issues. Moreover, integrating AI in healthcare is hindered by the complexity of obtaining and organizing clinical data from various sources. This study aimed to assess the knowledge, perception, use of AI, and willingness to learn AI, as well as explore the factors influencing the use of AI among healthcare workers in a teaching hospital. **Methods:** A cross-sectional study design was used to assess 227 healthcare workers recruited via a stratified random sampling technique from the University of Uyo Teaching Hospital, Uyo, Akwa Ibom State. Data was collected using self-administered questionnaires and analyzed using a statistical package for social science (SPSS) software version 25. A p-value <0.05 was considered statistically significant. **Result:** The findings showed 93.8% of the respondents were aware of AI, while 87.2% had good knowledge of AI, 49.8% of respondents had a positive perception of the benefits of AI in healthcare, and most of the participants 81.9% were willing to learn about AI applications in their workplace. Only 7.9% of participants acknowledged using AI in their departments, and 67.4% said they did not use AI in their activities. **Conclusion:** The study proves that there is poor utilization of AI among health workers despite their willingness to learn and apply AI in their work. We recommend that the Federal Ministry of Health should collaborate with technological agencies to train health workers on the application of AI. The hospital management should also train and equip health workers on the various applications of AI including the use of machine learning to make diagnoses, virtual assistants for dissemination of medical information and robotics in carrying out surgical procedures.

Keywords: Artificial intelligence, health workers, knowledge, perception.

INTRODUCTION

The current global trend of artificial intelligence (AI) is gaining momentum, and its usage has progressively increased. AI is a scientific and technological discipline concerned with the use of intelligent machines and computer programs to accomplish a variety of tasks that would normally require human intelligence. The impact of AI is extensive and spans across diverse fields. AI, which combines elements of computer science, logic, biology, psychology, philosophy, and many other fields, has produced astounding results in areas like speech recognition, image processing, natural language processing, automatic proof of theorems, and intelligent robots.¹ The healthcare system and medical practice are not left out.

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AI systems have become increasingly popular in medicine due to the successful implementation of AI-based machine learning. It involves using algorithms to program and instruct machines to analyse specific data types, such as in the context of diagnosis and treatment recommendations.² The tools used in AI include Deep learning and neural networks, natural language processing, rule-based expert systems, and robotic process automation.³ These technologies are

widely applied in major disease areas such as cancer, neurology, and cardiology in healthcare. For instance, AI applications are used in stroke-related cases for early detection and diagnosis, treatment optimisation, predicting outcomes and evaluating prognosis.⁴

Additionally, AI aids in predictive analytics by forecasting the likelihood of certain medical conditions or events. It accelerates the drug discovery process by analysing vast amounts of biological and chemical data, identifying potential drug candidates, and predicting their efficacy and safety.⁵ AI-powered robotic systems assist surgeons in performing complex procedures with precision, stability, and minimally invasive surgeries. It facilitates remote patient monitoring and telemedicine initiatives by collecting and analysing patient data in real-time.⁶ It has also been applied for research purposes.⁷

Nevertheless, there are counterarguments to employing AI in medicine, as critics highlight its drawbacks. AI-based systems raise concerns regarding data security and privacy.⁸ Healthcare professionals fear that AI could replace human roles. In healthcare, a significant obstacle AI faces is the lack of established ethical guidelines governing its use.⁸ This absence of standardised protocols has exacerbated the predicament in the healthcare sector, leading to ongoing discussions about the appropriate and ethical extent to which AI can be employed in clinical settings.⁸ Another major barrier is the availability of reliable and well-organized clinical data. Clinical data is typically scattered across various systems, often trapped in proprietary formats, necessitating expensive software for extraction.⁹

Healthcare workers lack sufficient knowledge about AI and its applications in the medical field, leading to limited integration of AI in their healthcare practices. Additionally, the perception of these workers plays a significant role in the reduced adoption of AI in healthcare.¹⁰ Given the significant impact and diverse applications of AI in healthcare, it becomes crucial to ensure that healthcare professionals possess the necessary knowledge to embrace and harness the potential of AI in this field.⁷ A global survey of 487 pathologists from 54 countries examined perspectives on AI in clinical practice. Overall, respondent

attitudes towards AI in diagnostic pathology were positive, with many either expressing interest in (41.2%) or excitement (32.1%) about AI integration. Many respondents felt that with appropriate training, AI tools could increase (58.0%) or even dramatically increase (13.7%) diagnostic efficiency.¹¹

