



The Impact of Artificial Intelligence in Clinical Education: Perceptions of Undergraduate Medical Students in Northeastern Nigeria and Recommendations for Trainers

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ABSTRACT

Artificial intelligence (AI) is increasingly being adopted in healthcare; however, the perceptions of undergraduate medical students in Nigeria on its role in clinical education remain underexplored. This study examined students' perceptions of AI in clinical education across four public universities in Northeastern Nigeria. A mixed method cross-sectional survey was conducted between February and May, 2026 using a 27-items questionnaire. Convenience sampling approach was employed, and 200 valid responses were analysed. Likert data and free-text responses were analysed using descriptive statistics and thematic analysis, respectively. Overall, 85.5% of the respondents reported a basic understanding of AI, 49.5% reported familiarity with AI in healthcare and 38.5% reported regular exposure to AI tools during their training. Most of the students perceived potential educational benefits: 90% agreed that AI could improve the quality of learning, and 85.5% agreed that it could enhance clinical decision support. However, 86% expressed concern that overreliance on AI could negatively affect clinical reasoning and judgement, while 59.5% believed AI could reduce hands-on practical training, and 57% agreed that it could replace medical roles. Only 20.5% of the respondent agreed to have adequate AI training in their medical curricula, while 72.5% supported incorporating AI into their curriculum. These findings suggest that respondents generally held positive perceptions of AI on clinical education but perceived some concerns about its responsible use and preparation for AI-enabled healthcare. We recommend that medical educators review the current medical curricula to incorporate AI literacy training, AI applications, and ethical concerns while preserving existing practical training and patient-centred care.

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INTRODUCTION

Advancements in computing power, the growth of digital data, and developments in algorithms have facilitated the development of Machine Learning (ML) and Deep Learning (DL) technologies, expanding the range of Artificial Intelligence (AI) applications across many sectors, including healthcare (Liu et al., 2022). In the healthcare, AI applications are continuously being used for task such as disease classification (Sani et al., 2026), medical image interpretation, clinical decision support and the analysis of electronic health records. Computer Vision (CV)-based models can detect anomalies in radiological images, assist clinicians in lesion identification, and enhance diagnostic precision (Alimadadi et al., 2020; Connie et al., 2023; Huiyan et al., 2023; Afif et al., 2023; Prakash et al., 2023). Natural Language Processing (NLP) algorithms can accelerate automated clinical documentation and extract useful insights from electronic health records (Dave et al., 2023; Kanwal & Rizzo, 2022; Thomas et al., 2023). In addition, AI-powered decision support systems have increased efficiency by prioritizing patient care and helping physicians make accurate and timely decisions (Latif et al., 2020; Wan et al., 2023). However, their potential value depends on the quality of the data, the context in which they are deployed, and appropriate clinical oversight.

Despite the growing recognition of AI's benefits in healthcare, several challenges and concerns remain barriers to

its adoption. A major challenge is the risk relating to the interpretability of AI models, often described as the "black box" problem, meaning most AI systems produce results without proper explanation of how the results were arrived at (Hassija et al., 2024). This is a major challenge, particularly in healthcare. Similarly, ethical concerns on trust, accountability, and fear that AI may reduce training opportunities for clinical skill development and/or replace some medical professional roles in the future also hinder its integration and application in healthcare (Paranjape et al., 2019).

Traditional medical education focused on training students to acquire knowledge, develop clinical reasoning, and develop procedural and interpersonal skills (Wartman & Combs, 2018). However, with contemporary AI tools capable of processing huge medical data and the ability to perform cognitive tasks such as document processing and clinical decision support, the competence required by today's medical professional is changing. Instead of learning medical concepts and developing practical and clinical reasoning skills, future medical personnel will need to understand how to interact and communicate effectively with AI systems. This change necessitates the need for the acquisition of new competence and skills, such as data literacy, algorithmic understanding, and critical appraisal skills for evaluating AI-assisted output (Zarei et al., 2024).

