The Role of Artificial Intelligence in Diagnostic Radiology: Knowledge, Attitude, and Practice of Radiologists and Radiology Residents in Kenya

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Abstract

Background: Phenomenal developments in Artificial Intelligence/ Machine Learning (AI/ML) have led to the creation of powerful computerized algorithms with proven capabilities in the performance of some tasks in the radiology workflow. Predictions of the impact that AI/ML will have in the field of Diagnostic Radiology (DR) range from rendering radiologists obsolete to drastic changes in its practice. This has resulted in varied attitudes and perceptions of AI among radiologists and radiology residents. It is, therefore, key that radiologists be well versed with terminologies, concepts, and applications of AI/ML in DR to enable them to accurately project their potential effects and prepare them for the same.

Objective: This study assessed the knowledge, attitudes, and practice of radiologists and radiology residents towards AI/ML in the field of DR in Kenya.

Methodology: A cross-sectional descriptive study method was used. The study was conducted among members of the Kenya Association of Radiologists (KAR). Eligible persons included radiologists and radiology residents based in Kenya.

Data was collected by sharing a web-based questionnaire on the association's WhatsApp platform, which had a membership of 199. Total sampling technique was used. Study variables were be calculated by the use of percentages and frequencies. Pearson's Chi-square and Mann-Whitney U test were utilized to compare categorical data and study groups, respectively.

This study is of help in identifying the level of knowledge of AI in DR, its utilization in daily practice, and the prevailing attitudes and perceptions surrounding it. The data was analysed using Statistical Package for Social Sciences (SPSS) version 26.

Results: A considerable majority of the participants had basic knowledge on Artificial intelligence, for they had read/watched/attended an AI presentation (n = 73, 65.8%). Less than half of the participants were knowledgeable on machine learning, artificial neural networks and deep learning concept. The use of AI in detection in radiology emerged as the most mentioned application (37.4%), with the remaining applications such as segmentation, speech recognition, registration, workflow management, protocol optimization and others only accounting for less than 20% individually. Utilization of AI application in daily radiology practice was scarce, with only 12.6% utilizing AI. Slightly more than two-thirds (68.5%) felt that the future practice of radiology would change as a result of AI. Nearly half of the participants felt that AI/ML application has both positive and negative effect on the field of radiology (44.1%), while the rest considered IA/ML as holding the potential to make radiology exciting and good (55.9%). Approximately two-thirds of the participants indicated their willingness to be involved in the process of development and training of ML algorithms so that they can do some of the tasks that a radiologist does (67.6%). At least 64% of the participants indicated that they had read an article on AI application in radiology. Around two-thirds of the participant felt that the current knowledge on AI applications has no bearing on their decision to pursue a career as a radiologist (61.3%).

Conclusion: The results from this study show that consultant radiologists and radiology residents have a basic knowledge of AI while lacking knowledge on related concepts. Consultant radiologists and residents generally have a positive attitude towards AI application in Radiology. The utilization of AI applications in daily radiology practice in Kenya is still low.

Recommendation: To bridge the knowledge gap, a course on AI/ML applications in Radiology should be introduced to the residency program while continuous medical education should be provided to radiologists.

Introduction And Background

The field of Artificial Intelligence (AI) has witnessed exponential growth in the 21st century (1). The phenomenal changes in AI have catapulted the development of society as we know it, with resultant radical shifts in the performance of tasks in diverse fields and industries, both in theory and technique (1). The Canadian Association of Radiologists(CAR) defines AI as a "branch of computer science dedicated to the development of computer algorithms to accomplish tasks traditionally associated with human intelligence, such as the ability to learn and solve problems"(2). Day to day AI applications include automated personal assistants, for instance, the popular Google Alexa, phone conversation behavioural algorithms, intelligent e-commerce shopping recommendations, and self-driving vehicles(2). AI tools are becoming more reliable and easy to integrate into daily tasks(2).

The field of DR is not only a product of technology but also evolves and advances as a result of it. DR applies imaging technology and radiation for diagnosis and therapy. It has gained heavily from advances in physics, engineering, and computer science. ML improves efficiency in the analysis and diagnosis of medical images and is predicted to greatly diminish the radiologists' workload(3).

