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Original Research Article

Evaluation of existing knowledge, perceptions and practices of diagnostic imaging among non-radiologist physicians in Makurdi, North-Central Nigeria

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ABSTRACT

Background: Despite the restricted diagnostic imaging knowledge, perceptions, and practices of non-radiologist physicians, the significance of radiology in establishing and verifying diagnoses in medicine is expanding globally. We aimed to evaluate existing diagnostic imaging knowledge, perceptions, and practices among referring non-radiologist physicians, identify aspects that are beneficial but substantially inconsistent, and determine those that can be improved.
Methods: A 3-month cross-sectional study, utilizing structured questionnaire, was responded to by physicians at Benue State University Teaching Hospital (BSUTH), Makurdi. Descriptive statistics were used for the statistical analysis and results presented as tables and figures. Statistical significance was determined at p=0.05.
Results: We recruited 137 physicians, aged 26 to 52 years, consisting of 111 (81.0%) males and 26 (19.0%) females. Majority,79 (57.7%) of respondents did not know which imaging modality; chest computed tomography (CT-chest) or chest X-rays (CXR), presented higher ionizing radiation hazards. Few 54 (39.4%) desired the radiologists' lifestyle, while less than half 62 (45.3%) believed that any referral involving radiation risks should be justified. The ratings for diagnostic imaging knowledge, perceptions and practices were consecutively excellent, 124 (90.5%), optimistic 5 (3.6%) and healthy 19 (13.9%). No statistically significant correlations were found between knowledge and perceptions, knowledge and practices, or perceptions and imaging practices.
Conclusions: Non-radiologist physicians demonstrated excellent knowledge but pessimistic perceptions and unhealthy imaging practices. A misconception existed over which modality, CT-chest or CXR, presented greater radiation risks. A few desired the radiologists' lifestyles while a minority sought justification for radiation-risky investigations. These aspects were beneficial but inconsistent, necessitating improvements through multidisciplinary clinical interactions.

Keywords: Diagnostic, Imaging, Knowledge, Nigeria, Perception, Practice

INTRODUCTION

There has been a growing global concern about non-radiologist physicians' restricted knowledge, perceptions, and practices of diagnostic imaging.[1] When people think of imaging in medicine, radiology is usually the first specialty that comes to mind. It is also where the majority of diagnostic imaging knowledge, perception, and practice research have been conducted. However, medical imaging encompasses a considerably wider spectrum of medical disciplines, such as ophthalmology, pathology, radiation oncology and cardiology.[2,3]

Radiological examinations are thought to be the basis of nearly half of all essential medical decisions. The rising demand for radiological services has also resulted in increased patient exposure to ionizing radiation, which is the single largest contribution to worldwide population

radiation exposure from artificial sources due to medical use. Despite the large number of patients who are exposed to medical exposures, no published research has been done to evaluate medical physicians' and clinical officers' knowledge, perceptions, and practices on the justification of radiological examinations.[4,5]

As the use of imaging services increases, so does concerns about their improper uses. From the radiologist's point of view, unjustifiable requests for radiological examinations are potential sources of professional misconduct that violate known ethical principles. The continued inappropriate diagnostic imaging practices add little or nothing to patient's care.[6] Therefore, referring physicians cannot justify investigations on the basis that the benefits outweigh the risks, if they are not knowledgeable about the radiation risks inherent in diagnostic imaging.[7,8]

Justification for referral is judged suboptimal in the absence of adequate radiation knowledge and use of referral guidelines.[9] Likewise, a timely and adequate radiology report based on adequate referral guidelines and acceptable diagnostic images are necessary for excellent clinical practice.[10]

Accordingly, this study aimed at evaluating existing diagnostic imaging knowledge, perceptions, and practices among referring non-radiologist physicians in Makurdi, identify aspects that are beneficial but substantially inconsistent, and determine those that can be improved**.**

METHODS

This was a 3-month cross-sectional survey from September to November 2021, evaluating the existing knowledge, perceptions and practices of diagnostic imaging among 137 practicing and accredited non-radiologist physicians at Benue state university teaching hospital (BSUTH), whose job involved referring patients for a variety of diagnostic imaging studies to establish and verify diagnoses. Makurdi, the Benue state capital, is located on the south bank of the Benue River between latitudes 7.3 degrees north and longitude 8.32 degrees east in north-central Nigeria, as is BSUTH, the study's location. The estimated population of the city and its environs in 2016 was 365,000.[11]

Convenience sampling method was used to select participants. At BSUTH, there are approximately 161 physicians employed. 160 questionnaires in all were distributed to participants in the following four specialties: surgery, pediatrics, internal medicine, and obstetrics and gynecology. A response rate of 85.6% was recorded from the 137 completed questionnaires that were returned.