In the United Kingdom, a study found that many healthcare workers had not encountered AI applications in their work and were unaware of the distinctions between machine learning and deep learning.¹⁰ In Ghana, a study showed that healthcare professionals had positive attitudes toward AI and were likely to support its application in electronic health records, medical diagnosis and laparoscopic surgery. Despite their positive perception of AI, a subsequent interview revealed that they had limited knowledge regarding its applications in healthcare. While this lack of awareness was not surprising, their impressive familiarity with other AI applications, such as voice recognition with SIRI and haptic feedback in goal-line technology, was noteworthy.¹²

In Rivers State, Nigeria, a 2020 study showed that most respondents were aware of AI, as only about 3% had not heard of it. It also revealed that 91.8% of the respondents did not use AI in their facility, and 85.1% documented no AI practice in their environment. Almost all had not received any formal or informal training, regarding the application of AI. Despite this, most respondents expressed a willingness to embrace AI if training were available. Concerns included job loss, poor IT knowledge, lack of legislation, poor internet connectivity, and the potential for AI to promote self-medication.¹³

This study aims to assess the knowledge, perception, use, and willingness to learn AI, as well as explore the factors influencing the use of AI among healthcare workers in a teaching hospital in Nigeria.

METHODS

Study design and population

This cross-sectional study was conducted at the University of Uyo Teaching Hospital (UUTH) in Akwa Ibom State from September to October 2023.

UUTH, a 500-bed facility, is one of the evolving tertiary healthcare institutions located in Uyo, Akwa Ibom State, South-South, Nigeria.¹⁴ The hospital has 25 departments comprising 21 clinical, 4 non-clinical, and several support units. Its core competencies include research, clinical training, and quality healthcare service delivery. It provides daily services obtained in the general outpatient department and a 24-hour emergency service through the accident and emergency unit and the children's emergency unit for paediatric cases. The study population comprised medical doctors, nurses, pharmacists, physiotherapists, and medical laboratory scientists at UUTH. Those who were ill or on leave at the beginning of the study were excluded.

Sample size estimation and sampling technique

The sample size was determined using the Raosoft sample size calculator.¹⁵ With a margin error of 5%, a confidence interval of 95%, a sample population of 936 (from the staff nominal roll health information management University of Uyo Teaching Hospital) and the proportion of good knowledge from a previous study of 89.4%.¹⁷ This resulted in an estimated sample size of 127. Two hundred and twenty-seven (227) participants were recruited for this study using a two-stage sampling technique. Stratified sampling was used to determine the number of respondents to recruit in each of the professional cadres, and systematic random sampling was used to select 86 nurses, 75 doctors, 32 pharmacists, 22 medical laboratory scientists, and 12 physiotherapists as participants in the study.

Respondents who gave consent were enrolled using a stratified sampling technique. A semi-structured self-administered questionnaire was used to obtain data on respondents' sociodemographic characteristics,

knowledge of AI, perceived benefits and drawbacks of using AI, willingness to learn about AI, utilization of AI, and the factors that influence the use of AI.

A 23-item questionnaire, developed by the researchers and validated through expert review and a pilot test conducted on 30 clinical workers at St. Luke's Hospital, Anua in Uyo, Akwa Ibom State was used to assess the objectives.

Statistical analysis

Data were analysed using the IBM SPSS version 25.0 and Microsoft Excel. Frequency distribution tables were used to present quantitative variables. Chi-square and Fisher's exact tests were performed to assess for associations between independent sociodemographic variables and the utilisation of AI.

Ethical considerations

Ethical approval for the study was obtained from the Institutional Research Ethics Committee of the University of Uyo Teaching Hospital, and all ethical standards were adhered to. Written informed consent was obtained from each participant.

RESULTS

Sociodemographic Characteristics of Respondents

A total of 227 clinical health workers from UUTH participated in this survey. The majority were aged 30 years and below (129, 56.8%) and had 1-5 years of work experience (145, 63.9%). Most were single (152, 67.0%), and a higher proportion were of the Ibibio tribe (106, 46.7%) and nurses (85, 37.4%). Nearly all respondents identified as Christians (96.5%) and all had attained a tertiary level of education (Table 1).