As AI tools become more proficient and are eventually integrated into the radiological workflow, it is essential that radiologists familiarize themselves with the fundamental concepts and technical terms(2). Studies predict that radiologists trained in the fields of programming and health informatics, which are key pillars of AI/ML, will be more employable in the future(4).

Even though the majority of the existing research data is primarily on the role of AI/ML in computer-assisted image detection, ML is predicted to impact all the steps of the radiology workflow(5). This workflow includes " order scheduling and patient screening, automated clinical decision support and examination protocoling, image acquisition, automated detection of findings and features, automated interpretation of findings, image management (display and archiving), postprocessing (image segmentation, registration, and quantification), image quality analytics, automated dose estimation, radiology reporting and analytics, and automated correlation and integration of medical imaging data with other data source"(6).

There is no data available on the knowledge, attitude, and practice of AI/ML in DR, in Kenya and Africa. In a survey done among medical students from 19 colleges in the United Kingdom (UK), the majority(88%)

believed that AI would play a critical role in the medical industry in the future(7). Almost half of the students reported that they had "a basic understanding of the principles that underpin AI."In addition, 49% reported that "they were less likely to consider a career in DR due to AI"(7). This was very concerning because there is an acute shortage of radiologists in the UK. Some students believed that some medical specialities would be wiped out completely as a result of AI(7).

In a study conducted by Gong et al. among 322 Canadian medical students, 48.6% agreed that they experienced anxiety caused by their perception of AI when considering Radiology as their line of speciality (8). Worse still, one-sixth of the participants who would otherwise pursue DR as their first choice reported that they would not consider it due to their anxiety about AI(8).In another study, Pinto Dos Santos et al. established that there was a prevailing lack of knowledge on AI among medical students(9). Furthermore, he identified that their knowledge on the topic was acquired from the mainstream media rather than peer-reviewed journals, and the majority of them agreed that training on AI should be incorporated into the medical school curriculum(9). Interestingly, both studies cited above established that participants with prior knowledge of AI were less anxious about it and were more willing to embrace the technology in their future practice.

Methodology

Study design

A cross-sectional descriptive study method was used. The distribution of variables and characteristics of the study subjects with regards to the topic of study was then adequately described.

Study population

Persons included in the study were all the attending/faculty consultant radiologists and all radiology residents in Kenya. These are the clinical decision-makers in the radiology patient workflow and will, therefore, be impacted by the changes AI/ML will have in the practice of DR.

Sampling and recruitment

Total sampling technique, which is a type of non-probability sampling technique, was used.

Study tools

A web-based anonymous questionnaire created on questionpro was used (https://www.questionpro.com/a/editSurvey.do?surveyID=8100744). It was then distributed to the radiologists and residents via WhatsApp group. No identifying information was requested.

The questionnaire contained 18 questions. A total of 13 similar questions were asked to all the respondents. Seventeen questions were Multiple Choice Type, and one question was open-ended.

Data collection procedures

A web-based questionnaire was distributed via WhatsApp as a non-serialized link. Constant reminders were sent to the study subjects periodically. The study participation was closed after two months. Informed consent was sought at the beginning of the questionnaire form.

Data management and analysis

All the data collected was automatically entered into a spreadsheet, after which it was exported as an Excel document for analysis.

Data was analyzed using the SPSS version 26 software.

Categorical variables were calculated by the use of percentages and frequencies. Pearson's Chi-square test was used to compare categorical data. The Mann-Whitney U test was also utilized to compare groups. However, due to the similarity of findings from the Mann-Whitney U test and Chi-square test, only the chi-square test's findings were incorporated in the tables.

Study limitations

There were few previous studies on the topic of AI/ML in Kenya and Africa. This presented an opportunity for this study to be, to our best knowledge, one of the pioneers for research on this topic in Kenya and Africa.

Results

A total of 111 radiologists and radiology residents were recruited into the study. Of these, 57 were radiologists, while 54 were radiology residents.

Socio-demographic Characteristics

A presentation of the socio-demographic characteristics of the respondents is presented in Table 1.

