JOURNAL OF BIOMEDICAL INVESTIGATION (JBI) VOLUME 12 NUMBER 3: DECEMBER 2024

ORIGINAL RESEARCH

KNOWLEDGE OF ARTIFICIAL INTELLIGENCE IN CLINICAL RADIOGRAPHY PRACTICE AMONG RADIOGRAPHERS IN SELECTED CITIES IN NIGERIA

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Received: 16/12/2024; accepted for publication 1/3/2025

ABSTRACT

Introduction: Artificial intelligence (AI) has found wide application in diagnostic radiology but the concepts and applications of AI in radiography practice is yet to be fully understood among Nigerian radiographers.

Aim: The main objective of the study was to access the knowledge of artificial intelligence in clinical radiography practice among radiographers in selected cities in Nigeria.

Methods: This cross-sectional prospective research survey was carried out using a questionnaire. A stratified convenience sample of 118 out of 168 radiographers aged 18-76 years in three Nigerian cities participated in the study between February 2021 and September 2023. This sampling method was used because of the poor attitude of radiographers towards research. The items in the questionnaire were reviewed by experts, tested for reliability and validity before being uploaded to online radiography social media platforms using

Google forms. Descriptive and inferential statistics were used for data analysis at <0.05 level of significance.

RESULTS: 73 (61.9%) of radiographers had basic knowledge of AI while 89 (75.4%) radiographers will support the deployment of AI in health facilities in Nigeria. Regression analysis showed that basic knowledge of AI is associated with support for AI, efforts at personnel development towards AI, professional status and fear of job losses. However, support for AI deployment was the only independent predictor of 'having knowledge of AI' in the population (R^2 = 0.092). There is a positive relationship between having knowledge of AI and support for the deployment of AI.

CONCLUSION: There was a general basic positive knowledge of AI among Nigerian Radiographers but this was limited by fear of job losses. There was a positive relationship between knowledge of AI and support for its deployment, with a need to create more awareness and incorporate AI in the training curriculum of radiography students.

Keywords: Nigerian radiographers, support, artificial intelligence, knowledge.

INTRODUCTION

Artificial intelligence refers to the manifestation of the greatest type of human behaviour in the execution of tasks, especially with the use of machines. The race for AI started long ago in the 1940s further to the development of foremost digital computers. The idea of the scientists then was to develop computer systems that can mimic the thinking and other characteristics of human beings to perform tasks especially difficult ones faster and more efficiently than human beings [1]. To be able to do this, the machines were designed and equipped with various components of human intelligence such as learning, reasoning, solving problems, handling tasks, mastery of languages, perceptions, and thoughts[2]. It also refers to the use of a device or robots usually controlled by a computer. These devices are designed in such a way that they are equipped with programmes that contain the traits and characteristics of human intelligence, thus making them act like superhuman beings. These systems make use of long parallel computers and utilize deep learning platforms, data analytics, and neural networks similar to the neurons of the brain in the collection of data, analysis of data, as well as making decisions[3]. They are applied in industry to optimize operations such as in gas turbines to optimize the emission of toxic substances, and in wind parks to fully optimize changing wind directions effectively to produce energy[4]. They also perform difficult tasks like targeted shootings, analysis of data, and radiographic image interpretation in radiological investigations.

Adoption of new technologies in medicine is known to be slow such that medicine lags behind technological advancements in most countries[5]. Despite this limitation, AI is an

important tool in medicine and radiography being used to make diagnosis (especially by radiologists), make important clinical decisions, and assist radiographers in manipulating radiographic technique, protocol selection as well as in interventional procedures[1] but the knowledge and support of radiographers toward full deployment of AI has not been fully documented in Nigeria.