Table 1: Showing Socio-Demographic Information

Variable	Frequency (n=227)	Percentage (%)
Age		
20-29	129	56.8
30-39	70	30.8
40-49	23	10.1
50-59	4	1.8
60 and above	1	0.4
Sex		
Male	151	66.5
Female	76	33.5
Level of education		
Tertiary	227	100
Occupation		
Medical Doctor	75	33.0
Medical laboratory scientist	22	9.7
Nurse	86	37.9
Pharmacist	32	14.1
Physiotherapist	12	5.3
Work experience in years		
1-5yrs	145	63.9
6-10yrs	51	22.5
11-20yrs	21	9.3
>20yrs	10	4.4
Total	227	100.0

Knowledge of Artificial Intelligence

As illustrated in Table 2, the survey revealed that most respondents (213, 93.8%) had heard of AI before, though less than half (42.3%) received formal training on it. Most respondents correctly identified AI as the simulation of human intelligence by machines (215,

94.7%) and believed AI could be used in the healthcare industry (89.0%) and improve healthcare practice (87.7%). Additionally, the majority acknowledged AI's applicability in other industries (218, 96.0%).

Table 2: Knowledge of Artificial intelligence

Variables	Yes	No	I don't know
Have you heard of AI before?	213 (93.8%)	11 (4.8%)	3 (1.3%)
Were you taught about AI while in training?	96 (42.3%)	131 (57.7%)	0
AI is the simulation of human intelligence processes by machines	215 (94.7%)	2 (0.9%)	10 (4.4%)
AI can be used in the healthcare industry	202 (89.0%)	12 (5.3%)	13 (5.7%)
AI can improve the practice of healthcare	199 (87.7%)	13 (5.7%)	15 (6.6%)
AI can be used in other industries	218 (96.0%)	3 (1.3%)	6 (2.6%)

Perceived Benefits and Drawbacks of AI

The survey responses indicate that 113 (49.8%) of participants strongly agreed or agreed (67, 29.5%) that AI can speed up processes in healthcare. Similarly, many believe AI can reduce medical errors, with 71 (31.3%) strongly agreeing and 75 (33.0%) agreeing. Most respondents disagreed (88, 38.8%) or strongly disagreed (43, 18.9%) that AI is subject to exhaustion

and emotional fatigue. Regarding the quality of data provided by AI, 76 (33.5%) strongly agreed and 90 (39.6%) agreed that it can offer clinically relevant, high-quality data. As for the flexibility of AI in being useful for every patient, 52 (22.9%) strongly agreed, 78 (34.4%) agreed, and 56 (24.7%) were neutral (Table 3).

Table 3: Perceived Benefits and Drawbacks of AI

Variables	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
AI can speed up processes in healthcare	113 (49.8%)	67 (29.5)	17 (7.5)	17 (7.5)	13 (5.7)
AI can reduce medical errors	71 (31.3%)	75 (33.0%)	37 (16.3%)	24 (10.6%)	20 (8.8%)
It is subject to exhaustion and emotional fatigue	15 (6.6%)	27 (11.9%)	54 (23.8%)	43 (18.9%)	88 (38.8%)
It can offer clinically relevant, high-quality data	76 (33.5%)	90 (39.6%)	26 (11.5%)	29 (12.8%)	6 (2.6%)
It is flexible enough to be useful for every patient	52 (22.9%)	78 (34.4%)	56 (24.7%)	28 (12.3%)	13 (5.7%)

Willingness to learn about AI

As detailed in **Table 4**, 81.9% of respondents strongly agreed or agreed that they wanted to know about AI applications in their work setting, while 88.1%

strongly agreed or agreed that they were interested in AI courses and training. The majority of the respondents also strongly agreed or agreed that they wanted to stay updated on AI applications (86.4%).

Table 4: Respondents' willingness to learn about AI

Variables	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I would like to know the applications of AI in my work setting	82 (36.1%)	104 (45.8%)	31 (13.7%)	0	10 (4.4%)
I would like to take some courses and training on the use of AI	90 (39.6%)	110 (48.5%)	16 (7.0%)	3(1.3%)	8 (3.5%)
I would like to be up to date on AI applications in my work	93 (41.0%)	103 (45.4%)	17 (7.5%)	8 (3.5%)	6 (2.6%)

Use of AI

The survey revealed that only a small portion of respondents (18, 7.9%) reported AI being used in their department, primarily for patient monitoring (3,

16.7%). Additionally, 74 (32.6%) respondents personally used AI, mainly for studying and research (40, 54.1%) (Table 5).

