



## COUNTRY REPORT

### Diagnostic Radiology in Nigeria: A Country Report

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#### Abstract

Nigeria is located in West Africa. The Nigerian healthcare system is stratified into three tiers corresponding to the three tiers of government: primary (local), secondary (state), and tertiary (federal). In addition to this public health structure, private facilities play a significant role in healthcare delivery. Nigeria has a shortage of healthcare equipment and personnel, with a doctor per 1,000 population ratio of 0.17, which is one of the lowest on the African continent.

Despite these challenges, a wide range of medical imaging services is available in the country, through a network of public and private facilities.

The public healthcare system, which serves the majority of Nigerians, is weak due to lack of adequate funding, personnel and equipment. This gap is closely bridged by private healthcare facilities, which account for 70% of health services coverage in the country.

Training in diagnostic radiology is evolving, with two postgraduate colleges being responsible for the regulation of radiology training in the country: the National Postgraduate Medical College of Nigeria and the West African College of Surgeons. There are also higher institutions of learning which are responsible for the training of other imaging professionals.

The major challenges of radiology practice in Nigeria are the unavailability of constant electricity as well as the problems of equipment availability and repair.

#### Introduction

The Federal Republic of Nigeria is located in West Africa, having boundaries with neighboring countries including Cameroon to the East, Benin Republic to the West, and Northern boundaries with Niger Republic and Chad (Figure 1). Southwards, Nigeria is bordered by the Gulf of Guinea and the Atlantic Ocean (1). Nigeria has 36 states and a Federal Capital Territory, which is the seat of power in the city of Abuja (1). Officially, Nigeria is a secular country with a democratic system of government (2).

English is the official language, but there are hundreds of ethnic nationalities, of which Igbo, Yoruba, and Hausa are the largest. With a population estimate of 197,403,529 in 2018, Nigeria is the most populous country in Africa and seventh in the world (3). Nigeria achieved independence from Great Britain on October 1, 1960 and became a republic on October 1, 1963 (2). There was a 30-month Civil War between 1967 and 1970 that left 1-3 million people dead from warfare, disease, and starvation (4,5). Besides a brief second republic between 1979-1983, Nigeria endured almost 33 years of military rule (from 1966 until 1999) (4,5). The country returned to democratic rule in May 1999 (4).

**Figure 1: Map of Nigeria.**

Retrieved From Wikimedia Commons, the free media repository. Available from [https://commons.wikimedia.org/wiki/Atlas\\_of\\_Nigeria#/media/File:Un-nigeria.png](https://commons.wikimedia.org/wiki/Atlas_of_Nigeria#/media/File:Un-nigeria.png) (9).

**Socioeconomic overview**

Nigeria has an estimated population growth rate of 2.5% and life expectancy of 54 years (6). The Nigerian economy is the largest in Africa and twentieth largest in the world, with a GDP of 509.9 billion dollars in 2013 (7). Since 2017, the Nigerian economy has continued to show evidence of recovery, with an estimated GDP growth rate of 0.8% in 2017 which represents an improvement from the recorded -1.5% in 2016 (8). In 2018 and years ahead, the Nigerian economic outlook is encouraging, with an estimated growth rate of 2.1% in 2018 and 2.5% in 2019 (8).

**State of healthcare in Nigeria****Healthcare structure and stratification in Nigeria**

The earliest record of the introduction of modern medical services in Nigeria dates back to the early-to mid-nineteenth century, during the various early European tours in the country (10). One of the earliest modern health care facilities in the country was a dispensary established in 1880 by the Church Missionary Society (10).

The Nigerian healthcare system is stratified into three tiers corresponding to the three tiers of government: primary (local government), secondary (state government), and tertiary (federal government). At the federal level, the federal ministry of health (FMOH) is tasked with the responsibility of formulating policies and providing organizational and technical support to the healthcare system as a whole (11). The federal government is also in charge of international relations on health, health information management, and the provision of tertiary healthcare through the federal teaching hospitals, federal medical centers and federal specialist hospitals (11). The states, through the state ministry of health (SMOH), are involved in healthcare regulation and healthcare provision through the state specialists and general hospitals, while the local governments are mainly involved with primary healthcare delivery through the comprehensive and basic health centers (11). In spite of these broad categorizations, the state governments have also been involved in the provision of tertiary healthcare through the state government-owned teaching hospitals and specialist hospitals.