In view of the above, studies in several settings have examined the role of AI in medical education and the perceptions of medical students regarding its integration into the medical curriculum. A study of medical students in Kuwait reported awareness of AI and positive attitude toward curriculum integration (Buabbas et al., 2023). Similar studies in the UK (Sit et al., 2020) and Palestine (Jebreen et al., 2024) have demonstrated strong enthusiasm about the future roles of AI in healthcare, despite limited formal AI training opportunities currently available in their respective medical curricula. The work of (Krive et al., 2023) have also shown that the adoption of structured AI training programs can significantly enhance understanding of AI and willingness to apply it in real clinical environments.

Although several studies have examined students' perceptions, readiness, and acceptance of AI in other regions such as Europe, the Middle East, and Asia, there is limited evidence from sub-Saharan Africa and Nigeria in particular. Existing studies indicate that while students generally have positive perceptions of the potential benefits of AI in medical education, they also report widespread concerns about its potential negative impacts on clinical competence and ethical practice (Civaner et al., 2022; Pinto dos Santos et al., 2019; Liu et al., 2022). The relevance of these findings to Nigerian medical schools cannot be assumed, given differences in infrastructure, access to digital resources, and the availability of locally relevant clinical data. Context-specific evidence can help educators consider how AI literacy and critical appraisal might be introduced without weakening core clinical training.

Therefore, this study aimed to examine undergraduate medical students' perception of AI in clinical education across four (4) public universities in Northeastern Nigeria, focusing on AI awareness and exposure, perceived educational benefits and risks, and concerns about AI and attitude toward AI integration.

MATERIALS AND METHODS

Research Design

A mixed-method cross sectional survey was conducted to investigate northeastern medical students' perceptions of AI in clinical education. The quantitative aspect uses Likert-type items to assess AI awareness, perceived educational benefits, perceived risks, ethical concerns, and attitudes toward curriculum integration. The qualitative component consists of two open-ended questions targeted at capturing respondents' views on AI integration and some related concerns. Data collection was conducted between February and May, 2026.

Participants

The study was conducted among undergraduate medical students offering MBBS programs at four public universities in the northeast region of Nigeria: Gombe State University (GSU), Gombe State; University of Maiduguri (UNIMAID), Borno State; Abubakar Tafawa Balewa University (ATBU), Bauchi State; and Yobe State University (YSU), Damaturu, Yobe State.

The target population comprised of 1,200 students enrolled across the four institutions during the 2025/2026 academic session. A planned sample size of 291 respondents was determined using Krejcie and Morgan's (1970) formula (Chuan & Penyelidikan, 2006), which recommends 291 participants for a population size of 1,200 students. Convenience sampling was used to recruit 100 students from each university, giving a total of 400 invitations. The recruitment of the participants was facilitated through email,

WhatsApp, direct contact, lecturers, peer networks, and members of the research team. This non-probability approach may limit representativeness and introduce self-selection bias.

Eligible participants were undergraduate medical students enrolled at one of the four participating universities in the 2025/2026 academic year. After removing incomplete or duplicate responses, 200 valid questionnaire responses were obtained for analysis. The final distribution was GSU (91), UNIMAID (55), ATBU (27), and YSU (27).

Survey Questionnaire

The study data were collected using a 27-item questionnaire developed by the researchers following an extensive review of related literature. The final questionnaire comprised of: six items on participants' demographic and AI background, 19 five-point Likert-scale items, and two open ended questions. The Likert-type items assess participants' response (agreement) level on statements about AI across four different domains including: AI awareness, perceived benefits, ethical concerns, and attitudes toward of respondent toward AI integration. The open-ended questions enabled participants to express additional views on AI in clinical education.

Validity and Reliability

The research instrument's content validity was reviewed by two experts, one specializing in AI and the other in medical education, who assessed clarity, relevance and adequacy. The Cronbach's alpha method was used to calculate the internal consistency of the survey items. The questionnaire showed good internal consistency reliability (Cronbach's $\alpha = 0.824$), exceeding the recommended threshold of 0.70

Data Analysis

Likert-type responses were analyzed using descriptive statistics (mean, standard deviation, and percentage scores) to interpret students' perceptions of AI's impact on clinical education. The findings were summarized in tables to describe participants' characteristics and their perceptions of AI in clinical education. Qualitative data from open-ended responses were analyzed using thematic analysis following the general approach described by (Braun & Clarke, 2006). Responses were coded independently by two coders, after which the codes were iteratively refined and categorized into themes and subthemes.