Table 5: Respondents' use of AI

Variables	Number	Percentage (%)
Is AI used in your department?		
Yes	18	7.9
No	193	85.0
I don't know	16	7.1
What is it used for? (n=18)		
For monitoring of patients	3	16.7
For analysing samples and staging disease	2	11.1
For research/knowledge generation	2	11.1
To prepare scientific presentations	2	11.1
For costing, dispensing and documentation of prescriptions	2	11.1
Invitro fertilization	1	5.6
Do you personally use AI?		
Yes	74	32.6
No	148	65.2
I don't know	5	2.2
What do you use it for? (n=74)		
Studying and research	40	54.1
Rendering health, services ^a	7	9.5
Others ^b	13	17.6

AI: Artificial intelligence

^a Patient monitoring, costing and documentation of prescription, critical nursing care

^b Gaming, graphic design, video editing, recreational use

As seen in Table 6, AI usage within departments was generally low; however, doctors had the lowest use of AI within their departments (4, 5.3%) after "others" (0%). There was no significant association between occupation and departmental AI usage ($p=0.715$). The

occupations with the highest proportion of personal AI usage were pharmacists (45.2%), and lab scientists/technicians (42.9%). There was also no significant association between occupation and personal AI usage ($p=0.235$).

Table 6: Association between AI use and Respondents' occupation

Variables	Yes	No/I don't know I don't know	Fisher's exact
Is AI used in your department?			
Occupation	n=18	n=209	
Medical doctor	4 (5.3%)	71 (94.7%)	2.691 p=0.715
Nurse	7 (8.2%)	78 (91.8%)	
Lab. Scientist/technician	2 (9.5%)	19 (90.5%)	
Pharmacist	4 (12.5%)	28 (87.5%)	
Physiotherapist	1 (8.3%)	11 (91.7%)	
Others	0 (0.0%)	2 (100.0%)	
Do you personally use AI?			
Occupation	n=74	n=151	
Medical doctor	26 (35.1%)	48 (64.9%)	6.563 p=0.235
Nurse	21 (24.7%)	64 (75.3%)	
Lab. Scientist/technician	9 (42.9%)	12 (57.1%)	
Pharmacist	14 (45.2%)	17 (54.8%)	
Physiotherapist	4 (33.3%)	8 (66.7%)	
Others	0 (0.0%)	2 (100.0%)	

Perceived barriers to AI use

Most respondents agreed or strongly agreed that there was a lack of information (77.1%), and a lack of training (85.0%) in AI. Most also agreed or strongly

agreed that it requires supervision and expertise (70.0%) and has high running costs (63.4%). Additionally, just below two-thirds of the respondents stated that regulatory and social constraints limit AI's use (61.2%) (Table 7).

Table 7: Perceived barriers to AI use among respondents

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Lack of information about AI	66 (29.1%)	109 (48.0%)	10 (4.4%)	26 (11.5%)	16 (7.0%)
Lack of training	85 (37.4%)	108 (47.6%)	12 (5.3%)	14 (6.2%)	8 (3.5%)
It needs supervision and expertise	62 (27.3%)	97 (42.7%)	46 (20.3%)	11 (4.8%)	11 (4.8%)
High running cost of AI	62 (27.3%)	82 (36.1%)	49 (21.6%)	18 (7.9%)	16 (7.0%)
Regulatory and social constraints limit its use	52 (22.9%)	87 (38.3%)	55 (24.2%)	14 (6.2%)	19 (8.4%)

Table 8 shows that the age and work experience of the health workers were associated with the utilization of AI among the health workers ($p=0.046$ and 0.033

respectively). Perception of regulatory constraints was also associated with AI use ($p=0.004$).