The healthcare structure in Nigeria is similar to what is

obtainable in other countries such as Rwanda, Liberia and Ghana (12-14), in which the healthcare structure utilizes a three-tiered approach (primary, secondary and tertiary) for healthcare delivery.

Additionally, the healthcare system in these countries involves an interplay of both private and public sectors, with the private facilities being on the forefront of primary care delivery in Nigeria (15). Non-governmental organizations play a limited role in primary care delivery in Nigeria (14).

### Numbers of healthcare facilities

As of March 2015, there were an estimated 23,640 healthcare facilities in Nigeria, with approximately 85.8% of these being primary healthcare facilities, 14% secondary facilities; , and 0.2% of the total figure being tertiary facilities (6). According to the Nigerian Health Sector Market Study Report of 2018 (6), at least 70% of healthcare services in the country are provided by private facilities.

### Healthcare human resources (medical doctors)

As of 2018, the estimated number of registered doctors was 72,000, but only about 35,000 of these doctors were actually practicing in the country (16). Consequently, the Nigerian doctor per 1,000 population ratio is 0.17 (3,16), one of the lowest ratios on the African continent (17). There is also a shortage of other categories of health workers such as nurses, radiographers, etc. (18). Besides the shortage, the distribution of health professionals is also skewed. For example, the North-East geopolitical zone is the worst hit, with the least number of physicians per 100,000 population, while the South-West zone has the highest number of medical practitioners per 100,000 population (19). Table 1 compares the percentage gross domestic product (GDP) spent on health and number of physicians per 1,000 people in some African countries (15).

**Table 1. Percentage GDP spent on health and number of physicians per 1000 people in some African countries (2018).**

Country	% GDP spent on Health	Physicians Per 1,000 People
Nigeria	3.7%	0.17
South Africa	9.0%	1
Kenya	5.7%	0.2
Zambia	5%	0.17
Tanzania	5.6%	0.03
Uganda	7.2%	1

\*GDP = Gross Domestic Product

### Training

Currently, there are 38 medical schools in Nigeria (34 fully accredited and 4 partially accredited), in comparison to only one in 1960, two in 1965, and 18 by the end of 2005 (18). Nigeria graduates about 3,325 doctors every year (20).

### Healthcare insurance in Nigeria

The National Health Insurance Scheme (NHIS), the main health insurance program in the country, was launched on June 6, 2005. The NHIS Secretariat is a government agency/regulator under the Federal Ministry of Health, and is headed by an Executive Secretary. The NHIS program provides health insurance coverage for a principal beneficiary, his or her spouse, and four children who are less than 18 years old. The family is required to register with an approved health care provider (hospital) through a Health Maintenance Organisation (HMO). The employee (principal beneficiary) and his/her employer contribute 5% and 10%, respectively, of the employee's basic salary to the NHIS monthly. Each time the principal beneficiary or any registered member of his/her family utilizes healthcare services covered by the NHIS program, they pay only 10% of the total charges (21) although some services such as laboratory investigations are not fully covered under the Scheme. This program has, however, not lived up to expectations, as about 90% of eligible Nigerians have remained uncovered by the program (22). The vast majority of insured individuals are federal civil servants, leaving the state civil servants, local government workers and the private sector operators uninsured. Efforts to improve on the coverage led to the development of the Tertiary Institution Social Health Insurance Programs, Community Based Social Health Insurance Programs and Public Private Social Health Insurance Programs by the NHIS. These are targeted at more vulnerable groups such as pregnant women, children under five years of age, tertiary institution students, prison inmates, retirees, and the aged (23). Beneficiaries in these categories are required to pay an annual subscription fee to the program ranging from N 9000 - N 20,000 (US \$25-55). Despite these efforts, healthcare insurance coverage has remained low due to poor awareness.