RESULTS AND DISCUSSION

Demographic Characteristics of Participants

A total of 200 undergraduate medical students from four educational institutions in Northeast Nigeria were included in the analysis. The most common age group was 21–23 years ($n = 55$; 27.5%), and the majority of participants were male ($n = 125$; 62.5%). Gombe State University (GSU) contributed 91 respondents (45.5%), followed by the University of Maiduguri (UNIMAID; $n = 55$; 27.5%), Abubakar Tafawa Balewa University (ATBU; $n = 27$; 13.5%), and finally Yobe State University (YSU; $n = 27$; 13.5%). The largest academic group was fourth-year students (Level 400; $n = 56$; 28.0%). A total of 161 respondents (80.5%) reported that they had not received any formal AI training, and 148 (74.0%) reported that AI was not included in their current medical curriculum, creating a low baseline context for AI integration, from which the findings must be understood. Table 1 summarizes the demographic and background characteristics of the respondents.

Table 1: Demographic and Background Characteristics of Survey Respondents (n = 200)

Characteristic	Category	n	%
Age Group	<18	11	5.5
	18–20	53	26.5
	21–23	55	27.5
	24–26	52	26.0
	>26	29	14.5
Gender	Male	125	62.5
	Female	73	36.5
	Prefer not to say	2	1.0
Institution	Gombe State University	91	45.5
	University of Maiduguri	55	27.5
	Abubakar Tafawa Balewa University	27	13.5
	Yobe State University	27	13.5
Level of Study	100-Level (Year 1)	15	7.5
	200-Level (Year 2)	36	18.0
	300-Level (Year 3)	33	16.5
	400-Level (Year 4)	56	28.0
	500-Level (Year 5)	41	20.5
	600-Level (Year 6)	19	9.5
Formal AI Training Received	Yes	39	19.5
	No	161	80.5
AI in the Current Curriculum	Yes	52	26.0
	No	148	74.0

Quantitative Analysis**AI Awareness and Familiarity with AI Applications**

Table 2 summarizes respondents' self-reported AI awareness and familiarity with AI applications. The students reported a high level of AI awareness ($M = 4.13$, $SD = 0.73$), with the majority (85.5%) of them agreeing or strongly agreeing that they have a basic understanding of AI. However, familiarity with AI applications in healthcare was considerably moderate

($M = 3.38$, $SD = 1.08$), while regular exposure to AI during training was relatively low ($M = 3.10$, $SD = 1.10$), with only 38.5% of the students agreeing or strongly agreeing to have regularly encountered AI tools during their training. These findings indicate a significant gap between conceptual awareness and applied exposure, emphasizing the need for curriculum developers to incorporate applied AI training modules into the medical curriculum.

Table 2: Students' AI Awareness and Familiarity with AI applications in healthcare (n = 200)

Items	M	SD	A+SA (%)	Remark
I have a basic understanding of what Artificial Intelligence (AI) means.	4.13	0.73	85.5	High
I am familiar with AI applications used in healthcare	3.38	1.08	49.5	Moderate
I regularly encounter AI-related tools or technologies during my medical training.	3.10	1.10	38.5	Low

Key: SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree; M = Mean; SD = Standard Deviation; A+SA% = combined percentage agreeing or strongly agreeing.

Perceived AI Benefits in Clinical Education

Table 3 summarizes respondents' perceptions of the possible educational benefits of AI. The results reveal that students have an overwhelmingly positive view of AI's potential benefits in medical education and training. Students expressed high positive view ($M = 4.39$, $SD = 0.72$) that AI can have a positive impact on medical education, with 92.5% agreeing or strongly agreeing. Agreement was also high for statements that AI could improve the quality of learning

(90.0%; $M = 4.33$, $SD = 0.74$), support the understanding of medical concepts and patient management (88.0%; $M = 4.29$, $SD = 0.74$), and enhance clinical decision support (85.5%; $M = 4.17$, $SD = 0.84$). The benefit item that received the lowest rating score ($M = 4.00$, $SD = 0.88$) was the item pertaining to improvement of clinical judgement and decision-making skills, still reflecting predominantly positive sentiments. These results describe students' expectations of AI's potential benefits.