Artificial intelligence is not a new invention or terminology but an outcome of years of improvements in the use of computers in solving human-related tasks. It has found great applications in the industry based on the understanding that deep learning algorithms of AI computer systems will be able to operate at the same level as human beings[6]. Machine learning systems and algorithms can be applied and adopted in medical imaging to recognize normal from abnormal objects or image details[7,8]. These systems can further be adopted in radiology for disease detection, lesion segmentation, and classification, volumetric assessment functions, bone age assessment, and image-based outcome predictions[9,10,11,12]. However, issues relating to the requirement for large data storage, and the confidentiality of patient data, in AI systems, using DICOM images were of great concerns among other factors. Recent reports indicate that patient identity details can be protected in AI systems with very expensive and labour-intensive curative imaging processing procedures[6]. Despite its limitations, AI systems have been projected to help radiologists prioritize their worklists by carefully identifying suspicious positive cases that require urgent reviews. It has also helped radiologists to extract certain specific information and details from radiographic images which ordinarily will not be discernible by the human eye. This increases diagnostic accuracy and prognostic outcomes[1]. It also reduces variabilities in image interpretations among radiologists, as well as reduces radiologist's workload[13]. AI has also found several applications in digital x-ray imaging, computed tomography imaging, magnetic resonance imaging and ultrasonography and are not likely to displace radiographers or radiologists who use them but will negatively affect those who do not use them[14]. Therefore, radiographers are to initiate high-quality radiographic examinations and produce images of excellent diagnostic quality in the shortest possible time using AI-specific moderated protocols. What is required is for radiographers to acquire requisite knowledge and work hard with industry experts to innovate radiography friendly AI systems. This will help to develop profession-specific algorithms and deep learning platforms to reduce patient waiting times, and improve patient turnaround times without compromising overall image quality. This will invariably come at a cheap cost and less radiation dose to the patient.

Despite the widespread applications of AI in medical imaging, many radiographers do not fully understand AI principles and how it can be applied in practice[15]. Earlier studies indicate that radiographers are willing to accept and support AI in radiography practices but are worried that the clinical roles of radiographers and radiologists will

be taken over by AI[16,17]. The reason for the worries over job stability with AI among many radiographers has been attributed to lack of knowledge and understanding of the applications of AI concepts into radiographic examinations[15]. National and international radiography groups such as the International Society of Radiographers and Radiologic Technologists and the European Federation of Radiographer Societies have advocated on the need for radiographers to have good knowledge of the concept of AI through training and education to maximize its benefits for the welfare of their patients[18]. To achieve these, radiographers especially those in Nigeria must have adequate knowledge of AI which is still lacking among radiographers in Africa[19]. As a result, this study aimed to answer the following research questions;

1. Do radiographers in selected cities in Nigeria have good knowledge of AI?
2. How does support for AI deployment, making personal efforts toward AI development, professional status and fear of job losses due to AI affect radiographer's knowledge of AI?

Limited literature exists on the knowledge of radiographers on AI and the few available pieces of literature were narrowed in scope to African radiographers and medical personnel especially radiologists, and none focused recently on the knowledge base of Nigerian radiographers on the concept of AI which necessitated this study [5,20,21,22]. This study therefore aimed to assess the knowledge of artificial intelligence in clinical radiography practice among radiographers in selected cities in Nigeria. The result of this study will create awareness on the knowledge of radiographers on artificial intelligence in clinical radiography practice. It will also help stakeholders in the radiography profession to design strategic policies that will deepen AI knowledge and its integration into radiography practice in Nigeria.

MATERIALS AND METHODS

The study adopted a cross-sectional prospective research survey using questionnaires. The structured questionnaire was divided into two sections- A and B. The items in section A were used to collect the participants' socio-demographic data while section B of the questionnaire evaluated the perception of radiographers on the deployment of AI in radiography practice. The items in the questionnaire were reviewed by a panel of experts for reproducibility and validity of measurements. Items were included if they met the scale content validity index (S-CVI) score of 0.72[23]. Using the S -CVI of 0.72, a total of 4 and 13 questions were included in sections A and B of the questionnaire, respectively. The questionnaire thereafter returned an average reliability coefficient of 0.70 using the Cronbach alpha and Kuder Richardson (KR) – 20 tests[24]. A pilot study was done with 10 radiographers and intern radiographers to remove ambiguity. Three cities in Nigeria were selected for this study by stratified sampling between February 2021 and September 2023. The cities that