With the projected improvement in the country's economy, it is expected that there will be an improvement in the healthcare budgetary allocations as well as health insurance coverage, which has persistently been lower than international recommendations (24).

For example, in 2018, the healthcare budgetary allocation was N 340.45 billion which represented only 3.9 per cent of the country's (Federal Government) total annual budget (25). This is a far cry from the 15% of the total budget recommended by the 'Abuja Declaration' of African leaders at an African Union (AU) summit in Abuja in 2001, of which Nigeria is a signatory (25). Improved budgetary allocation to healthcare is expected to have a positive effect on health insurance policy and the practice of radiology in Nigeria.



### Healthcare facilities and capability in Nigeria

A wide range of healthcare services is available in the country, ranging from primary care to tertiary level of care. Treatment of minor ailments is obtainable at both private and public primary healthcare service clinics across the length and breadth of the country, while secondary centers – termed general and state specialist hospitals – offer a wide range of specialty care, including pediatrics, obstetrics and gynecology, ophthalmology, internal medicine and general surgery services. Limited radiological services, such as ultrasound and X-ray services, are also obtainable at this level.

A more robust healthcare service delivery, with more advanced forms of the services rendered by the secondary facilities, is available at the tertiary level. More specialized services such as open-heart surgeries, neurosurgical services and organ transplant services are available in some tertiary centers across the country (26-28).

Specialized orthopedic and neuropsychiatric hospitals are also located in most geopolitical zones of the country.

Radiological services are more advanced at the tertiary level, with access to equipment such as CT and MRI scanners. Some entrepreneurial radio-diagnostic service outlets are also present in major cities of the country and offer services obtainable in the tertiary centers, often with more advanced equipment.

### Diagnostic imaging in Nigeria

#### Regulation, policy and radiation protection

The Nigerian Nuclear Regulatory Authority (NNRA), established under the Nuclear Safety and Radiation Protection Act of 1995, is tasked with the responsibility of policymaking, regulation, and monitoring for nuclear safety and radiological protection in the country (29).

#### Radiology environment and structure in Nigeria

The field of radiology is still evolving. Radiologists usually assume leadership positions and administrative functions where necessary, in addition to providing interpretation for acquired medical images. Radiographers are generally responsible for acquisition of medical images. The technicians provide auxiliary services to the radiographers, but also help with medical imaging acquisition in resource-poor settings. Biomedical engineers are tasked with repairs and equipment servicing, and medical physicists function in radiation management and control, as well as rendering quality control services where necessary. Below is a breakdown of the radiology workforce in the country.

#### Workforce

The diagnostic imaging workforce in Nigeria and their regulatory framework are shown in Tables 2 and 3.

#### Radiologists in Nigeria

The latest estimate puts the number of radiologists in Nigeria at between 250 and 300 (29,30) which is approximately one

radiologist for 658,000 people. No record was found on the number of nuclear medicine specialists in Nigeria, as the field is still somewhat nascent in the country.

#### Radiography in Nigeria

There are about 1,318 registered radiographers in Nigeria, with an average of one radiographer to about 150,000 people (31).

The Radiographers Registration Board of Nigeria (RRBN) is the body tasked with monitoring, training, registration and licensing of qualified radiographers in Nigeria. Radiography is offered in about seven universities in Nigeria as a five-year degree course (34), followed by a year internship before licensure. RRBN also conducts seminars, training and other continuous professional development courses for radiographers (35).