Table 3: Students' Perceived Educational Benefits of AI in Medical Education (n = 200)

Items	M	SD	A+SA (%)	Remark
AI has a positive impact on medical education	4.39	0.72	92.5	High
The use of AI can improve the quality of training and medical education	4.33	0.74	90.0	High
AI can support my understanding of clinical concepts, disease processes, and patient management.	4.29	0.74	88.0	High
AI-based systems can enhance learning through clinical decision support and diagnostic assistance.	4.17	0.84	85.5	High
The use of AI in clinical education can improve my clinical judgement and decision-making skills.	4.00	0.88	78.5	High
The integration of AI into clinical education is necessary to keep medical training relevant in the digital era.	4.13	0.85	79.0	High
AI should be used as a supportive tool alongside traditional clinical teaching methods.	4.25	0.80	87.0	High

Perceived Risks and Ethical Concerns

Table 4 presents respondents' perceived risks and ethical concern. Most respondent (86.0%) reported a high level of agreement (M = 4.28, SD = 0.91) that overreliance on AI could impair clinical reasoning. A total of 59.5% perceived that AI could reduce hands-on training opportunities (M = 3.54, SD = 1.12), while 70.5% expressed concerns about

ethical issues related to AI in medicine (M = 3.85, SD = 0.88). However, opinions on whether AI might replace some medical roles in the future were more mixed, with 57.0% agreeing or strongly agreeing (M = 3.38, SD = 1.23). This item reported the highest variance of any risk item and reflects the diverse opinions on AI's long-term professional impact.

Table 4: Respondents' Perceived Risks and Ethical Concerns (n = 200)

Item	Mean	SD	A+SA (%)	Remarks
The use of AI may reduce opportunities for hands-on clinical skills training	3.54	1.12	59.5	Moderate
Over-reliance on AI could negatively affect students' clinical reasoning skills.	4.28	0.91	86.0	High
AI systems may eventually replace some roles of medical doctors	3.38	1.23	57.0	Moderate
I am concerned about ethical issues related to AI use in medicine.	3.85	0.88	70.5	High

Attitudes toward AI Integration

Table 5 summarizes respondents' attitudes toward AI integration. 83.5% of the respondents agreed or strongly agreed that on the need for education on the safe and effective use of AI (M = 4.17, SD = 0.82), and 72.5% supported the formal integration of AI into undergraduate medical training (M = 3.85, SD = 0.91). Additionally, 77.5% expressed willingness to use AI based tools as part of their medical

education and training (M = 4.03, SD = 0.78). In contrast, only 20.5% agreed or strongly agreed that sufficient AI training is available in their current curriculum (M = 2.54, SD = 1.14). These findings suggest that although students are willing to use AI in their future careers and support its formal integration into the medical curriculum, the majority perceive existing AI training opportunities as inadequate.

Table 5: Students' Attitudes toward AI Integration into Medical Curriculum (n = 200)

Items	Mean	SD	A+SA (%)	Remark
I am willing to use AI-based tools as part of my medical education and training	4.03	0.78	77.5	High
There is currently sufficient AI training in my medical curriculum.	2.54	1.14	20.5	Low
AI education should be formally integrated into undergraduate medical training.	3.85	0.91	72.5	High
Medical students should be taught how to safely and effectively use AI in clinical practice.	4.17	0.82	83.5	High
Learning about AI will be beneficial to my future medical career.	4.16	0.79	86.5	High