Table 1
Socio-Demographic Characteristics of Radiologists and Radiologist Residents

Variable		Frequency	Percent (%)
Category of clinician	Consultant	57	51.4
	Registrar	54	48.6
	Total	111	100
Category of consultancy	General Radiologists	46	80.7
	Specialized Radiologists	11	19.3
	Total	57	100
Years of experience	Less than 2 Years	14	24.6
	3–5 Years	13	22.8
	6–10 Years	13	22.8
	11–15 Years	9	15.8
	Above 15 Years	8	14
	Total	57	100
Place of employment	Radiologist-County Hospital	18	31.6
	Radiologist-Public university/National Teaching and Referral Hospital	19	33.3
	Radiologist- Private University/Private Teaching Hospital	4	7
	Radiologist-Private Hospital /Private Practice	13	22.8
	Other	3	5.3
	Total	57	100
Year of study for resident/registrar	First Year	13	24.1
	Second Year	11	20.4
	Third Year	17	31.5
	Fourth	13	24.1
	Total	54	100
University studying in	Public University	48	88.9
	Private University	6	11.1

Variable		Frequency	Percent (%)
	Total	54	100
Gender	Male	45	40.5
	Female	66	59.5
	Total	111	100

A total of 111 individual responses were collected, representing a response rate of 55.7%) (111/199) for radiologists and radiology residents who are members of the KAR WhatsApp group. There were 43 men (40.5%) and 66 women (59.6%). Consultant radiologists represented 57 respondents (51.4% of the population) while radiology residents accounted for 54 respondents (48.6%). Of the consultant radiologists, 46 (80.7%) were general radiologists while the remaining were sub-specialized radiologists (11/57, 19.3%). A breakdown of the consultant radiologists in terms of years of experience revealed that the majority (70.2%, 40/57) had worked for 10 years and below, the remaining 29.2% (17/57) had worked for more than 10 years. Public hospital radiologists were the largest group to respond, 37 in total (64.9%), and private practice radiologists were the minority, with 20(35.1%). Senior radiology residents constituted the majority of residents (30/57, 55.6%), followed by junior residents at 24(44.4%). Nearly all the residents were from a public university (48/54, 88.9%), with only six residents from private universities (11.1%).

Familiarity With The Basic Ai Concepts And Terminologies

Knowledge of Radiologist and Radiology registrars on different aspects of AI was examined as presented in Table 2 and 3.

Table 2
Knowledge of Radiologists and Radiology Residents on Various AI Concepts

Variable		Frequency	Per cent
Read an article/watched/attended AI presentation	Yes	73	65.8
	No	38	34.2
	Total	111	100
Knowledgeable about Machine learning (ML) concept	Yes	49	44.1
	No	62	55.9
	Total	111	100
Knowledgeable about Artificial neural networks (ANN) concept	Yes	23	20.7
	No	88	79.3
	Total	111	100
Knowledgeable about Deep learning (DL) concept	Yes	24	21.6
	No	87	78.4
	Total	111	100

Almost three-quarters of the participants indicated to have read/watched/attended an AI presentation (n = 73, 65.8%). Nearly a half of the participants (n = 49, 44.1%) were knowledgeable on machine learning concept. Less than a fifth of the participants were knowledgeable about artificial neural networks (n = 23, 20.7%) and about Deep learning (n = 24, 21.6%).

Table 3
Knowledge on Basic AI Concepts Based on Category of Participants (Consultants vs Residents)

Variable			Category of clinician		Total	p-value
			Consultant	Resident		
Read an article or watched/attended a presentation on Artificial intelligence (AI)	Yes	N	40(70.2%)	33(61.1%)	73(65.8%)	0.314
	No	N	17(29.8%)	21(38.9%)	38(34.2%)	
	Total	N	57(100%)	54(100%)	111(100%)	
Knowledgeable about Machine learning (ML) concept	Yes	N	21(36.8%)	28(51.9%)	49(44.1%)	0.024
	No	N	36(63.2%)	26(48.1%)	62(55.9%)	
	Total	N	57(100%)	54(100%)	111(100%)	
Knowledgeable about Artificial neural networks (ANN) concept	Yes	N	7(12.3%)	16(29.6%)	23(20.7%)	0.111
	No	N	50(87.7%)	38(70.4%)	88(79.3%)	
	Total	N	57(100%)	54(100%)	111(100%)	
Knowledgeable about Deep learning (DL) concept	Yes	N	9(15.8%)	1(27.8%)5	24(21.6%)	0.125
	No	N	48(84.2%)	39(72.2%)	87(78.4%)	
	Total	N	57(100%)	54(100%)	111(100%)	