participated in this study were Maiduguri metropolis, Borno State, Lagos Mainland, Lagos State, and Nnewi, Anambra State, Nigeria to represent the Northern, western and eastern Nigeria respectively. The population of radiographers included all practicing radiographers in the selected cities. The population of radiographers in each stratum was obtained from the local branch of the Association of Radiographers of Nigeria in each state. The number of radiographers (sample) in each stratum was determined by the method described by Chaudhuri and Dutta[25] for calculation of the sample size of finite populations. Using this method, a sample of 118 radiographers from all strata was obtained from the total population of 168 radiographers. Radiographers who met the inclusion criteria and who consented to participate in the study were enlisted for the study by convenience sampling. This sampling technique was used because of the poor attitude of radiographers towards research. Therefore, convenience sampling became the most practical and cost-effective method to recruit participants from diverse geographic locations into the study based on their willingness to participate in the study[7]. The researcher diversified the locations of the samples and also combined convenience sampling with stratified sampling to reduce bias[3]. This has also been captured as forming part of the limitations of this study. However, this sampling method is commonly used in online based studies just like the present study where it is usually used to easily pool participants from different locations at the shortest possible time[8]. The questionnaire was designed using Google format and uploaded to various radiographers' platforms using social media and distributed to radiographers social media platforms in the northern, western and eastern regions of Nigeria to introduce diversification and obtain an appropriate cross section of the population. Descriptive and inferential statistics were used for the analysis of the questionnaires at <0.05 level of significance using the statistical package for social sciences (SPSS) version 23.

RESULTS

The majority 47 (39.8%) of the respondents were between the ages of 18-29 years while a few of the respondents were aged more than 65 years of age (Table 1). Table 2 shows that 45 (38.1%) of the participants in this study were clinical radiographers followed by 43 (36.4%) who were intern radiographers.

The participants are aged between 18years and above 65years. Majority of the participants are between the age group of 18-29 years, followed by 54-65years and above 65years age groups. 73 (61.9%), 89(75.4%) of the respondents have basic knowledge of AI and will support the deployment of AI but 80(67.8%) were not pursuing personal development efforts towards AI. 63(61.9%) of the radiographers especially intern and clinical radiographers were afraid that incorporating AI in clinical radiography practice will take away their jobs. This is shown in Table 3.

Clinical radiographers 31(68%) have basic knowledge of AI compared to other categories of radiographers and 34(75.6%) of the clinical radiographers will support the deployment of AI in hospitals but the majority of clinical radiographers 30(66.7%) were not making personal efforts toward personal development in the area of AI. Fear of job losses due to the deployment of AI is common among radiography students 32(74.4%**).** See table 4.

Table 1: AGE DISTRIBUTION OF RESPONDENTS

Age	Frequency (n)	%
18-29	47	39.8
30-41	12	10.2
42-53	16	13.6
54-65	24	20.3
65-76	19	16.1
Total	118	100

Table 2: CATEGORY OF RADIOGRAPHERS

PROFESSIONAL STATUS	Frequency (n)	%
Intern Radiographers	43	36.4
Lecturers	30	25.4
Clinical radiographers	45	+38.1
Total	118	99.9

Table 3: KNOWLEDGE AND ATTITUDE OF RADIOGRAPHERS TOWARDS AI

PARAMETERS	STRONGLY AGREE n(%)	AGREE n(%)	UNDECIDED n(%)	DISAGREE n(%)	STRONGLY DISAGREE- n(%)
knowledge of AI	32(27.1)	41(34.7)	29(24.6)	13(11.0)	3(2.5)
support for deployment of AI	45(38.1)	44(37.3)	17(14.4)	7(5.9)	5(4.2)
No personal efforts towards AI	37(31.4)	43(36.4)	26(22.0)	7(5.9)	5(4.2)
AI will take away my job	34 (28.8)	29(33.1)	22(18.6)	13(11.0)	20(16.9)