Inclusion criteria

Inclusion criteria were practicing physicians who agreed to participate in the study, that is consultants, residents, casualty officers, and house officers who had been accredited by the Medical and Dental Council of Nigeria (MDCN) and employed by BSUTH for at least six months, which was considered the absolute minimum for adaptation.[12]

Exclusion criteria

Exclusion criteria were physicians with less than 6 months experience in the services of BSUTH. Professionals who were not physicians but employed by BSUTH and those who declined participation in the research were excluded. Similarly excluded were radiologists and medical students, since they primarily do not refer patients for radiological examinations.

Prior to real data collection, the questionnaire was piloted, and all necessary modifications were made. Participants' names were replaced with codes and each person signed an undertaking to participate voluntarily and knowingly.

A self-reporting questionnaire with 27 items, some of which were open-ended and others multiple-choice, served as the study's evaluation tool. We started by looking at the 8-items' demographic data of non-radiologist physicians, including their age, gender, place of employment, duration of current employment, department, and rank, among others. The survey also examined components of the physicians' everyday practices that were related to the theme of the study to see if there were any aspects of their existing knowledge, perceptions, and practices of diagnostic imaging that were beneficial but substantially inconsistent, or aspects that needed improvement. It also looked at whether or not non-radiologist physicians were satisfied with diagnostic imaging services at BSUTH and their feedback on how to improve these services in our environment.

The non-radiologist physicians were graded on their knowledge (poor, fair, good, or excellent), perceptions (pessimistic or optimistic), and aspects of their daily practices of diagnostic imaging (unhealthy or healthy) based on a systematic scoring methodology of the remaining 19 item questionnaire's subheadings. For each question that was correctly answered, one mark was awarded; however, no points were awarded for incorrect responses, "don't know" responses, or multiple-choice answers that were not permitted.

Physicians with knowledge scores of 1-6, 7-12, 13-18 and 19-24 marks out of a maximum 24, representing approximately 1-25, 26-50, 51-75, and 76-100% based on the individual item subheadings was rated as having consecutively poor, fair, good, or excellent knowledge of the subject matter. Those who score ≤4.0 (≤50.0%) marks or ≥5 (≥50.0%) marks out of a maximum marks of 8 (100.0%) for the perceptions section based on specific item subheadings describing radiology perceptions was considered to have had respectively, pessimistic or

optimistic view of diagnostic imaging as a profession, while those who score ≤6.3 (≤50.0%) marks or ≥6.4 (≥50.0%) marks on the allocated maximum marks of 12.5(100.0%) for the everyday practices section was evaluated to have had unhealthy or healthy practice of diagnostic imaging, respectively.

The data from the structured questionnaire was entered into the statistical package for social science (SPSS) version 23 software, 2015 (IBM, New York city, USA) and Microsoft Excel 2017 for analysis. For the quantitative variables, the data were presented as means and standard deviation, and for the categorical variables, they were presented as frequency tables and figures. Statistical significance was determined at p=0. 05.

The protocols were approved by the institutional Health Ethical Committee at BSUTH, Makurdi.

RESULTS

A total of 137 non-radiologist physicians from the BSUTH, made up of 111 (81.0%) males and 26 (19.0%) females, completed the questionnaire.

Table 1: Distribution of socio-demographic information of the respondents (n=137).

Variables	Frequency	Percentage
Age group (years)		
26-30	7	5.1
31-35	58	42.3
36-40	48	35.0
41-45	12	8.8
46-50	10	7.3
51-55	2	1.5
Total	137	100.0
Gender		
Male	111	81.0
Female	26	19.0
Total	137	100.0
Marital status		
Single	42	30.7
Married	93	67.9
Divorced	2	1.5
Total	137	100.0
Nationality		
Nigerian	135	98.5
Others	2	1.5
Total	137	100.0
Time in service at BSUTH (years)		
1/2-11/12	14	10.2
1-5	85	62.0
>5	38	27.4
Total	137	100.0
Employer		
BSUTH	137	100.0
Others	0	0.0

Their ages ranged from 26 to 52 years, with a mean age of 37.2±4.4 years and 34 as the modal age. Majority, 58 (42.3%) of the physicians were in the 31-35 years age range, followed by 48 (35.0%) in the 36-40 years range, with the age range of 51-55 having the least number of 2 (1.5%). A minimum of 6 months was thought to be ideal for adaptation, thus 14 (10.2%) respondents have had worked at BSUTH for at least that long, with the majority even much longer, as shown in Table 1.

Table 2A: The study participants' responses to inquiries about knowledge of diagnostic imaging (n=137).