A majority of consultant radiologists (n = 50, 70.2%) and radiology residents (n = 33, 61.1%) had read an AI article/ watched a presentation/ attended a presentation on AI. A minority of consultant radiologists are knowledgeable about machine learning (n = 21, 36.8%) while majority of residents (n = 28, 51.9%, p = 0.024)) are knowledgeable about machine learning. Less than 30% of both consultant radiologists (n = 7, 12.3%; n = 9, 15.8%) and residents (n = 23, 20.7%; n = 24, 21.6%) were knowledgeable about Artificial neural networks (ANN) and Deep learning (DL) concepts respectively. Of significance was the realization that residents were still more knowledgeable than consultant radiologists in ANN and DL. In terms of p-values, only the variable 'knowledgeable about ML' was dependent on category of participants (p < 0.05).

Awareness On Existing Ai Applications In Radiology

Table 4
Awareness of Existing AI Applications in Radiology

Applications	N	Percent
Detection	68	37.40%
Segmentation	22	12.10%
Speech recognition	17	9.30%
Registration	25	13.70%
Workflow management	23	12.60%
Protocol optimization	19	10.40%
Others	8	4.40%
Total	**182**	**100.00%**
Mentions for Three Applications		
First Application	82	73.87%
Second Application	69	62.16%
Third Application	55	49.55%

Analysis of the responses revealed that only 183 responses, as opposed to 333, were realized from the study, as seen in Table 4, with 82, 69 and 55 responses for the first application, second application and third application, respectively. Findings of the multiple response questions revealed that AI application in detection was the most common response (n = 68, 37.4%). Other AI applications in radiology represented less than 20% of the total responses (Table 5) and include: segmentation (n = 22, 12.1%), speech recognition (n = 17, 9.3%), registration (n = 25, 13.7%), workflow management (n = 23, 12.6%), protocol optimization (n = 19, 10.4%) and others (n = 8, 4.4%).

Table 5: Potential Areas of AI Applications Based on Consultant Radiologists and Radiology Residents Views

| Artificial Intelligence Applications | | Category of clinician | | Total |
		Consultant	Resident	
Detection	N	38(66.7%)	33(61.1%)	71(63.9%)
Segmentation	N	12(21.1%)	13(24.1%)	25(22.5%)
Speech recognition	N	7(12.3%)	10(18.5%)	17(15.3%)
Registration	N	17(29.8%)	9(16.7%)	26(23.4%)
Workflow management	N	13(22.8%)	10(18.5%)	23(20.7%)
Protocol optimization	N	10(17.5%)	9(16.7%)	19(17.1)
Others	N	3(2.7%)	5(9.3%)	8(7.2%)
Total	N	57(51.4%)	54(48.6%)	111(100%)

Further analysis showed that for both consultant radiologist (n = 38, 66.7%) and resident (n = 33, 61.1%), AI application in detection had the highest mention. However, there were differences in the second and third highest mentions for consultant and residents in regards to AI application in radiology. The former mentioned registration (n = 17, 29.8%) and workflow management (n = 13, 22.8%) respectively while the latter mentioned segmentation (n = 13, 24.1%) and speech recognition (n = 10, 18.5%) and workflow management (n = 10, 18.5%).

Utilization Of Existing Ai Applications In Radiology

Table 6: Utilization of AI in Daily Work

AI/ML Utilization in daily work	Frequency	Per cent
	14	12.6
No	97	87.4
Total	111	100
Utilization based on Consultants Place of Work		
Radiologist County Hospital	2	22.2
Radiologist Public University/National Teaching and Referral Hospital	3	33.3
Radiologist Private Hospital	4	44.5
Total	9	100

A considerable majority of consultant radiologists and radiology residents had not used any AI/ML application in their work (n = 97, 87.4%), as seen in Table 6. This trend was also confirmed from cross-

tabulation based on the category of radiologists, as supported in Table 7. Of the consultants who answered in the affirmative, most of them (44.5%) were working in the private sector, with the remaining working in national teaching and referral hospital (33.3%) and county hospital (22.2%).