Qualitative Analysis

Of the 200 respondents, 125 (62.5%) commented on AI integration and 129 (64.5%) responded to the question about concerns. Thematic analysis of the free-text responses identified two main themes, facilitative integration and risks and concerns) as summarized in Table 6. Within the first theme, the majority of the respondents viewed AI as a support tool rather than a replacement for clinical roles. One of the sub-themes was the use of AI-driven patient simulations to

support diagnostic reasoning, history taking, and feedback within a controlled learning environment. Respondents also supported structured curriculum integration, recommending the introduction of AI from pre-clinicals to clinical phases of medical training. Several respondents also emphasized that AI should be used as a supervised learning tool to enhance clinical reasoning and skill acquisition among students. The risks and concern themes included sub-themes such as weakening clinical judgement and bedside skills due to

overreliance on AI, including algorithmic bias and limited generalization, especially for AI systems trained on non-African datasets. Ethical concerns included data privacy, accountability for AI-assisted decisions, and potential

impacts on the doctor–patient relationship. As one respondent noted, “Without clear regulation, training, and supervision, AI could compromise patient safety rather than improve care.”

Table 6: Themes, Sub-themes, and Representative Examples from Thematic Analysis of Free-text Responses (n = 125–129 responses)

Theme	Sub-theme	Examples
Theme 1: Facilitative Integration	AI as an active simulation tool	"There are AI applications that have simulations that act like a real patient. I think tools like this should be integrated into the medical curriculum."
	Structured curriculum inclusion from early years	"It should be part of the curriculum since the 200 level."
	AI as a reference and evidence tool	"It could be integrated so students have basic knowledge of AI used currently, as a form of search tool for textbooks, templates, discoveries, and updates to clinical protocols."
Theme 2: Risks and Concerns	Supervised, ethics-grounded AI instruction	"AI should be integrated as an ethical, supervised learning tool that enhances understanding, clinical reasoning, and skills acquisition without replacing human judgment."
	Over-reliance and deskilling	"Over-reliance on AI is going to make some doctors not different from patients who put their symptoms into AI and browse."
	Erosion of critical thinking and clinical reasoning	"The integration of AI into practice may gradually reduce the knowledge acquisition and effort invested by practitioners."
	Bias, inaccuracy, and patient safety	"AI systems reflect the data they are trained on and may perform poorly in under-represented populations."
	Ethics, data privacy, and accountability	"Without clear regulation, training, and supervision, AI could compromise patient safety rather than improve care."
	Doctor–patient relationship and trust	"People will begin to think that medical training is no longer valuable since most intellectual work and decision-making will be backed by AI."

Discussion

This study examined undergraduate medical students' perceptions of AI in clinical education across four universities in Northeastern Nigeria. The findings reveal that respondents generally perceived potential educational benefits from AI and supported its inclusion medical education, while also reporting limited formal readiness and concerns about practical skills, overreliance and ethics. These findings provide context-specific evidence that may inform discussions about AI education in the participating institutions. However, they should be interpreted as students' reported perceptions rather than evidence of AI's actual effects on educational outcomes or clinical competence.

AI Awareness and Familiarity with AI Applications

The findings of this study reveal that most respondents (85.5%) reported a basic understanding of AI, but fewer reported familiarity with its clinical applications (49.5%) or had direct exposure to AI tools. This pattern suggests a difference between students' self-reported general awareness and their reported exposure to AI in healthcare and medical education. The findings broadly aligned with other studies examining medical students' awareness and attitudes towards AI in other contexts, including Kuwait and the UK Kingdom (Buabbas et al., 2023; Sit et al., 2020). However, this comparison should be made with caution as differences in study populations, research instruments and educational settings may influence the reported results.

The gap between reported general awareness and specific familiarity suggest an area that need further exploration. As noted by Krive et al. (2023), structured and practice-oriented AI training can substantially improve applied competence. Limited exposure may cause students to either over-trust AI output or underutilize it due to a lack of confidence, both of which have implications for clinical decision-making.

Perceived AI benefits in Clinical Education

Respondents expressed strong optimism that AI could benefit them across all survey items of educational benefits, with agreement across the benefits items ranging from 78.5% to 92.5 %. These findings align with studies conducted in other settings that similarly explored medical students' attitudes towards AI and its potential role in medical education (Buabbas et al., 2023; Sit et al., 2020; Jebreen et al., 2024). Although the related studies provide useful comparative context, differences in study design and questionnaire items limit direct comparisons between percentages. Overall, the findings of the current study highlight that respondents see potential value in AI while recognizing that its educational contribution would depend on appropriate implementation and evaluation.