Knowledge	Frequency	Percentage
Are you aware of the following 10 diagnostic imaging modalities?		
i) Ultrasonography (US)		
Yes	137	100.0
No	0	0.0
Computed tomography (CT)		
Yes	137	100.0
No	0	0.0
Plain radiography (X-rays)		
Yes	135	98.5
No	2	1.5
Mammography		
Yes	133	97.1
No	4	2.9
Magnetic resonance imaging (MRI)		
Yes	129	94.2
No	8	5.8
Fluoroscopy		
Yes	127	92.7
No	8	5.8
Don't know	2	1.5
Angiography		
Yes	123	89.8
No	12	8.8
Don't know	2	1.5
ii) Nuclear imaging studies (NUC)		
Yes	123	89.8
No	14	10.2
iii) Positron emission tomography (PET)		
Yes	123	89.9
No	12	8.8
Don't know	2	1.5
iv) Special investigations		
Yes	110	80.3
No	21	15.3
Don't know	6	4.4

Table 2A, B and C, depicts the study participants' responses to inquiries about knowledge of diagnostic imaging with table 2A showing the awareness of the listed 10 diagnostic imaging modalities in radiology, that is, plain radiography (x-rays), ultrasonography (US), computed tomography (CT), magnetic resonance imaging (MRI), mammography, nuclear imaging (NUC),

fluoroscopy, angiography, positron emission tomography (PET) and special investigations. This was impressive, predictably with all 137 (100.0%) respondents expressing maximum awareness about US and CT, followed by X-rays 135 (98.5%). The least awareness was on special investigations, by 110 (80.3%) respondents.

Table 2B: The study participants' responses to inquiries about knowledge of diagnostic imaging (n=137) continued.

Knowledge	Frequency	Percentage
Are you familiar with the following imaging modalities currently in use at BSUTH?		
i) Ultrasound (US)		
Yes	137	100.0
No	0	0.0
ii) Plain radiography (x-rays)		
Yes	135	98.5
No	2	1.5
iii) Computed tomography (CT)		
Yes	133	97.1
No	2	1.5
Don't know	2	1.5
vi) Mammography		
Yes	75	54.7
No	44	32.1
Don't know	18	13.1
Which imaging modalities utilize ionizing radiation?		
i) Plain radiograph (x-rays)		
Yes	135	98.5
No	2	1.5
ii) Computed tomography (CT)		
Yes	129	94.2
No	4	2.9
Don't know	4	2.9
iii) Nuclear imaging		
Yes	129	94.2
Don't know	8	5.8
iv) Hysterosalpingography (HSG)		
Yes	111	81.0
Don't know	26	19.0
v) Mammography		
Yes	108	78.8
Don't know	29	21.2
vi) Fluoroscopy		
Yes	80	58.4
Don't know	57	41.6
vii) Angiography		
Yes	79	57.7
No	2	1.5
Don't know	54	39.4

Physicians displayed acceptable familiarity with the current imaging modalities being utilized at the department of radiology, BSUTH in the following order: US 137 (100.0%), x-rays 135 (98.5%), CT 133 (97.1%), and mammography 75 (54.7%). There was outstanding knowledge of imaging modalities associated with ionizing radiation, with the majority of 135 (98.5%) physicians identifying X-rays as one of such modalities, while the least, but still good number 79 (57.7%) of the respondents listed angiography as shown in Table 2B.

Table 2C: The study participants' responses to inquiries about knowledge of diagnostic imaging (n=137) continued.

Knowledge	Frequency	Percentage
Which of these imaging modality poses greater ionizing radiation risks?		
Chest computed tomography (CT chest)	24	17.5
Chest X-rays (CXR)	34	24.8
Don't know	79	57.7
Which imaging modality utilizes magnetic energy?		
Magnetic resonance imaging (MRI)	132	96.4
Don't know	5	3.6
What are your major sources of information on diagnostic imaging?		
Clinical rounds	60	43.8
Textbooks	36	26.3
Internet	33	24.1
Friends	4	2.9
TV	2	1.5
Family	2	1.5

More than half, 79 (57.7%) of respondents stated that they did not know which imaging modalities posed more radiation hazards to the patient, between chest-CT and chest X-rays (CXR). Among the majority, 132 (96.4%) correctly identified MRI as a diagnostic imaging modality that utilizes magnetic energy, whereas 5 (3.6%) did not. The three most important sources of information on diagnostic imaging were clinical rounds 60 (43.8%), textbooks 36 (26.3%) and the internet 33 (24.1%), as illustrated in Table 2C.

Table 3: Distribution of non-radiologist physicians' knowledge of diagnostic imaging scores with age and gender.