**Table 2. Diagnostic imaging personnel per million population in Nigeria.†**

Personnel	Year the available estimate was made	Estimated number of personnel	Personnel/ Million Population
Radiologists	2015	300	1.5
Radiographers	2016	1,318	6.7
Medical Physicists	2019	100	0.57
Biomedical Engineers	2017	280	1.4
X-Ray ("Dark Room") Technicians	2018	1,111 <sup>‡</sup>	5.63
Radiology Nurses	NYD	NYD	NYD

NYD: Not yet developed in the country

NB: This table is based on registration and may not necessarily reflect the current human health resources across the country

†Table compiled using information in references 27,29-31

‡Figure obtained from the register of members, Association of Medical X-ray Technicians of Nigeria via personal communication. However, we were informed that there are technicians who are not registered with them and some technicians register with other groups.

**Table 3. Professional associations and their regulatory bodies.**

Profession	Association(s)	Year Founded	Regulator	Year Founded
Radiology	ARAWA	1962	MDCN	1963
	ARIN	2010	MDCN	1963
Radiography	ARN	1958	RRBN	1987
Medical Physics	NAMP	1986	None yet	NA
Darkroom Technicians	NAMDT	NA	RRBN	1987
	AMXTN	NA	RRBN	1987
Biomedical Engineering	NABET	2009	COREN	1970

ARIN – Association of Radiologists in Nigeria (<https://www.arin.org.ng/>); ARAWA – Association of Radiologists of West Africa (Nigerian Radiologists constitute the bulk of this West African regional Association); ARN – Association of Radiographers of Nigeria (<http://www.arn.org.ng/>); NAMP – Nigerian Association of Medical Physicists (<https://namp.ng/>); NABET – Association of Biomedical Engineers and Technologists of Nigeria (<http://www.nabet.org.ng/membership.html> & <https://www.nigerianbme.org/>); MDCN – Medical and Dental Council of Nigeria (<https://www.mdcn.gov.ng/>); RRBN – Radiographers Registration Board of Nigeria (<http://www.rrbn.gov.ng/>); COREN – Council for the Regulation of Engineering in Nigeria (<https://www.coren.gov.ng/>); NAMDT – National Association of Medical Darkroom Technicians; AMXTN – Association of Medical X-ray Technicians of Nigeria; NA – Not Available; Darkroom Technicians A.K.A. Medical Imaging Processing Technicians; The Nigerian Nuclear Regulatory Authority (NNRA; established in 1995 and started operations in 2001; <http://www.nnra.gov.ng/home>); registers, licenses, inspects and enforces nuclear safety and radiological protection in Nigeria.

#### Biomedical engineering in Nigeria

According to the WHO, there were 280 biomedical engineers in Nigeria as of 2017 (32). The field of biomedical engineering is relatively new to the Nigerian university system, with only a few universities offering biomedical engineering as a degree course (36,37).

#### Medical physics in Nigeria

As of 2016, the number of medical physicists in Nigeria was about 70 (33). Most medical physicists in Nigeria are employed in radiotherapy and oncology departments with a few in diagnostic radiology and nuclear medicine departments (33).

Only about six universities in Nigeria offer the medical physics curriculum, and those that offer it do so without clinical or on-the-job training components (33,38). Currently, there is no formal or official recognition for the profession of medical physics in Nigeria and as such, there is no accreditation or registration process for the proper regulation of the profession. There is, however, a Nigerian Association of Medical Physicists (NAMP), which does not serve regulatory functions (38).

(NPMCN) and the West African College of Surgeons (WACS) are the two colleges responsible for organizing radiology training in Nigeria. They oversee the training activities, accreditation of training facilities, certification and management of radiologists in the country (39).

Radiology trainees in Nigeria undergo at least 48 months of rigorous clinical training in diagnostic radiology, after which they can be deemed eligible to take the certification examination. Candidates have the opportunity to attempt the examinations of either or both colleges twice a year (39). The examinations are organized by the colleges in three stages:

- Primary examination (“Primaries”), which assesses candidates’ knowledge of basic medical sciences and O-level general physics. This is usually a prerequisite examination for admission into radiology training programs.
- Part 1 (Membership) examination can be taken halfway into the training, following 24 months of rigorous clinical rotations in radiology. This examination assesses candidates’ knowledge of radiologic anatomy, radiology physics, and clinical radiology.
- Part 2 (Fellowship) examination is the final examination prior to certification. Candidates may take the final examination after completing 24 months of active

## Radiology training in Nigeria

The National Postgraduate Medical College of Nigeria

clinical rotations (post-part 1 examination success). In addition, candidates are obligated to carry out a research study under the supervision of certified trainers during this period, and submit a dissertation to the college (39).