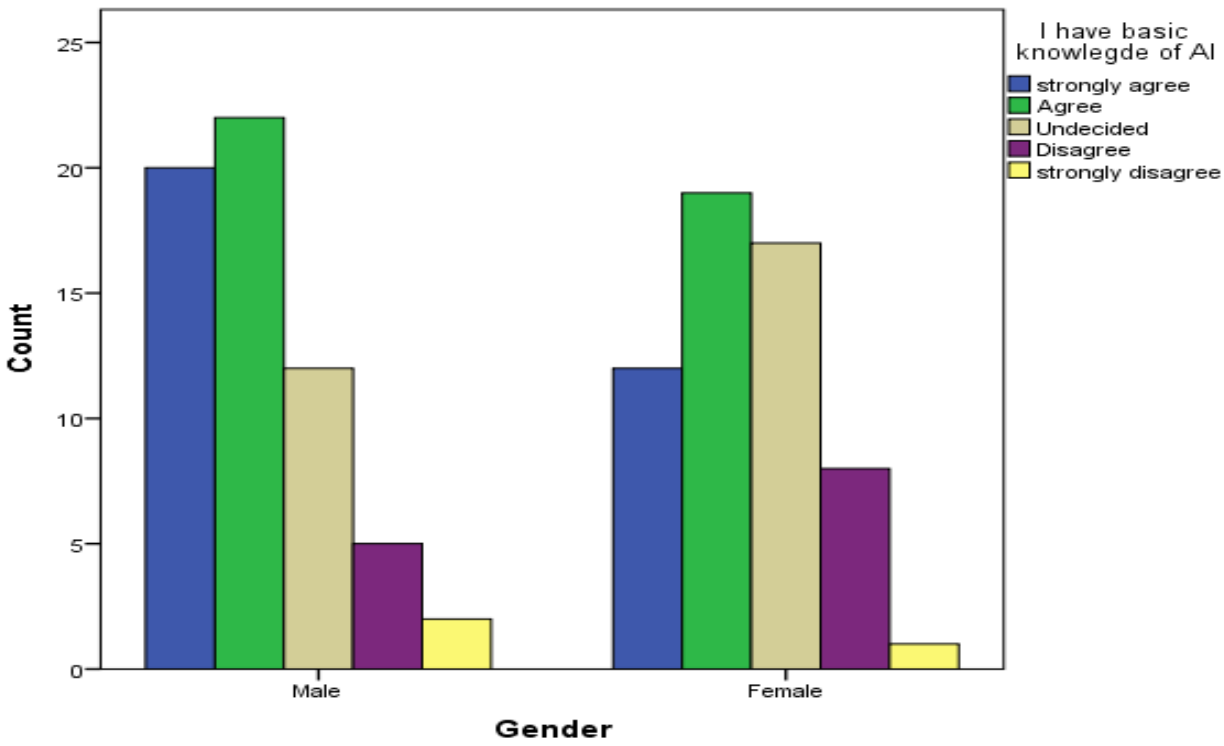

Figure 2: Knowledge of AI by gender

Male radiographers agreed and strongly agreed that they have more knowledge of AI than female respondents.

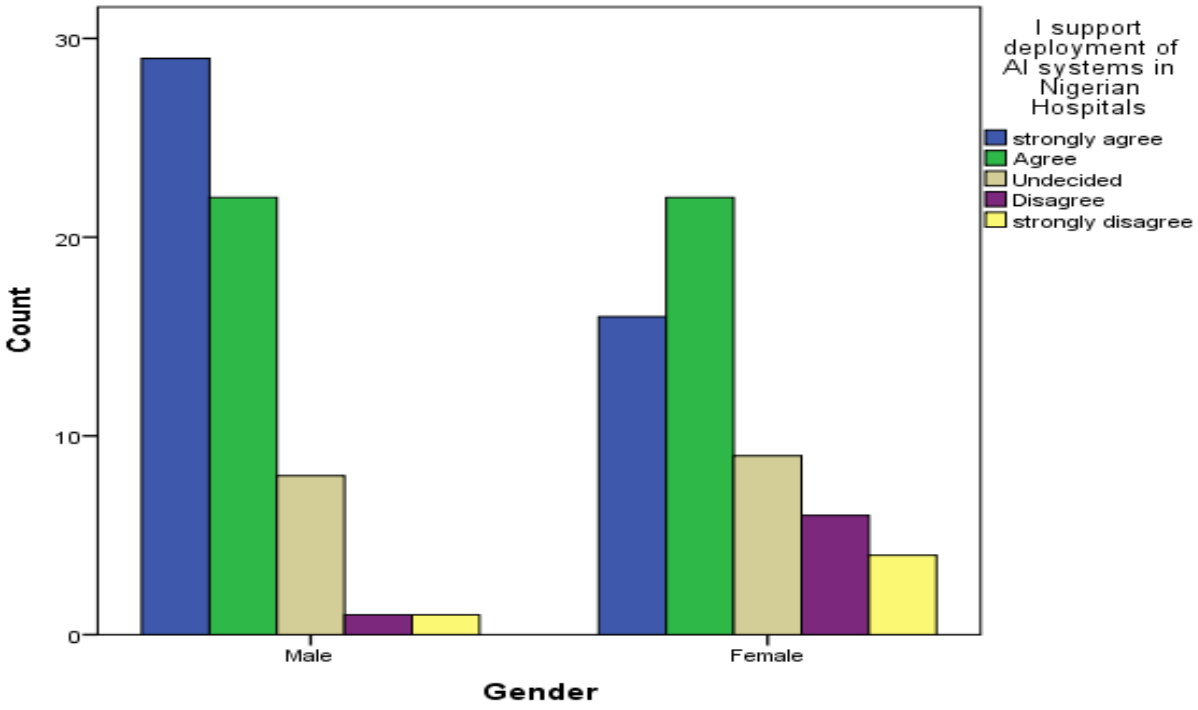

Figure 3: Gender support for AI

Male radiographers will support the deployment of AI in Nigerian Hospitals than female respondents.