Knowledge of diagnostic imaging scores				
	Fair 1 (0.7%)	**Good 12 (8.8%)**	**Excellent 124 (90.5%)**	**Total 137 (100.0%)**
Age (years)				
26-30	0	0	7	7
31-35	1	10	47	58
36-40	0	2	46	48
41-45	0	0	12	12
46-50	0	0	10	10
51-54	0	0	2	2
Total	1	12	124	137
Gender				
Male	1	8	102	111
Female	0	4	22	26
Total	1	12	124	137

Table 3 depicts distribution of non-radiologist physicians' knowledge of diagnostic imaging scores with age and gender in which 124 (90.5%) respondents, made up of 102 males and 22 females, displayed excellent knowledge of radiology because they scored between 19-24 (76-100%) marks out of the total possible 24 marks on specific item subheadings of this subject matter. Twelve (8.8%) physicians had good knowledge of diagnostic imaging having scored 13-18 (51-75%) marks. One (0.7%), respondent, a male, age range 31-35, had fair score of 7-12 (26-50%) marks.

Table 4: The study participants' responses to inquiries about perceptions of diagnostic imaging (n=137).

Perception	Frequency	Percentage
Would you like to earn a living as a radiologist?		
i. Yes	54	39.4
ii. No	83	60.6
If yes, what are your reasons?		
i. Excellent field of specialization	16	11.7
ii. Improve patients' management	10	7.3
iii. Pathology appreciated better with images	10	7.3
iv. Better medical practice	6	4.4
v. Increase my knowledge	6	4.4
vi. All above	4	2.9
vii. No reason	2	1.5
Total	54	39.4
If no, why?		
i. Radiation risk	31	22.6
ii. Not my preference	29	21.2
iii. Already specialized	17	12.4
v. Not interested	6	4.4
Total	83	60.6

Table 4 demonstrates the study participants' responses to inquiries about perceptions of diagnostic imaging in which a minority 54 (39.4%) of respondents desired earning a living as radiologists, while the majority 83 (60.6%) did not. The minority perceptions were mainly because diagnostic radiology is an excellent field of specialization 16 (11.7%), innovative improvement in patients' management 10 (7.3%) and the ability for pathology to be appreciated better on images 10 (7.3%), while the majority, but negative perceptions were mainly as a result of radiophobia 31 (22.6%), aversion to diagnostic imaging 29 (21.2), already specialized 17 (12.4%) and lack of interest 6 (4.4%) in radiology.

Table 5 presents the distribution of non-radiologist physicians' perceptions of diagnostic imaging scores with age and gender. Only 5 (3.6%) of the respondents, made up of 4 males and 1 female had optimistic perception of radiology, having scored ≥5 (≥50.0%), out of a possible maximum 8 marks on specific item subheadings on the questionnaire. Two (2) of these physicians were equally distributed at the 31-35 and 36-40 age ranges, respectively. Majority 132 (96.4%) of the respondents, made up of 107 males and 25 females had a pessimistic perception of diagnostic imaging having scored ≤4.0 (≤50.0%) marks out of a possible maximum 8 marks on the questionnaire.

Table 5: Distribution of non-radiologist physicians' perceptions of diagnostic imaging scores with age and gender.

Perceptions of diagnostic imaging scores			
Age (years)	**Pessimistic 132 (96.4%)**	**Optimistic 5 (3.6%)**	**Total 137 (100.0%)**
26-30	7	0	7
31-35	56	2	58
36-40	46	2	48
41-45	11	1	12
46-50	10	0	10
51-54	2	0	2
Total	132	5	137
Gender			
Male	107	4	111
Female	25	1	26
Total	132	5	137

Table 6A: The study participants' responses to inquiries about practices of diagnostic imaging (n=137).

Practice	Frequency	Percentage
Which imaging modality do you frequently request?		
Ultrasound	96	70.1
Plain radiography (x-rays)	21	15.3
Computed tomography	16	11.7
Magnetic resonance imaging	2	1.5
Mammography	2	1.5
Total	137	100.0
What is the frequency of requests?		
Ultrasound (US)		
Often (>75%)	86	62.8
Sometimes (25-75%)	6	4.4
Rarely (<25%)	4	2.9
Plain radiography (x-rays)		
Often (>75%)	15	10.9
Sometimes (25-75%)	2	1.5
Rarely (<25%)	4	2.9
Computed tomography (CT)		
Often (>75%)	12	8.8
Sometimes (25-75%)	4	2.9
Rarely (<25%)	0	0.0
Mammography		
Often (>75%)	0.0	0.0
Sometimes (25-75%)	2.0	1.5
Rarely (<25%)	0.0	0.0
Magnetic resonance imaging (MRI)		
Often (>75%)	0.0	0.0
Sometimes (25-75%)	0.0	0.0
Rarely (<25%)	2.0	1.5

Table 6B: The study participants' responses to inquiries about practices of diagnostic imaging (n=137) continued.