A number of radiology-oriented update courses and conferences are organized periodically by the radiology faculty of both the West African College of Surgeons (WACS), as well as the National Post Graduate Medical College of Nigeria (NPMCN). Attendance to a specified number of update courses is mandatory for residents in training, as prerequisites for each stage of their examinations. Practicing radiologists are equally mandated to obtain a minimum of 20 continuing medical education points before being eligible for annual license renewal. Radiology subspecialty fellowship programs are not readily available in the country, as sub-specialization in the field of radiology is still in its infancy. Table 4 shows a summary of the evolving radiology sub-specialties in the country.

### Equipment audit and current radiology capability

There are basic radiology equipment and resources to support the service of specialists such as physicians, surgeons, pediatricians, orthopedists, ENT surgeons, ophthalmologists, obstetricians/gynecologists, etc. in some tertiary government hospitals and private health facilities in the country. Table 5 provides a synopsis of available radiological equipment in Nigeria.

#### X-ray machines

X-ray machines are relatively more available in Nigeria compared to other costlier radiological equipment, with approximately 5,000 machines (40) distributed across the

country in both public and private radio-diagnostic centers. It is difficult to ascertain what percentage of these machines is currently functional.

#### Ultrasonography

Ultrasound machines are also readily available, though availability in the rural and remote areas is still quite limited.

#### Fluoroscopy

We were unable to ascertain the exact number of fluoroscopy units in the country. Most of the fluoroscopic machines are owned by public tertiary hospitals, with a few in some private hospitals and diagnostic centers in the major cities. Some of these units are used in operating theaters, while the vast majority are used in radio-diagnosis departments. In many of the centers, the fluoroscopy units suffer frequent breakdowns.

#### Mammography machines

Most mammographic units are installed in public tertiary hospitals and some private hospitals or private diagnostic centers. With the increasing awareness of breast cancer, breast cancer and mammography screening initiatives are springing up around the country, driven largely by non-governmental organizations, and mammography penetration is likely to improve (41).

#### Angiography

Only a few public tertiary institutions in the country, such as University College Hospital, Ibadan (South-West Nigeria), Aminu Kano Teaching Hospital, Kano (North-West Nigeria) and University of Maiduguri Teaching Hospital, Maiduguri (North-East Nigeria), are equipped with dedicated angiographic suites for various (interventional) angiographic procedures. The actual number of interventional radiologists

**Table 4. Existing radiology sub-specialties in Nigeria.**

Subspecialty	Year founded	Website/Facebook page/Email
Society of Pediatric Imaging in Nigeria [SPIN] (12)	June 2013	spinnigeria2013@gmail.com
Nigerian Society of Interventional Radiology [NiSIR]	2016	<a href="https://nisir.org.ng/">https://nisir.org.ng/</a>
Breast Imaging Society of Nigeria [BISON] (24)	November 2018	<a href="https://www.facebook.com/breastradiologistsbisonites@gmail.com">https://www.facebook.com/breastradiologistsbisonites@gmail.com</a>
Society of Musculoskeletal Imaging in Nigeria [SMIN]	2019	sminradiology2019@gmail.com
Neuroradiological Society of Nigeria [NRSN]	August 2019	nrsnigeria2019@gmail.com

NB: All these sub-specialty associations are affiliates of the umbrella body of radiologists in Nigeria, i. e., ARIN - Association of Radiologists in Nigeria ([www.arin.org.ng](http://www.arin.org.ng))