Table 8: Relationship between sociodemographic characteristics and personal utilization of AI among the respondents

Socio-demographic characteristics	Utilization n (%)		Statistical indices
	Yes (n=74)	No (n=153)	
Age (years)			
20-29	49 (38.0)	80 (62.0)	P value=0.046+*
30-39	15 (21.4)	55 (78.6)	
40-49	7 (30.4)	16 (69.7)	
50 and above	3 (60.0)	2 (40.0)	
Sex			Df=1
Male	44 (29.1)	107 (70.9)	$X^2=2.457$
Female	30 (39.5)	46 (60.3)	P value=0.134
Occupation			
Medical doctors	26 (34.7)	49 (65.3)	Df=4
Nurse	21 (24.1)	66 (75.9)	
Lb scientist/technician	9 (42.9)	12 (57.1)	
Pharmacist	14 (43.8)	18 (56.2)	
Physiotherapy	4 (33.3)	8 (66.7)	
Work experience			
1-5	54 (37.2)	91 (62.8)	P value=0.033+*
6-10	9 (17.7)	42 (82.3)	
11-20	9 (42.9)	12 (57.1)	
21 and above	2 (20.0)	8 (80.0)	
Lack information			Df=1
No	15 (28.9)	37 (71.1)	$X^2=0.432$
Yes	59 (33.7)	116 (66.3)	P value=0.511*
Lack of training			Df=1
No	13 (38.2)	21 (61.8)	$X^2=0.578$
Yes	61 (31.6)	132 (68.4)	P value=0.447*
Lack of supervision and expert			Df=1
No	24 (35.3)	44 (64.7)	$X^2=0.321$
Yes	50 (31.4)	109 (68.6)	P value=0.571*
High cost			Df=1
No	16 (47.1)	18 (52.9)	$X^2=3.805$
Yes	58 (30.0)	135 (70.0)	P value=0.051*
Regulatory constraints			Df=1
No	18 (54.6)	15 (45.4)	$X^2=8.464$
Yes	56 (28.9)	138 (71.1)	P value=0.004+

*Fischer's exact test; +significant p -value

DISCUSSION

This study was conducted to determine the knowledge, perception, and use of Artificial intelligence among core clinical health workers in UUTH, Akwa Ibom State. The findings revealed that 93.8% of the respondents had heard of AI. Most correctly identified AI as the simulation of human intelligence by machines and believed it could be utilized in the healthcare industry to improve healthcare practice. Additionally, the majority acknowledged AI's applicability in other industries. This is similar to a study in Ghana which showed that almost all the participants (97.4%) were aware of the concept of AI.¹² However, the finding in this study is higher than that in other similar studies among health workers in UAE and in western Turkey where 88.3% and 75.4% of respondents respectively were aware of AI and robotic nurses.¹⁶ Good awareness and knowledge of AI among core clinical health workers can be used to harness the potential of AI to improve public health outcomes and enhance patient care. Adigwe et al in a study carried out among healthcare professionals across the six geopolitical zones in Nigeria proved that the majority of respondents (57.2%) had good knowledge of artificial intelligence and machine learning, about 32.2% had average knowledge and only about 10.6% of the cohort had poor knowledge.¹⁷

The study shows that a significant number of health workers at UUTH agree that AI has numerous benefits in healthcare and that the advantages outweigh the disadvantages. A systematic review conducted globally, which assessed participants' attitudes towards AI among 487 pathologists practising in 54 countries mainly Canada, the USA, and the UK revealed that most respondents believed that with appropriate training, AI tools could increase (58.0%) or even dramatically increase (13.7%) diagnostic efficiency. Just over half of respondents anticipated that the implementation of AI would increase research productivity and allow pathologists to address previously unanswerable questions (53.6%). Responses were mixed regarding the impact of AI on clinical skills with 26.1% of respondents expressing concern that AI tools would erode pathologists' talent. In contrast, others felt AI tools would either enhance

the development of 'traditional skills' (21.0%) or have no effect on clinical skills (34.0%).¹⁸

A positive perception of AI can lead to increased adoption and effective implementation of AI technologies in healthcare services.¹⁹ It can also motivate health workers to develop and adopt new skills, which, in turn, would improve patient outcomes. A positive perception could inform research priorities and AI development ensuring that AI systems meet healthcare needs. It can also shape healthcare policy, influencing the regulation and integration of AI in healthcare systems. Whereas, negative perception can result in resistance to adopting AI and, unwillingness to share patients' data and work alongside AI systems, impacting the effectiveness of human-AI collaboration and hindering healthcare innovation and progress.¹⁹