Perceived Risks and Ethical Concerns

Although respondents hold a positive attitude toward artificial intelligence (AI), they also expressed concerns regarding its impact on medical care and professional ethics. The majority of respondents (86.0%) agreed or strongly agreed that over-reliance on AI could affect clinical reasoning skills. Furthermore, 59.5% of respondents believed it could impact opportunities for practical learning, 70.5% expressed concerns about ethical issues arising from the use of AI in healthcare, and 57.0% felt that AI could replace certain clinical roles.

These findings highlight several issues that should be addressed when developing AI-related educational content. In particular, the students' perceptions regarding clinical reasoning and practical training suggest that AI education should be designed to complement—rather than replace—supervised clinical experience. Educational initiatives could encourage students to voice their opinions, challenge AI-

generated recommendations, identify uncertainties, and apply relevant clinical knowledge to clinical decision-making.

Attitudes toward AI Integration into Curriculum

On the curriculum integration, the findings of this study indicate a perceived gap between interest in AI and the training currently available. Only 20.5% of the respondents agreed or strongly agreed that their curriculum have sufficient AI training. This finding is consistent with similar concerns about limited formal AI training reported by Jebreen *et al.* (2024) about Palestinian medical students. Similarly, Buabbas *et al.* (2023) found a parallel gap in Kuwait, where students had high awareness of AI but with limited structured educational provision. The convergence of these findings identifies a local need that warrants curriculum review and further assessment.

Alongside the limited AI training opportunities, respondents expressed strong support on the safe and effective use of AI., 83.5% agreed that medical students should be taught to use AI safely and effectively, and 77.5% reported willingness to use AI tools in training. These findings suggest that curriculum developers could consider introductory AI literacy, clinical-use cases, critical appraisal of AI outputs, privacy, bias, accountability, and appropriate human oversight.

Contextual Considerations for LMIC Medical Education

In contrast to the related studies carried out in other regions of the world, the Nigerian context is characterized by distinct realities. Some of the challenges hindering the adoption of and its integration into medical training reported by respondents in the qualitative responses include inadequate electricity supply, poor Internet connectivity, and limited availability of AI diagnostic tools. Most of the respondents reported that institutional AI-based systems are limited and restricted, AI apps provided through mobile phones are more affordable and accessible than the institutional-based AI system. This finding resonates with the mobile-first health approaches increasingly recommended for sub-Saharan Africa (Agbeyangi & Lukose, 2025). In addition, the limited availability of African clinical data in most AI training dataset concern raised by many of the qualitative respondents, which is useful in this context. Therefore, an AI curriculum designed for Nigerian medical students must not only contain technical competence but also critical evaluation skills to determine whether the AI system has been properly tested in clinical settings and populations similar to those in which it will be finally deployed. These evaluation skills are very useful, particularly in LMIC settings, where medical personnel are more likely to be users rather than developers of the AI system and where the consequences of the algorithmic bias may be unequally borne by an already vulnerable patient population. In light of this, the Nigerian context reveals some AI education priorities that were not addressed by several related studies from the literature, which represents a vital contribution of the present study.

Implications for Clinical Curricula and Recommendations for Educators

The findings of this study suggest several considerations for educators and curriculum developers in the participating institutions, it indicate the need for a balanced, contextually relevant, and clinically appropriate integration of AI into undergraduate medical education in Nigeria. The recommendations below are implications drawn from respondents' perceptions and the study context; they should be adapted to local curricular requirements and evaluated in

practice. AI education should complement core medical knowledge, supervised clinical experience, and patient-centered care rather than replace them.