**Table 5. Census of Radiology equipment in Nigeria.\***

Equipment**	Year invented	Year of first installation in Nigeria	Site of first installation	Current estimate	Year estimate was computed
X-Ray	1895	1910	LIGH	5000	2006
CT	1972	1987	UCH	183	2018
MRI	1977	1999	NHA	58	2018
Ultrasound	1942	1975	UCH	4500	2018
Angiography	NA	1961	UCH	NA	NA
Mammography†	1965	1999	NHA	180	2018
Fluoroscopy	1896	1972	UCH	28	2018
Lithotripter	1980	1992	IHMRC	NA	NA
DEXA	1987	NA	NA	NA	NA
LINAC	1952	1999	NHA	5	2017
Cobalt-60 Machine	1951	1975	LUTH	3	2016
SPECT	1963	2006	UCH	3	2018
OPG	1961	NA	NA	NA	NA

LIGH: Lagos Island General Hospital; UCH: University College Hospital, Ibadan, Oyo State; NA – Not Available; NHA: National Hospital Abuja; LUTH: Lagos University Teaching Hospital; IHMRC: Igbinedion Hospital and Medical Research Centre, Okada, Edo State; LINAC: Linear Accelerator (dedicated Medical LINAC); CT: Computerized Tomography; MRI: Magnetic Resonance Imaging; DEXA: Dual Energy X-ray Absorption Photometry; OPG: Orthopantomography; SPECT: Single Photon Emission Computerized Tomography; X-ray: X-ray Machines

\*Table compiled using information in references (27,29-31,37,41,46-61)

\*\*No PET, PET-CT, PET-MRI, fMRI machines in the country yet

†Refers to dedicated mammography unit

in Nigeria is not known. However, the perception is that they represent a small percentage of the nearly 300 radiologists in the country. Interventional cardiology and uterine fibroid embolization facilities are also available in a few private facilities.

### **Interventional radiology**

The vast majority of interventional procedures are ultrasound-guided or fluoroscopy-guided procedures. Interventional angiographic procedures are equally performed by few centers with the facilities, especially in Northern Nigeria (42). However, there are no published data on the number of interventional radiology examinations in Nigeria.

### **Computed tomography**

Nigeria installed its first CT scanner on November 19, 1987 at the University College Hospital (43) in Ibadan, Southwest Nigeria (39). There are now many CT scanners installed across the country and the trend is expected to continue (39). As of March 2018, there were 183 CT scanners in Nigeria (27).

One hundred and five (57.4%) of these scanners are privately owned, while public institutions (owned by the federal and state governments) accounted for 78 scanners (42.6% of the total installed number) (43). Three states in Northern Nigeria (Kogi, Kebbi, and Zamfara States) had no CT scanner installed

(43).

Most of the available CT scanners are 2, 4, 16, and 64 slices (44). However, a few centers have 128, 160 and 640 slice scanners (45-47). Currently, two 640 slice CT scanners are available in the country, one in a public hospital (Akwa-Ibom state) and the other in a private radio-diagnostic center in Lagos State. General Electric and JNCI are the foremost suppliers of diagnostic equipment across the country (29).

### **Magnetic resonance imaging**

There are 58 installed MRI units in Nigeria (48). Nearly half of the units are low-field strength systems. However, there are some centers with 1.5T machines, especially in the cities. There is no 3T unit in the country yet. The distribution of MRI units in Nigeria is reasonably even across its six geopolitical zones, albeit most of the units are installed in urban areas, with Lagos state (South-West Nigeria), being home to 14 (25%) of the installed MRI scanners in Nigeria (48). The majority (approximately two-thirds) of scanners in the country are privately owned (48).

### **Nuclear medicine and radiotherapy equipment**

Nigeria has nine radiotherapy centers. One is private, while the Federal Government of Nigeria owns the other eight (49). The distribution of facilities amongst these nine is as follows: five linear accelerators, three Co-60 treatment machines,



two high dose rate (Co-60 and Ir-192) and three low-dose rate brachytherapy machines (Cs-137), four CT-SIMS and two conventional simulators, as well as six treatment planning systems. Two of the treatment planning systems are not functional (49).