Practice	Frequency	Percentage
What are your reasons for the choice of a particular imaging modalities? Ultrasonography (US)		
Cost effective	29	21.2
More relevant to my specialty	17	12.4
Impact on treatment decision	14	10.2
Availability	12	8.8
Avoid radiation	3	2.2
All above	21	15.3
Computed tomography (CT)		
Impact on treatment decision	6	4.4
More relevant to my specialty	6	4.4
Cost effective	4	2.9
Availability	0	0.0
Avoid radiation	0	0.0
All above	0	0.0
Plain radiography (x-rays)		
Availability	10	7.2
Impact on treatment decision	4	2.9
More relevant to my specialty	4	2.9
Cost effective	3	2.2
Avoid radiation	0	0.0
All above	0	0.0
Magnetic resonance imaging (MRI)		
Cost effective	0	0.0
Availability	0	0.0
More relevant to my specialty	0	0.0
Avoid radiation	2	1.5
Impact on treatment decision	0	0.0
All above	0	0.0
Mammography		
Cost effective	0	0.0
Availability	0	0.0
More relevant to my specialty	0	0.0
Avoid radiation	0	0.0
Impact on treatment decision	2	1.5
vi. All above	0	0.0
Should any activity involving radiation exposure be justified in relation to available alternatives?		
Yes	62	45.3
No	66	48.2
Don't know	9	6.6
Total	137	100.0

Table 6A and B, depicts the study participants' responses to inquiries about practices of diagnostic imaging. The three frequently requested diagnostic imaging modalities are US, x-rays, and CT, with the following sequential frequencies: 96 (70.1%), 21 (15.3%), and 16 (11.7%). Predictably US, x-rays, and CT were frequently requested by physician as often as >75% of the times, while mammography and MRI, are respectively requested only sometimes (25-75%) and rarely (<25%), as shown in Table 6A.

Different reasons were given for the choice of particular imaging modalities. While US and CT were commonly selected respectively, because of their cost-effectiveness and relevance/impact on treatment decision, x-rays were mainly chosen for their availability. MRI and mammography were mainly chosen to avoid radiation and for the positive impact on treatment decision, respectively. Overall, 62 (45.3%) respondents believe that any activity involving radiation exposure should be justified in relation to available alternatives, whereas a slight majority 66 (48.2%) did not, as depicted in Table 6B.

Table 7: Distribution of non-radiologist physicians' practices of diagnostic imaging scores with age and gender.

Practices of diagnostic imaging scores			
	Unhealthy 118 (86.1%)	**Healthy 19 (13.9%)**	**Total 137 (100.0%)**
Age (years)			
26-30	7	0	7
31-35	50	8	58
36-40	41	7	48
41-45	8	4	12
46-50	10	0	10
51-54	2	0	2
Total	118	19	137
Gender			
Male	96	15	111
Female	22	4	26
Total	118	19	137

Table 7 presents the distribution of non-radiologist physicians' practices of diagnostic imaging scores with age and gender in which 118 (86.1%) respondents, with a M:F ratio of approximately 4:1 made entries that were considered unhealthy to the practice of diagnostic imaging. They scored ≤6.3 (≤50.0%) out of a possible maximum 12.5 (100.0%) marks on the questionnaire. Only 19 (13.9%) physicians, M:F ratio of nearly 4:1, made submission that were adjudged healthy to the practice of diagnostic imaging because their entries scored ≥6.4 (≥50%) marks out of a possible maximum 12.5 (100.0%) marks.

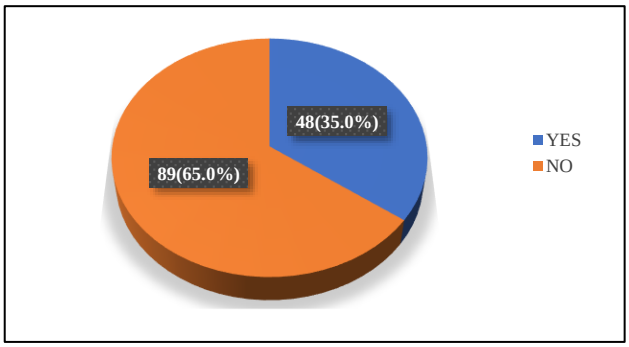

Figure 1: The study participants' level of satisfaction with diagnostic imaging services at BSUTH.

Less than half 48 (35.0%) of the respondents were pleased with the quality of services rendered at BSUTH, while the majority, 89 (65.0%) were not as highlighted in Figure 1.