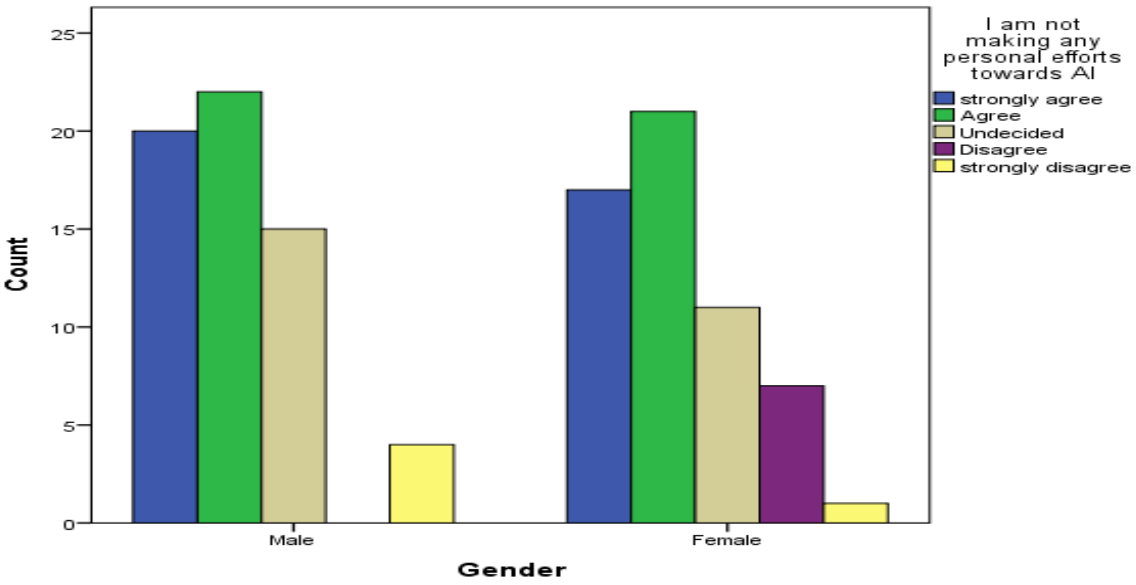

Figure 4: Gender distribution of Personal development efforts toward AI

Male radiographers were making more personal efforts toward developing themselves in the area of AI