First, medical curricula should be reviewed to include AI training. The current medical curriculum should be reviewed to include AI training from the preclinical years to the clinical stage of education. The training should include modules on fundamental concepts of AI, machine learning, decision support, and specific applications in areas such as pathology, internal medicine, and radiology. The training should, in addition to equipping students with technical competence, emphasize Applied AI methods, stressing clinical interpretation, safety, and critical evaluation

Second, AI related ethics and governance could be integrated into existing medical ethics and professionalism modules. A major concern in the use of AI systems in the African context is the limited availability of African clinical datasets and the potential repercussions it may have for diagnostic accuracy, equity, and patient safety. The medical curriculum should be reviewed to include AI ethics, bias, and data management in the current curriculum. Training should also include topics such as accountability, transparency, privacy, and the responsible use of AI in clinical practice.

Third, Curriculum developers should ensure that AI integration does not undermine traditional clinical training. The integration of AI into medical education should enhance traditional clinical training rather than undermine it. Curriculum designers should ensure a balance between the technical competence for using AI and the traditional clinical competence. Medical students must still acquire practical bedside skills, procedural skills, and clinical reasoning abilities. AI tools should be used as supportive educational and clinical assistants, not a replacement for physical judgement. Hence, assessment frameworks should continue to evaluate essential clinical competencies regardless of AI-assisted performance.

Fourth, implementation strategies should prioritize equitable access to digital assets, taking into account the infrastructural challenges faced by many medical schools in Nigeria. Policymakers and curriculum designers should emphasize the need for equal access to the resources needed to integrate artificial intelligence (AI) into the medical education curriculum. If appropriate and secure, the use of reading devices that require less bandwidth or are compatible with mobile devices may help increase uptake; institutions should also establish clear policies regarding the privacy, fair use, and authentication of AI-generated content before integrating such tools into the training process.

Finally, future studies should cover more institutions and regions of Nigeria and should use longitudinal designs where possible. These studies could combine perception surveys with validated AI literacy assessment tools, and evaluate the impact of structured AI education on clinical reasoning, professional identity development, and patient-centered care. The overall findings indicate that Nigerian Northeast medical students hold positive perceptions towards AI and support its integration into the current medical curriculum despite having some concerns.

Limitations

Several limitations should be considered when interpreting the findings of this study and planning for future research. First, the survey covered only four institutions offering medical education in the Northeast Geopolitical Zone of Nigeria and uses convenience sampling, so the results may be biased toward these institutions and may not be generalizable to institutions in the remaining five geopolitical zones in

Nigeria, which may produce different results due to differential urbanization, institutional resources, and technological exposure. Recruitment through institutional and peer networks may have favored students who were more accessible or more interested in AI.

Second, while this survey collected self-reported AI awareness and encounter frequency, it did not include a validated AI literacy instrument to determine participants' baseline knowledge independent of perception. The significant gap between self-reported understanding and healthcare-specific familiarity suggests heterogeneous and potentially inflated self-assessment.

Third, the number and depth of free-text responses varied by question, limiting the breadth of the qualitative analysis. Finally, the qualitative response rate was not uniform across all participants; only a few of the participants provided substantive analytical commentary, while the majority provided responses of limited depth. Therefore, the thematic conclusions drawn from the qualitative analysis represent only a few selected subsets of the survey population and should not be interpreted alone but alongside the quantitative findings.

Conclusion

AI is increasingly being incorporated into healthcare, understanding medical students' perceptions about AI is essential for informing evidence-based curriculum reforms. This study assessed undergraduate medical students' perceptions of AI in clinical education across four universities in Northeastern Nigeria using convenience sampling technique. The results indicate that respondents generally perceived potential educational benefit and supported teaching medical students how to safely use AI, while expressing concerns about practical training, overreliance, ethics and adequacy of the current curricular preparation. These findings demonstrate the need for a balanced approach to AI integration. Medical curriculum should be reviewed to include AI literacy modules, AI applications in healthcare, AI ethics, and AI bias literacy while protecting training in clinical reasoning, practical skills, and patient care. Future research should use longitudinal and multi-institutional study designs to assess the effectiveness of AI-integrated medical curricula on students' AI competencies, clinical reasoning abilities, professional development, and healthcare outcomes. Such evidences will be essential for guiding the responsible and effective integration of AI into medical education in Nigeria.

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