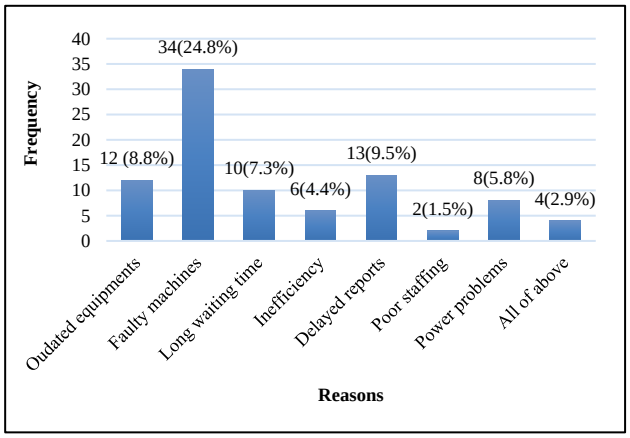

Figure 2: The study participants' reasons for dissatisfaction with diagnostic imaging services at BSUTH.

Faulty machines, delayed reports and outdated equipments were the three most prominent reasons given for dissatisfaction with diagnostic imaging services at BSUTH, with respective frequencies of 34 (24.8%), 13 (9.5%), and 12 (8.8%). Others included long waiting times, power outages, inefficiency, poor staffing and all of the above, as shown in Figure 2.

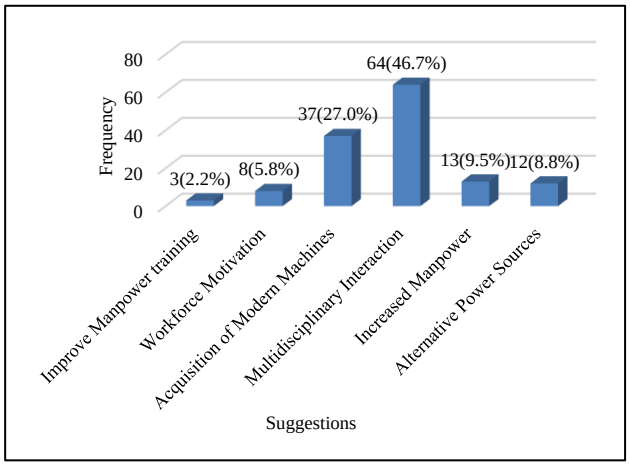

Figure 3: The study participants' feedback suggestions for improving diagnostic imaging services at BSUTH.

Multidisciplinary interaction, acquisition of modern machines, increased manpower, provision of alternative power sources, workforce motivation and improved manpower training, with their corresponding frequencies of 64 (46.7%), 37 (27.0%), 13 (9.5%), 12 (8.8%), 8 (5.8%) and 3 (2.2%) being several of the feedback suggestions for improving diagnostic imaging services at BSUTH, as depicted in Figure 3.

There was no statistically significant correlation between knowledge and perception (r=0.061; p=0.479), knowledge and practices (r=0.126; p=0.143), or perception and practices (r=0.035; p=0.689) of diagnostic imaging at BSUTH, as shown in Table 8.

Table 8: Pearson's correlation (r) between scores of diagnostic imaging knowledge, perceptions, and practices of referring physicians at BSUTH.

Variable/scores	Pearson's correlation (r)	P value
Knowledge versus perceptions	0.061	0.479
Knowledge versus practices	0.126	0.143
Perceptions versus practices	0.035	0.689

DISCUSSION

An uneven gender distribution with a male to female (M:F) ratio of approximately 4:1 was observed among the 137 non-radiologist physicians from BSUTH who participated in our study. Despite being higher, the ratio was consistent with findings of a nearly 2:1 M: F ratio by Salaam et al.[1] However, another study found a M:F ratio of 1:1, while Sattar et al reported a reversed M:F ratio of about 1:2 in favour of females, indicating that the situation for women is improving.[13,14] The reasons behind gender disparities among professionals are diverse and complicated, affecting not just medical institutions but also every facet of society.[15] The incidental gender gap in our research may be due to a shortage of female mentors with expertise in the various medical disciplines to inspire others to pursue the same career.[16] Men and women are always two sides of the same coin as complementary opposites, and despite everyone being equally talented, the apparent gender gap, is regrettable.[17]

Seven (5.1%) of our respondents were younger than 30, while many others, 58 (42.3%) were in the 31-35 years' age range. This is comparable with the report from a previous study, in which the majority of respondents 50 (40.7%) were aged 29-38.[1] These figures are re-assuring in the light of the recent decision of the federal government of Nigeria (FGN) to raise the retirement age for physicians and other medical professionals to 65 years of age and to 70 years for clinical consultants, indicating that we won't be short on referring physicians in the near future.[18]