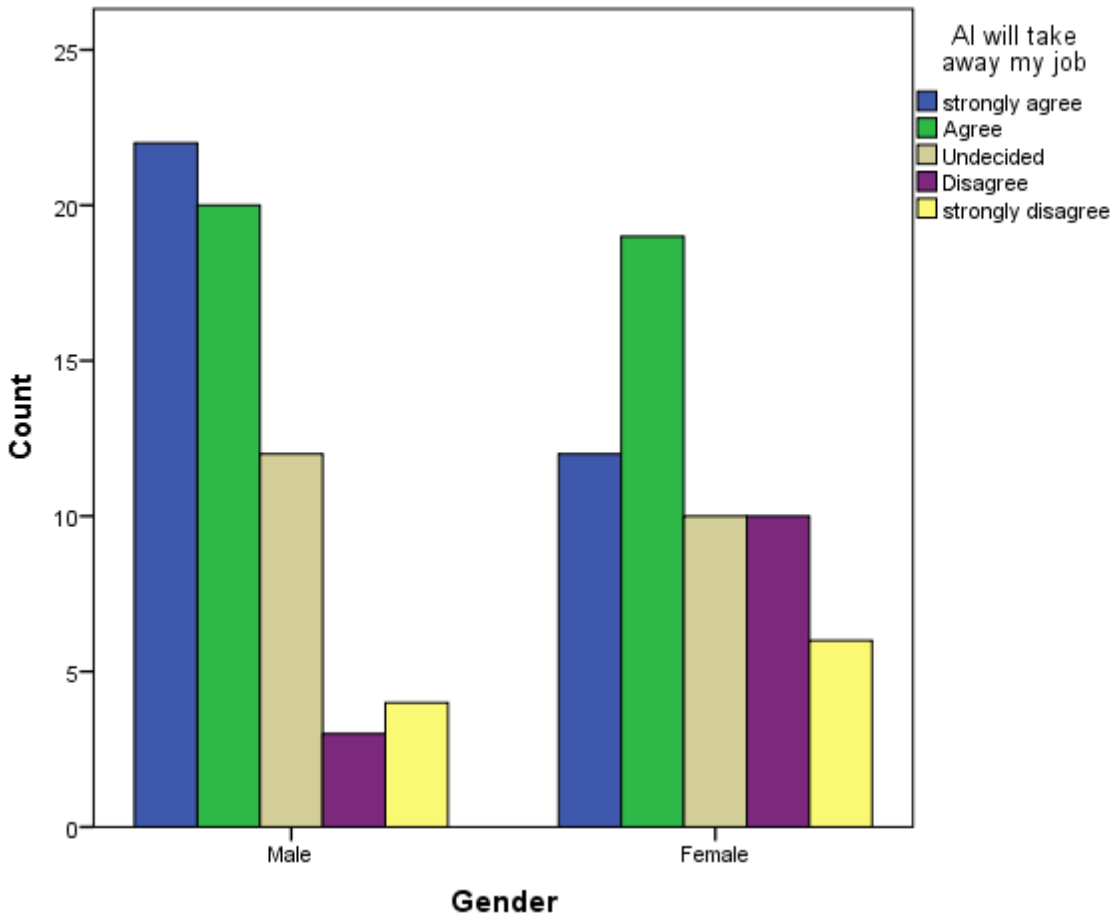

Figure 5: Gender and job security

Male radiographers feared that AI will take away their jobs than female radiographers

Table 4: Perception of AI among different groups of radiographers

Parameters	Category of radiographers	Strongly agree n(%)	Agree n(%)	Undecided n(%)	Disagree n(%)	Strongly disagree n(%)	TOTAL
Basic knowledge of AI	Intern radiographers	11(25.5)	15(34.9)	11(25.6)	4(9.3)	2(4.7)	43(100)
	lecturers	8(26.7)	8(26.7)	9(30.0)	4(13.3)	1(3.3)	30(100)
	Clinical radiographers	13(28.9)	18(40.0)	9(20.0)	5(11.1)	0(0.0)	45(100)
Support for AI	Intern radiographers	13(30.2)	20(46.5)	6(14.0)	2(4.7%)	2(4.7)	43(100)
	lecturers	11(36.7)	11(36.7)	2(6.7)	4(13.3)	2(6.7)	30(100)
	Clinical radiographers	21(46.7)	13(28.9)	9(20.0)	1(2.2)	1(2.2)	45(100)
No personal development in AI	Intern radiographers	12(27.9)	16(37.2)	12(27.9)	2(4.7)	1(2.3)	43(100)
	lecturers	11(36.7)	11(36.7)	3(10.0)	3(10.0)	2(6.7)	30(100)
	Clinical radiographers	14(31.1)	16(35.6)	11(24.4)	2(2.4)	2(2.4)	45(100)
AI will lead to job losses	Intern radiographers	19(44.2)	13(30.2)	5(11.6)	3(7.0)	3(7.0)	43(100)
	Lecturers	6(20.0)	7(23.3)	9(30.0)	4(13.3)	4(13.3)	30(100)
	Clinical radiographers	9(20.0)	19(42.2)	8(17.8)	6(13.3)	3(6.7)	45(100)

Table 5: Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constant)	1.474	.360		4.092	.000
	I support deployment of AI systems in Nigerian Hospitals	.314	.093	.319	3.386	.001
	AI will take away my job	.071	.075	.083	.943	.348
	I am not making any personal efforts toward AI	.070	.093	.070	.752	.454
	Professional status	-.076	.109	-.062	-.698	.486

a. Dependent Variable: I have basic knowledge of AI

Support for the deployment of AI is the only independent predictor of knowledge of AI