Most respondents in this study strongly agreed or agreed that they wanted to know about AI applications in their work setting, they also indicated interest in AI courses and training. The majority of the respondents also strongly agreed or agreed that they wanted to stay updated on AI applications. This is higher than the findings in a study among physicians working at tertiary hospitals, interns and residents from the Oman Medical Specialty Board, and medical students from the College of Medicine at Sultan Qaboos University, Middle East, Asia where only 33% wanted to know more about AI.²⁰ The willingness of healthcare workers to learn about artificial intelligence AI would enable them to leverage AI to make more accurate diagnoses, develop personalized treatment plans, enhance patient care and safety, streamline clinical workflows, reduce errors, and improve productivity.²¹ This can result in reduced burnout for healthcare workers and improved job satisfaction. AI-trained health workers can develop telemedicine and remote monitoring programmes, thereby expanding access to healthcare. Also, health workers who are familiar with AI can effectively analyse large health datasets, informing public health policy and decision-making.²¹ The survey revealed that only a few of the respondents (7.9%) reported AI being used in their department, primarily for patient monitoring. Additionally, 32.6% of respondents personally used AI, mainly for studying and research (54.1%). This is lower than the findings in Germany which showed 22% of the GPs

had experience with AI-enabled systems, and 50% explicitly mentioned using it in their GP work.²² The disparity in these findings may be attributed to the fact that Germany has a more developed healthcare system, with access to the internet and technology making it easier to make use of AI at work.²³ The health workers in Germany compared to Nigeria have access to AI training and education, enabling them to effectively integrate AI into their practice, whereas the Nigerian health workers have limited opportunities for AI training. Germany has more funding, equipment, and personnel to invest in AI adoption while Nigeria faces financial and economic constraints that hinder the adoption of AI in her health facilities.²⁴

LIMITATIONS

Due to the small sample size, findings from this study may not be generalizable or applicable to healthcare workers across Nigeria.

CONCLUSION

The findings from this study revealed a good awareness and knowledge of AI. Less than half of the respondents had a positive perception of the benefits of AI. The majority of the respondents expressed a willingness to learn about AI. Only a minimal proportion utilise AI in their departments, while about a third utilise AI personally. Age, work experience and perception of regulatory constraints were significantly associated with the use of AI. Given that the majority of healthcare workers demonstrated a willingness to learn about AI, the responsibility now lies with the hospital to understand the role of AI in healthcare and prioritize organizing seminars and training on the application of various AI tools in medical diagnosis and interventions. There is also a need to address the fears and concerns of health workers regarding the potential of AI to replace their jobs. This study serves as a call to action for the government, which can provide sponsorships through funding and the provision of training materials and information technology programs to facilitate the integration of AI in healthcare. Additionally, the medical council responsible for curating academic curricula for medical and allied schools in Nigeria should incorporate teachings on the use of AI in healthcare to ensure in-depth knowledge and make AI an integral part of healthcare careers.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Zhang C, Lu Y. Study on artificial intelligence: The state of the art and future prospects. *J Ind Inf Integr.* 2021 Sep 1; 23:100224.
2. Buabbas AJ, Miskin B, Alnaqi AA, Ayed AK, Shehab AA, Syed-Abdul S, et al. Investigating Students' Perceptions Towards Artificial Intelligence in Medical Education. *Healthc Basel Switz.* 2023 May 1;11(9):1298.
3. The Future of Artificial Intelligence in Healthcare [Internet]. [cited 2023 Aug 18]. Available from: <https://www.amygb.ai/blog/the-future-of-artificial-intelligence-in-healthcare>
4. Jiang F, Jiang Y, Zhi H, Dong Y, Li H, Ma S, et al. Artificial intelligence in healthcare: past, present and future. *Stroke Vasc Neurol.* 2017 Dec;2(4):230–43.
5. Karger E, Kureljusic M. Using Artificial Intelligence for Drug Discovery: A Bibliometric Study and Future Research Agenda. *Pharm Basel Switz.* 2022 Nov 30;15(12):1492.
6. Greis C, Maul LV, Hsu C, Djamei V, Schmid-Grendelmeier P, Navarini AA. [Artificial intelligence to support telemedicine in Africa]. *Hautarzt Z Dermatol Venerol Verwandte Geb.* 2020 Sep;71(9):686–90.
7. Dave M, Patel N. Artificial intelligence in healthcare and education. *Br Dent J.* 2023 May;234(10):761–4.
8. Drawbacks of Artificial Intelligence and Their Potential Solutions in the Healthcare Sector | SpringerLink [Internet]. [cited 2023 Jul 27]. Available from: <https://link.springer.com/article/10.1007/s44174-023-00063-2>
9. An awakening in medicine: the partnership of humanity and intelligent machines - The Lancet Digital Health [Internet]. [cited 2023 Jul 27]. Available from: [https://www.thelancet.com/journals/landig/article/PIIS2589-7500\(19\)30127-X/fulltext](https://www.thelancet.com/journals/landig/article/PIIS2589-7500(19)30127-X/fulltext)
10. Castagno S, Khalifa M. Perceptions of Artificial Intelligence Among Healthcare Staff: A Qualitative Survey Study. *Front Artif Intell [Internet].* 2020 [cited 2023 Jul 27];3. Available from: <https://www.frontiersin.org/articles/10.3389/frai.2020.578983>
11. Sarwar S, Dent A, Faust K, Richer M, Djuric U, Van Ommeren R, et al. Physician perspectives on integration of artificial intelligence into diagnostic pathology. *Npj Digit Med.* 2019 Apr 26;2(1):1–7.
12. Blogger SG. Perceptions Ghanaian healthcare workers have about AI [Internet]. *SwissCognitive*,