Table 7
Daily Work Utilization of AI-based on Consultant Radiologists and Radiology Residents Views

AI/ML application in daily work		Category of clinician		Total	p-value
		Consultant	Resident		
Yes	N	9(15.8%)	5(9.3%)	14(12.6%)	0.31
No	N	48(84.2%)	49(90.7%)	97(87.4%)	
Total	N	57(100%)	54(100%)	111(100%)	

Table 8
Perception and Attitude of AI in Radiology

Variable		Frequency	Per cent
AI/ML influence on Radiologist job in the next 10−20 years?	Have Little or No Influence	29	26.1
	Drastically Change My Job	76	68.5
	Make my Job Obsolete	6	5.4
	Total	111	100
General view of AI/ML applications in the field of radiology?	Good for My Work	17	15.3
	Bad for My Work	3	2.7
	Both Good and Bad for My Work	49	44.1
	Makes Radiology more Exciting for Me	38	34.2
	There is Nothing I Can Do About It	4	3.6
	Total	111	100

Approximately two-thirds of the participants felt that AI/ML would drastically change the job of radiologists (n = 76, 68.5%), while around a quarter of the participants were of the view that AI/ML will have little or no influence on the radiologists' job (Table 8). Only 6 participants (5.4%) considered AI/ML as a threat to making the radiologists' job obsolete. Nearly half of the participants felt that AI/ML

application has both positive and negative effect on radiology work (n = 49, 44.1%) while 17(15.3%) considered IA/ML as good for radiology work, and slightly more than a third of the participants view AI/ML as making radiology exciting (n = 38, 34.2%). Three participants (2.7%) considered AI/ML as bad for their work, while 4 participants (3.6%) felt helpless about the impact of AI/ML in radiology. Further analysis of perception and attitude towards AI according to consultant radiologists and radiology residents revealed similar results, with the majority of both consultants (n = 38, 66.7%) and residents (n = 38, 70.40%) believing that AI/ML will drastically change their job while most of the consultants (n = 23, 40.4%) and residents (n = 26, 48.1%) view AI applications as both good and bad for their work as outlined in Table 9 and Table 10. Perception and attitude of AI in Radiology according to the category of participants did not reveal any dependency (p = 0.485, 0.176).

Table 9
Perception and Attitude of AI in Radiology based on Category of Participant (Consultants vs Residents)

Variable			Category of clinician		Total	p-value
			Consultant	Resident		
AI/ML influence on Radiologist job in the next 10–20 years?	Have Little or No Influence	N	17(29.8%)	12(22.2%)	29(26.1%)	0.485
	Drastically Change My Job	N	38(66.7%)	38(70.40%)	76(68.5%)	
	Make my Job Obsolete	N	2(3.5%)	4(7.4%)	6(5.4%)	
	Total	N	57(100%)	54(100%)	111(100%)	
General view of AI/ML applications in the field of radiology?	Good for My Work	N	11(19.3%)	6(11.1%)	17(15.3%)	0.176
	Bad for My Work	N	2(3.5%)	1(1.9%)	3(2.7%)	
	Both Good and Bad for My Work	N	23(40.4%)	26(48.1%)	49(44.1%)	
	Makes Radiology more Exciting for Me	N	21(36.8%)	17(31.5%)	38(34.2%)	
	There is Nothing I Can Do About It	N	0(0%)	4(7.4%)	4(3.6%)	
	Total	N	57(100%)	54(100%)	111(100%)	

<p style="text-align:center">Table 10</p>
<p style="text-align:center">Perception of AI/ML on Career Prospects as Radiologists</p>

Potential of current knowledge of AI/ML applications on the practice of Radiology effects on the decision to pursue career as radiologist	Frequency	Percent
No	68	61.3
Yes	9	8.1
Maybe	34	30.6
Total	111	100

Around two-thirds of the participants felt that the current knowledge on AI applications does not affect their decision to pursue a career as a radiologist (n = 68, 61.3%) as opposed to 34 participants who felt that maybe their current knowledge on AI/ML would have affected their decision to pursue a career as a radiologist. Only 9 participants felt that their current knowledge of AI/ML application would have affected their decision to pursue a career as a radiologist.