Regarding ratings on knowledge of diagnostic imaging, 124 (90.5%), 12 (8.8%), and 1 (0.7%) non-radiologist physicians successively received excellent, good, and fair scores; displaying remarkable expertise of the various 10 listed diagnostic imaging modalities in radiology, with between 75 (54.7%)-137 (100.0%) of the responders demonstrating exceptional familiarity with the imaging modalities in use at BSUTH**.** Our findings, differed with those of Salaam et al who reported that just 14 (11.3%) respondents could name 6 diagnostic imaging modalities,

with the highest response from 46 (37.1%) of them listing only 4 modalities.[19] Physicians exhibited exceptional knowledge of imaging modalities that utilize ionizing radiation, with the majority of 135 (98.5%) recognizing x-rays as one such modality and the least but sizeable number, 79 (57.7%), mentioning angiography. This is important as regards justification of medical exposures, in order to minimize radiation hazards. Our findings were consistent with a previous study which reported that 66 (97.1%) of respondents were knowledgeable about ionizing radiation hazards.[4] A report by Alreshidi disputed our claims with only a minority 45 (31.0%) having adequate knowledge of ionizing radiation.[20] More than half 79 (57.7%) of our respondents admitted that they did not know the answer to which imaging modality, chest-CT or CXR, presented higher ionizing radiation risks to the patients. This is supported by previous research by Alchallah et al, in which a sizeable number 107 (39.8%) of respondents claimed it was a plain radiograph, whereas 94 (34.9%) respondents correctly identified a CT scan.[21] This discriminatory awareness is necessary when choosing lower-dose x-rays or radiation-free imaging modalities for the patients, like ultrasound, which uses high-frequency sound waves, or MRI, which uses magnetic energy.[4,22] MRI was correctly identified by 132 (96.4%) respondents as the modality that relies on magnetic energy without the risk of ionizing radiation, while 5 (3.6%) could not. Our findings collaborated those of Salaam et al, which reported that majority 115(93.5%) correctly identified MRI.[1] Other researchers refuted our findings with only 24 (35.3%) and 36 (27.4%) respondents respectively, identifying MRI.[4,5] BSUTH currently does not have an MRI equipment installed, however, the state government recently acquired a 1.5 Tesla MRI machine, which is ready for full installation, much to the delight of physicians, most likely accounting for the amazing response on this issue. Our findings of clinical rounds 60 (43.8%), textbooks 36 (26.3%) and the internet 33 (24.1%) as the three main sources of information on diagnostic imaging was at variance with the report of internet 90 (33.5%), social media 82 (30.5%), and lectures 65 (24.2%) by Alchallah et al.[21] Wang et al cited news media 152 (42.8%), a teacher/textbook 131 (36.9%), and a friend 116 (32.7%).[23] These researchers recruited undergraduate medical students rather than physicians, which differs from our methodology, thus explaining the discrepancies.[21,23]

Perceptions of diagnostic imaging by the non-radiologist physicians were, respectively, optimistic in 5 (3.6 %) cases and pessimistic in the remaining 132 (96.4%) instances. Less than half of the respondents, 54 (39.4%) with a M: F ratio of nearly 13:1 would like to earn a living as radiologists in our environment, while the majority 83 (60.6%) did not. These low female numbers are nothing new and haven't changed much in the last decade.[24] Despite being higher in our index research, the ratio supports the results of another study.[1] However, separate reports by other researchers suggests that things might be improving for women.[13,14] The primary motivations for wanting to earn a living as radiologists was obvious. More than ever, radiology has become an important link in the medical health chain since it is a service department that provides answers, so physicians often request diagnostic tests even before seeing the patients.[25] Diagnostic imaging attracted interest mostly because a good number of our respondents perceived it as an excellent specialty in which pathology is appreciated better with images, thus greatly improving patients' management. However, radiophobia, having already specialized and not being interested were some of the reasons that contributed to the lack of interest in radiology. The outcome of our study supports the previously held view that, indeed, the reasons for and against interest in radiology by physicians are multifactorial.[26]