The centers with radiotherapy units in the country are Ahmadu Bello University Teaching Hospital (ABUTH) Zaria, Federal Medical Centre (FMC) Gombe, Usmanu Danfodiyo University Teaching Hospital (UDUTH) Sokoto, National Hospital, Abuja (NHA), University of Benin Teaching Hospital (UBTH) Benin-City, University of Nigeria Teaching Hospital (UNTH) Enugu, University College Hospital Ibadan (43), Lagos University Teaching Hospital (LUTH) Lagos, and EKO Hospitals Lagos (a private hospital in the South-Western part of Nigeria) (49).

Two federal tertiary health institutions have nuclear medicine departments: National Hospital, Abuja and the University College Hospital in Ibadan.

### **Picture Archiving and Communication System (PACS)**

Functional PACS is available in only a few public teaching hospitals, some large multi-specialty private hospitals, and some of the dominant entrepreneurial private radio-diagnostic centers.

### **Needs and challenges of radiology practice**

A major challenge of radiology practice in Nigeria is the unavailability of constant electricity to power the machines. Most radiology facilities, both public and private, rely on diesel-powered generators for the smooth running of the equipment, thereby adding considerably to the cost of investigations (29).

Many centers do not have a functional PACS system or a Radiology Information System for interpreting imaging studies (29). Due to the unavailability of effective PACS systems for storage, images are usually stored locally on the equipment (29).

Maintenance of equipment is another major problem. There are only a few qualified biomedical engineers with the technical know-how to service and maintain equipment; many of the centers rely on foreign engineers. Most centers try to overcome the challenge of equipment maintenance by entering service contracts or part-ownership with manufacturers to maintain equipment. The complex chain involved with repairs and maintenance makes equipment downtimes longer than necessary, often lasting several weeks to months (44,62,63).

### **Future expectations**

With the current drive of the present government towards improving power supply in the country (64), it is expected that the power situation in the country will improve, thereby cutting down the cost of running radio-diagnostic facilities and, by extension, the cost of various investigations. Additionally, with improvement in the country's economic situation and the anticipated increase in health funding (8),

the National Health Insurance Scheme (NHIS) is expected to achieve better insurance coverage of citizens, thereby allowing more access to radiology investigations.

Regarding servicing of equipment, it is anticipated that the proliferation of radio-diagnostic centers in Nigeria would attract more maintenance and service companies into the country, thereby obviating the problem of equipment maintenance and long downtimes.

### **Job opportunities**

There is a wide gap between the number of personnel in the fields of radiology and the over 197 million estimated population of Nigeria: a ratio of 1.5 radiologists per million. Despite this mismatch, employment opportunities are not so readily available because governments at various levels are the major employer of labor in Nigeria. Nigeria spends less than 4% of its budget on health care (65), leaving the system with severe funding constraints. With the current surge in the number of private diagnostic centers in Nigeria, the employment outlook might improve.

### **Cost of radiological imaging in Nigeria**

Radiological investigations, especially CT and MRI scans, are pricey for the average citizen of a country where the monthly minimum wage is N18,000 – N30,000 (\$50 - \$83 USD) (66,67). A cranial CT scan costs about N35,000 - N40,000 (\$97 - \$111 USD), while a lumbosacral MRI costs up to N75,000 - N80,000 (\$208-\$222 USD). Even for those enrolled in the National Health Insurance Scheme (NHIS), expensive investigations, such as CT scans and MRI scans, are only partly covered (68,69).

### **Role of private sector and investment opportunities**

The public healthcare system is weak due to lack of adequate funding, personnel, and equipment for optimum service delivery. Payment is made out-of-pocket by most individuals requiring radiological evaluation and management (31).