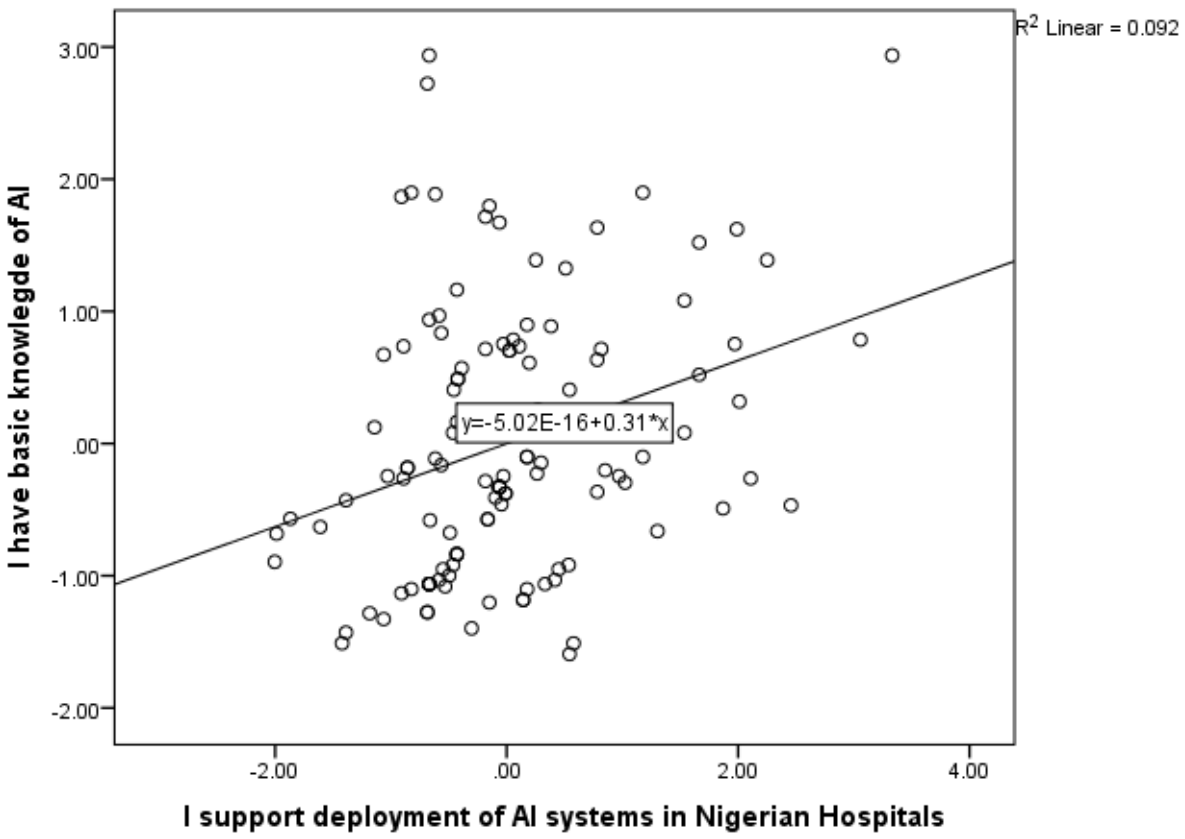

Figure 6: Regression plot of knowledge of AI and support for AI

The relationship between radiographers knowledge of AI and support for AI in selected Nigerian institutions

DISCUSSION

Current advances in healthcare delivery systems and increasing computerization of radiography imaging globally necessitated the concept of AI in radiography practice in Nigeria. Various bodies saddled with imaging practice in the United States of America, Canada, and India have gone far at incorporating AI into their practice [26,27,28].

Majority of the respondents were intern radiographers between the ages of 18-29 years. Radiographers working either as interns or in clinical practice between the ages of 18-29 years constituted the bulk of the respondents in this study. There were more clinical radiographers in the study group compared to other categories of radiographers. This is expected because the clinical radiographers constitute the bulk of radiographers that will be saddled with the use and operation of AI when it is fully deployed into clinical practice. Intern radiographers in training constituted the second-largest (36.4%) of the population studied which is comparable to 31% reported in a related study among radiology residents in training[5]. The earlier study focused mainly on the perception of radiologists and residents in training on the deployment of AI in clinical radiological practice[5] only but we have expanded the scope to accommodate intern radiographers in training, clinical radiographers as well as radiography lecturers who are academics to provide a more robust study.