<p style="text-align:center">Table 11</p>
<p style="text-align:center">Perception on willingness to contribute to the integration of AI application in Radiology Practice.</p>

Willingness to help make or train an ML algorithm so it can do some of the tasks that a radiologist does	Frequency	Per cent
Yes	75	67.6
No	36	32.4
Total	111	100

Results in Table 11indicates that slightly more than two-thirds of the participants indicated their willingness to help make or train an ML algorithm so that it can do some of the tasks that a radiologist does (n = 75, 67.6%).

<p style="text-align:center">Table 12</p>
<p style="text-align:center">Perception of AI/ML on Career Prospects as Radiologists based on Category of Participant (Consultants vs Residents)</p>

Potential of current knowledge of AI/ML applications on the decision to pursue a career as a radiologist		Category of clinician		Total	p-value
		Consultant	Resident		
No	N	39(68.4%)	29(53.7%)	68(61.3%)	0.278
Yes	N	4(7%)	5(9.3%)	9(8.1%)	
Maybe	N	14(24.6%)	20(37%)	34(30.6%)	
Total	N	57(100%)	54(100%)	111(100%)	

Less than 10% of radiologists (n = 4, 7%) and residents (n = 5, 9.3%) did not consider their current knowledge on AI as having the potential to change their career decision to pursue radiology (Table 12). Slightly more than a third of residents felt that their current knowledge of AI applications could alter their career decision (n = 20, 37%), while only 14 radiologists (24.6%) were of similar views. Potential of current knowledge of AI/ML applications on the decision to pursue a career as a radiologist was found to be independent of the category of radiologist (p = 0.287).

Table 13
Perception on willingness to contribute to the integration of AI application in Radiology Practice based on Category of Participants (Consultants vs Residents)

Willingness to help make or train an ML algorithm so it can do some of the tasks that a radiologist does		Consultant	Resident		
Yes	N	41(71.9%)	34(63%)	75(67.65)	0.313
No	N	16(28.1%)	20(37%)	36(32.4%)	
Total	N	57(100%)	54(100%)	111(100%)	

Further analysis on knowledge seeking behaviour on current information revealed that the majority of consultant radiologists (n = 41, 71%) and radiology residents (n = 34, 63%) were willing to help make or train an ML algorithm so it can do some of the tasks that a radiologist does as shown in Table 13. Perception on willingness to contribute to the integration of AI application in Radiology Practice was shown to be independent of the category of radiologist (p = 0.313).

Knowledge Seeking Behavior On Ai
Table 14
Knowledge-Seeking Behavior on AI Current Information

Last time you read a scientific article on the topic of AI/ML in radiology	Frequency	Per cent
Never Read One	40	36
Less than 6 Months ago	34	30.6
6 to 12 Months Ago	22	19.8
More than 1 Year Ago	15	13.5
Total	111	100

Results in Table 14 on the readership of scientific article showed that forty participants (36%) have never read an article on AI/ML while around a third of the participants (n = 34, 30.6%) have read an article less than six months ago. Twenty-two participants (19.8%) were found to have read an AI article 6–12 months ago as opposed to the remaining 15 participants (13.5%) that read an article more than a year ago.

Table 15
Knowledge-Seeking Behavior on AI Current Information according to Different Cadre of Radiologist

Last time you read a scientific article on the topic of AI/ML in radiology		Category of clinician		Total	p-value
		Consultant	Resident		
Never Read One	N	12(21.1%)	28(51.9%)	40(36%)	0.003
Less than Months ago	N	24(42.1%)	10(18.5%)	34(30.6%)	
6 to 12 Months Ago	N	14(24.6%)	8(14.8%)	22(19.8%)	
More than 1 Year Ago	N	7(12.3%)	8(7.2%)	1(13.5%)5	
Total	N	57(100%)	54(100%)	111(100%)	

On readership of AI scientific article, majority of radiology residents (n = 28, 51.9%) had never read an article on AI/ML, which demonstrates that only 48.1% of residents have read an AI/ML article, as shown in Table 15 above. The majority of consultant radiologists (n = 45, 78.9%) have read a scientific article on AI. Both consultant radiologists (n = 39, 68.4%) and residents (n = 28, 51.9%) felt that their current knowledge of AI applications does not affect their decision to pursue a career as a radiologist. Readership of an article on AI in radiology was demonstrated to be dependent on the category of radiologist (p = 0.003).