Despite the advent of entrepreneurial diagnostic centers, the radiological market is far from being saturated, with several goldmines still untapped. For example:

- No Health Management Organization (HMO) is listed on the Nigerian Stock Exchange (70,71). There is an opportunity for mergers of HMOs to enhance capacity to manage millions of enrollees and enhance coverage of radiological investigations.
- No standard software exists for industry operations (29). Thus, there is an opportunity to provide technology solutions to drive healthcare and radiological operations. A huge market exists for cost-effective Electronic Medical Records and PACS Systems in Nigeria.
- Expanding the health insurance packages to include coverage of private radio-diagnostic centers in order to improve access to radiological services.



### **Availability of internet connection**

There is high internet penetration in Nigeria, with over 98.3 million active internet subscribers (72). All major operators in the mobile telecommunication industry currently boast broadband internet services with available 3G and H+ (Evolved High-Speed Packet Access) in most towns and villages. 4G LTE technology is currently available in the major cities such as Lagos, Abuja, and Port-Harcourt, with gradual spread into the remote areas. Free Wi-Fi services are available at selected locations, such as hotels and airports. Various prepaid and post-paid data packages are available for individual and corporate entities on the major carriers.

### **Disease profile**

With the increase in Westernization, there has been a gradual rise in the prevalence of lifestyle-related diseases such as hypertension (28.9%) (73) and diabetes mellitus (2%) (74). The prevalence of HIV is approximately 2.8% (75), malaria 61.1 % (76) and tuberculosis 24.8% (77). The leading causes of death in Nigeria as of 2017 are malaria (20%), lower respiratory infections (19%), HIV (9%), diarrheal diseases (5%), road injuries (5%), cancer (3%), and tuberculosis (2%) (78).

## **Visiting Nigeria**

### **Culture and tourism**

There are at least 250 ethnic nationalities distributed across the 36 states (79) and the Federal Capital Territory of Nigeria. The three largest ethnic groups are Hausa, Yoruba, and Igbo. The large number of ethnic groups reflects great diversity in spoken languages as well as cultural practices (79). Nigeria is home to a large number of tourist attractions, including abundant waterfalls, warm and cold springs, game reserves, plateaus, beaches, and other natural attractions. Currently, Nigeria has two UNESCO-designated World Heritage Centres and another 10 on a tentative list (80-82). Apart from these, there are many other tourist attractions in the country (83,84).

### **Climate and time to travel**

Nigeria has only two seasons: the dry season and the rainy season. The rainy season spans from late March or April until November, while the dry season spans November to February or March.

The dry season is usually accompanied by a dusty air mass from the Sahara Desert, locally referred to as Harmattan. Abuja, the Federal Capital Territory located in central Nigeria, has an average temperature of 18.45 C to 36.9 C, with an annual rainfall of about 1,500 mm (85,86). Nigeria can be visited all year round, with international airports in Lagos, Kano, Abuja, and Port-Harcourt.

### **Local currency**

The local currency is the naira (N). Major foreign currencies such as USD, Euro and GBP can be converted to naira and vice versa at any of the local banks or bureau de change. By law, the maximum allowable cash you can travel with is

capped at \$10,000 USD or its equivalent in other currencies.

### **Accommodation**

There are standard hotels ranging from one-star to five-star accommodations. Depending on location and taste, a decent room could cost between N5,000 and N150,000 per night.

### **Health advisory**

Like most sub-Saharan countries, proof of yellow fever vaccination is required for entrants into the country above nine months of age (87). There is also the risk of malaria. Malaria prophylaxis is needed while traveling in Nigeria. Insecticide-treated nets are recommended for prevention of mosquito bites. There are standard pharmaceutical stores, and it is relatively easy to schedule an appointment to see a physician in one of the numerous private health facilities. Hygienic bottled water is ideal for drinking. There is a wide variety of both local and continental dishes available at most hotels and restaurants.

### **Local safety and security**

Most parts of the country are peaceful and safe. Boko Haram terrorism in the North-Eastern part of the country has been significantly curtailed (88). The restive Niger Delta has been enjoying stability and relative harmony due to renewed social inclusiveness and a commitment to implementing the comprehensive peace, security and development plan for the region (88).

### **Conflict of interest**

The authors report no conflict of interest.

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