- World-Leading AI Network. 2022 [cited 2023 Jul 28]. Available from: <https://swisscognitive.ch/2022/03/29/perceptions-ghanaian-healthcare-workers-have-about-ai/>
13. Robinson. Artificial intelligence in healthcare; its knowledge, practice, and perception among medical personnel in the developing economy [Internet]. [cited 2023 Jul 27]. Available from: <https://jrmt.org/article.asp?issn=WKMP-0200;year=2020;volume=1;issue=1;spage=13;epage=19;aulast=Robinson;type=3>
14. University of Uyo Teaching Hospital – Learning, Compassion & Service [Internet]. [cited 2024 Oct 22]. Available from: <https://www.uuthuyo.net/>
15. Sample Size Calculator by Raosoft, Inc. [Internet]. [cited 2023 Sep 25]. Available from: <http://www.raosoft.com/samplesize.html>
16. Koçak B. Key concepts, common pitfalls, and best practices in artificial intelligence and machine learning; focus on radiomics. *Diagn Interv Radiol Ank Turk*. 2022 Sep;28(5):450–62.
17. Adigwe OP, Onavbavba G, Sanyaolu SE. Exploring the matrix: knowledge, perceptions and prospects of artificial intelligence and machine learning in Nigerian healthcare. *Front Artif Intell*. 2023; 6:1293297.
18. Ahmed AA, Brychcy A, Abouzid M, Witt M, Kaczmarek E. Perception of Pathologists in Poland of Artificial Intelligence and Machine Learning in Medical Diagnosis—A Cross-Sectional Study. *J Pers Med*. 2023 Jun;13(6):962.
19. Chew HSJ, Achananuparp P. Perceptions and Needs of Artificial Intelligence in Health Care to Increase Adoption: Scoping Review. *J Med Internet Res*. 2022 Jan 14;24(1): e32939.
20. Jutzi TB, Krieghoff-Henning EI, Holland-Letz T, Utikal JS, Hauschild A, Schadendorf D, et al. Artificial Intelligence in Skin Cancer Diagnostics: The Patients' Perspective. *Front Med*. 2020; 7:233.
21. Alowais SA, Alghamdi SS, Alsuhebany N, Alqahtani T, Alshaya AI, Almohareb SN, et al. Revolutionizing healthcare: the role of artificial intelligence in clinical practice. *BMC Med Educ*. 2023 Sep 22;23(1):689.
22. Buck C, Doctor E, Hennrich J, Jöhnk J, Eymann T. General Practitioners' Attitudes Toward Artificial Intelligence-Enabled Systems: Interview Study. *J Med Internet Res*. 2022 Jan 27;24(1): e28916.
23. World Health Organization Assesses the World's Health Systems [Internet]. [cited 2024 Nov 13]. Available from: <https://www.who.int/news/item/07-02-2000-world-health-organization-assesses-the-world's-health-systems>
24. Döring A, Paul F. The German healthcare system. *EPMA J*. 2010 Dec 18;1(4):535.