Discussion

This is a discussion on the knowledge, attitude and practice (KAP) of consultant radiologists and radiology residents on the role of AI/ML in radiology. Radiology practice is largely dominated by general radiologists, contrary to western countries. This is attributed to the nascent stage of radiology practice in African countries as compared to developed countries (15). The workplace setting for the majority of radiologists is in the public sector, also confirmed in a Nigerian study (16). A considerable majority of consultant radiologists had been practising for more than five years. Similar findings were reported in a study conducted among African radiographers(13). Radiology residents largely study in public universities, also reported in a Nigeria study on Radiology residents (17).

The main finding of this study was that majority of participants knew about AI but did not have in-depth knowledge of AI concepts. This was evident by the fact that most of the respondents did not understand the concepts and terminologies used in AI. This suggests that AI has not has been given the attention it

deserves amongst consultant radiologist and residents. The result of limited knowledge of AI is consistent with findings from a related study conducted in Ghana (13). Surprisingly, the findings showed that only the majority of residents were knowledgeable on the machine learning concept. This could be linked to interest amongst residents because they feel that AI applications are going to play a significant role in their future profession (36). Limited knowledge on all the AI concepts tested amongst consultant radiologists could be attributed to low prioritization of the need to acquire theoretical knowledge about AI due to high workload (15) as well as due to limited supportive infrastructure in their stations of work (32).

Different Applications of AI in radiology were reported, with the application on detection attracting the highest number of responses. This aligns with the results reported in previous findings(18, 19), where the use of AI in detection was ranked the first for AI applications in Radiology. This is informed by the need to have effective detection systems with high sensitivity and specificity (20). Surprisingly in terms of other AI applications utilization in radiology, little difference was observed. The only difference was in the application of AI in registration as reported more by consultants as opposed to registrars. This is attributed to the reason that the preprocessing step of registration may involve complex tissue deformations that may prove challenging in daily work experience (19).

The utilization of AI applications in radiology in the participants' daily work is still low. The low usage of AI applications in radiologists' daily practice proves that we are still at the dawn of AI (21). This also shows that the local radiology environment is still not friendly for AI applications use like in western countries (16), whereby the workforce fails to see a possible role. Many health institutions in low-income countries such as Kenya lack the necessary physical and digital infrastructures such as advanced imaging equipment, reliable internet connection and PACS in their health care systems, and hence low adoption of AI-based applications in radiology.

This survey reported that participants largely consider AI applications as holding potential on radiology practice but do not view it as a threat to their job. Previous surveys (22, 23) have also shown that AI has the potential to change the radiologist's daily workload, though whether such changes will entail more focused or less focused radiologists' role is still a subject of debate (3). The general picture that emerged from the findings is that consultant radiologists and radiology residents viewed AI/ML as most likely to change their work. This indicates optimism about the future of AI in radiology, with less effect on radiologist's satisfaction. Most of the consultant radiologists and radiology residents felt that AI applications in the field of radiology are both good and bad. This could imply that the current knowledge about the potential effect of radiology at both theoretical and practical level is speculative. A good proportion of consultant radiologists and residents also consider AI application as making radiology more exciting. This situation could be related to the expectation that AI application will revolutionize the radiology profession by freeing radiologists from tedious or difficult tasks (such as segmentation and quantification), focusing more on cognitive tasks for improved quality in the radiology practise (13, 15, 19).

The sentiments of consultant radiologists and radiology residents on their career prospects were largely optimistic. The findings revealed that the majority of the participants could not change their decision to pursue a career as a radiologist because of their current knowledge of AI/ML applications in the practice of Radiology. This suggests that to the consultants and residents, AI does not have a negative influence on their decision about radiology as a career. This contradicts the findings by Dahmash et al. (24) that showed that AI has a negative influence on the decisions of medical students to pursue careers as radiologists. A major reason for this difference could be because consultant radiologists and residents in the current study view AI applications in radiology as a friend and not a foe as far as their careers are concerned. This also aligns with previous studies that have documented that radiologists and registrars do not consider AI applications as a threat to their profession(10, 25–27).