Concerning practices of diagnostic imaging, only 19 (13.9%) non-radiologist physicians displayed healthy imaging practices, compared to 118 (86.1%) who did not. US, X-rays, and CT were consecutively listed as the top three diagnostic imaging modalities for patients as attested to by 96 (70.1%), 21 (15.3%), and 16 (11.7%) respondents. MRI and mammography were the least popular procedures. This is consistent with another study where mammography and MRI were once again classified as the least often utilized diagnostic imaging modalities, with US, x-rays, and CT being the most frequently requested.[1] Predictably, physicians at our facility mainly requested US, x-rays, and CT scans >75% of the time, whereas mammography and MRI were only sometimes (25-75%) and rarely (<25%) requested, respectively. While US was frequently requested due to its cost effectiveness by 29 (21.12.2%) responders, CT was selected primarily due to its relevance/impact on treatment decisions by 6 (4.4%) others. Ten (7.2%) physicians chose x-rays because of its availability. The main reasons why MRI and mammography were chosen each by 2 (1.5%) respondents, was to avoid radiation and for positively influencing treatment choices**,** respectively. The choice of imaging modality depends on the purpose of the examination, how quickly images are acquired, the patient`s age and other factors related to the strengths and weaknesses of such a modality, in consultation with the radiologist.[27] Sixty-two (45.3%) of our respondents believed that any radiation-exposure-related activity should be justified in relation to available alternatives, while 66 (48.2%) others disagreed. In contrast, a previous study indicated that 66 (97.1%) respondents agreed to justification of medical referrals even though a good number 42 (61.8%) of them were ignorant of the justification principle, a fundamental component of the "as low as reasonably achievable principle (ALARA)".[4] Sadly, radiologists and physicians occasionally disagree, with the former frequently rejecting the latter's requests for radiological investigations believed to be unjustified. This is concerning because the goal of medicine should be interdisciplinary collaborative activities focused on

patient`s ultimate care and benefit, not professionals hanging onto patients as "theirs".[5]

Majority 89 (65.0%), in our index study, were dissatisfied with the quality of services offered at BSUTH. Faulty equipment, delayed reports, outdated equipment, among others were listed as the reasons for the discontentment. This was in line with findings from an earlier study in which 64 (52.0%) physicians expressed comparable dissatisfaction with diagnostic imaging services.[1] Our findings differed from another survey in which the majority of respondents expressed satisfaction with the radiological services they received (28% very satisfied, 52% satisfied).[28] But in our poor resource environment, how can radiology maintain its expected level of efficiency? The quicker radiology can provide a simple referral process, generate timely, accurate reports and offer referring physicians the required services, the better the outcome for everyone.[28]

Some recommendations to improve diagnostic imaging services at BSUTH included multidisciplinary interaction, acquisition of modern machines, increased manpower, provision of alternative power sources, workforce motivation, and improved manpower training. These suggestions are somewhat in line with those made in earlier research which recommended personnel training and retraining as a way of enhancing the diagnostic imaging services.[1]

Our index study found no statistically significant correlation between knowledge and perception (r=0.061 p=0.479), knowledge and practices (r=0.126; p=0.143), or perception and practices (r=0.035; p=0.689) of diagnostic imaging. This supported the earlier conclusions by Bwanga et al, that they found no statistically significant results in all three cases.[4]

Limitations of study

The fact that this study was conducted as a single-center study at BSUTH constrained the researchers from drawing comparisons and ultimately discovering any discrepancies among non-radiologist physicians' knowledge, perception, and practice of diagnostic imaging from various health centers. Another potential drawback is that whereas some respondents completed the questionnaires while on duty at BSUTH, others did so at home, where they had more time to even use theoretical references. Similarly, while some respondents quickly returned the completed questionnaires, others did so a few days later, giving them more time to search for the correct answers elsewhere. The results must therefore be interpreted with caution because, in addition to the inherent limitations of using questionnaires, such as bias, misinterpretations, and dishonest answers, some responses reflect the subjective assessment of the respondents' own knowledge, perceptions, and practices of diagnostic imaging, which may not be representative of the views of all non-radiologist physicians in our environment.

CONCLUSION

The non-radiologist physicians at BSUTH had exceptional knowledge but were constrained in how they perceived and practiced diagnostic imaging, which could have a negative impact on clinical decisions by increasing risks in comparison to anticipated diagnostic imaging benefits. The study revealed outstanding knowledge on ionizing and non-ionizing radiation, which is helpful in justifying medical exposures so as to minimize hazards associated with radiation exposure. Disappointingly, the physicians were not knowledgeable about which imaging modality, chest-CT or CXR, presented higher ionizing radiation risks for their patients. Referring physicians ought to be able to compare the radiation hazards associated with different imaging modalities so as to make an informed referral. A troubling aspect of the research is the fact that physicians frequently refer patients for diagnostic imaging examinations without justification. This practice carries a high risk of medico-legal disputes, avoidable stochastic consequences, unnecessary radiation exposure, and, in some cases, a disregard for evidence-based medicine. The research also highlighted the desire by some non-radiologist physicians to earn a living as radiologists, which was beneficial but substantially inconsistent. Although it may take some time to completely change the existing restricted perception and practice of diagnostic imaging among non-radiologist physicians in our environment, their awareness can be tremendously improved through multidisciplinary clinical meetings and instructional activities, as well as major curriculum modification at the undergraduate and post-graduate levels of medical training with regard to knowledge, and notably the perceptions and practices of diagnostic imaging.

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