Clinical radiographers and intern radiographers have more basic knowledge of AI in this study. Males have better knowledge of AI compared to their female counterparts which have been reported in similar studies among radiologists and residents[5]. The clinical radiographers must have developed this basic knowledge over time due to exposure and interaction with biomedical engineers as well as their experiences over many years of practice. To the interns, this may be attributed to their quest for new knowledge and a better way of reducing their workload because most of the radiography examinations in public and private health facilities were mostly performed by intern radiographers under the supervision of their superiors. They would therefore need assistance in the form of AI to help perform their duties, especially in radio-diagnostic centres where there is minimal supervision.

Majority of the radiographers agreed that they have good knowledge of AI and will support its deployments in hospitals while few radiographers were either not making efforts towards AI or felt that AI will take over their jobs. Radiographers involved in clinical practice either as clinical radiographers or internee radiographers provided greater support to the deployment of AI, unlike radiographers who were not fully involved in clinical practice. Fear for loss of job due to the deployment of AI was less among lectures and clinical radiographers above 55years of age compared to interns and clinical radiographers less than 55 years of age. Fifty-four percent of the respondents feared that AI will take over their jobs and this was common in both gender but male radiographers were slightly more apprehensive than the female radiographers. The fear of job insecurity (44%% and 30.2%) was common among intern radiographers probably because their training curriculum is yet to fully incorporate AI. In related studies fear for job security following the deployment of AI were similar to the findings of this study and constituted 42% and 39% respectively [5,22]. This shows that the fear of job losses due to

AI is real among Radiographers irrespective of geographic locations and may the reason behind the slow pace of full deployment of AI in radiology departments in many countries including Nigeria.

This could be attributed to the fact that most of the clinical radiographers were part of the management of their respective health facilities and were aware that the health facility has no immediate plan to deploy AI. Again, the intern radiographers did not pay much attention to vigorously pursuing personnel development in AI because AI has not been fully incorporated into their training curriculum. Also, the intern radiographers may be following the examples of their senior clinical radiographer colleagues. This is contrary to the findings of a related study which opined that radiologists and residents (under training) were more proactive in career development in AI[5.] The differences between the present study and the later study were attributed to environmental factors and differences in the populations studied.

There is a positive relationship between having knowledge of AI and support for AI deployment. The regression plot shows that when radiographers have good knowledge of the role of AI in radiographic practice, they are more likely to support the deployment of AI in clinical practice. Regression analysis showed that basic knowledge of AI is associated with support for the incorporation of AI in clinical radiography practice, fewer efforts at personnel development, professional status and fear of job losses. However, support for AI deployment was on the only independent predictor of 'having knowledge of AI' in the population. 92% of the variations in the observed variations in the knowledge of AI among the radiographers was explained by the support for AI deployment. This means that those who support the deployment of AI will definitely have a good knowledge of AI thereby showing a positive association between having knowledge of AI and support for AI. This shows a more general positive attitude toward the deployment of AI in radiography practice among radiographers in the population studied and is similar to the findings of similar studies in Europe[5,12] and Africa[20]. As a result, more education and awareness on the benefits of AI are needed for all categories of radiographers in Nigeria. Incorporating AI into the training curriculum for radiography students will be a step in the right direction to deepen their knowledge of AI applications in radiography and alleviate the fears of young radiographers about the deployment of AI.

A low response rate (11.17%) was the major limitation of this study which necessitated the use of convenience sampling method in this study which might have introduced a selection bias that is usually associated with questionnaire-based research work[29]. This has been mitigated by combining convenience sampling with other sampling methods such as stratified sampling and the diversification of sample selection[3]. However, there was obtained a better than the response rates of 3.9% compared to response rate of 2.8% reported in related studies respectively[5,22].

CONCLUSION

There is a general basic positive knowledge of AI among Nigerian radiographers in the selected cities, especially among clinical and intern radiographers but this is limited by fear of job losses mostly among male radiographers. There is a need to create more awareness of AI in radiography practice and incorporate AI into the training curriculum of radiography students to stimulate interest in AI.

Funding: No external funding was received for this study

Consent for publication: All the respondents provided written informed consent to publish the data contained in this study.

Disclosure of conflict of interests: All the authors declare that they have no competing interests.

Availability of data and materials: The datasets as well as the analysis used for this study are freely available on request.

Abbreviations: AI: Artificial intelligence; S-CVI: Scale content validity index

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