Positive and favourable perception was revealed by the majority of participants in regard to their willingness to contribute to the integration of AI applications in the radiology practice. This possibly indicates the readiness amongst the consultants and residents to embrace AI applications in their practice. This supports the results by Abuzaid et al. (28) that demonstrated the willingness of most radiologists to contribute to the integration of AI into their radiology practice.

Slightly over a third of the participants had never read a scientific article on the topic of AI/ML in radiology, with the majority of these participants being residents. This implies that a good proportion of radiologists have a vague understanding of AI. This situation could be linked to the low exposure to recent scientific articles about this subject since only a few articles have been published in major radiology journals (23). Another possible reason that may account for the lack of readership amongst registrars is the absence of AI-related units in the current residency programs curricula. Interestingly, most of the consultant radiologists had read an AI article on radiology over the past month. A possible explanation for this may be due to motivation to learn new applications/technologies linked to their daily radiology practice (26).

The findings demonstrated that most of the participants felt that AI/ML applications have both positive and negative effect on radiology work as opposed to a third of participants that viewed AI as having the potential to make radiology work more exciting. This highlights that most radiologists and residents still see AI applications as having strengths and opportunities for the radiology practice, as well as weakness and threats for the practice. This point may have been inferred in the fact that very few participants considered AI/ML as both good or bad for radiology work in the study. This is in support of other studies that have shown that AI application in interventional radiology is a strength as well as an opportunity, while on the other hand, the promise of AI-augmented radiology could end up pushing radiologists further from practice (26, 29–31). However, given that those who viewed AI as good for radiology and likely to make radiology exciting constituted nearly half (49.5%), it can be argued that most of the radiologists and radiology residents are inclined to view AI applications in DR favourably as a strength and opportunity. This is in agreement with the study by the European Society of Radiology (ESR) that showed that radiologists believe that AI applications are more of a strength and opportunity to their practice (32).

Conclusion

Aside from the majority who are knowledgeable about AI, only very few have sufficient in-depth knowledge about AI and its related concepts. AI algorithms in radiology have various applications in the clinical radiology workflow, wherein detection role is considered as one of the major application. The utilization of AI applications in Radiology is still very low.

Consultant radiologists and radiology residents in Kenya possess a favourable attitude towards the adoption of AI in the radiology practice. Most radiologists believe that their working activity will benefit from AI, as shown by their willingness to train AI/ML algorithms to undertake some radiology tasks. Hence it can be concluded that consultant radiologists and radiology residents have an open attitude towards AI applications.

Consultant radiologists are more proactive in seeking information on AI-related concepts than the residents, as evidenced by their readership habits on AI articles. Fear of replacement and career doubt because of the potential ramifications of AI applications on the radiology practice is generally low amongst consultant radiologists and radiology residents.

Recommendation

The study recommends that the subject of informatics with emphasis on AI/ML applications in DR should be incorporated in the radiology residency curriculum. Continuous medical education of radiologists on AI and its applications should also be carried out on a regular basis. The study also recommends that sensitization of radiologists and residents should put an emphasis on the proven benefits of AI applications and their potential to impact the radiology practice positively. Based on the acceptance that AI will drastically change radiology work practice, the study recommends that AI applications be introduced quite gently in ways that minimize the creation of risks to workflow speed.

Declarations

Ethics approval and consent to participate

The study approval was obtained from the Kenyatta National Hospital and University of Nairobi ethical and research committee (KNH-UoN ERC) with approval number- P474/09/2020.

All methods were carried out in accordance with relevant guidelines and regulations

Informed consent was obtained from the patients at the beginning of the study.

Consent for publication

Not applicable

Availability of data and materials

The data sets analyzed during this study are available from the corresponding author on reasonable request

Competing interests

There are no competing interests to declare

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Authors' contributions

E.K.M and C.K.O wrote the main manuscript. E.K.M carried out the study. C.K.O and J.C.R appraised the manuscript for critical content. All authors reviewed the manuscript.

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