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ORIGINAL ARTICLE

Density and regional distribution of radiologists in a low-income country: the Ghana situation

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Abstract

Background This study assessed the density and distribution of radiologists across all 16 regions in Ghana to generate reference information for planning and policy formulation to encourage radiology specialization and in designing systems to improve the dissemination of radiological services across all the regions in Ghana.

Method A cross-sectional design was used to collect secondary data on all radiologists ($n=93$) registered with the Medical and Dental Council of Ghana (MDCG) as of December 2022. This information collected on the records of the MDCG was confirmed with records from the Ghana Association of Radiologists. Population and land area data were also collected from the National Statistical Service of Ghana for each region in the country. The Stata statistical software version 15 was used to analyze the data collected.

Results There were 93 radiologists in the country. The majority were male ($n=60$, 65%) and about one-third of the radiologists were female. The national density of radiologists was 1.9 radiologists per 5000 km^2. Only 3 of the 16 regions in the country had a better distribution of radiologists per 5000 km^2. There were three radiologists per million people in Ghana with a skewed regional distribution. Seven out of the 16 regions lacked radiologists. The proportion of female radiologists stationed within the Greater Accra and Ashanti regions was 87.9% (29/33). The Bono, Eastern, Northern, and Western regions had one female radiologist each.

Conclusions Actions are needed to improve the shortage and skewed distribution of radiologists. The outcome will help to improve radiological services across all the regions in Ghana.

Keywords Radiologists · Ghana · Radiology human resources · Low-income country · Imaging

Abbreviations

CHPS Compound	Community-based health planning and services
MRI	Magnetic resonance imaging
CT	Computed tomography

Introduction

Radiologists play an unmatched role in healthcare institutions across the world. They provide valuable input in policy formulation, screening, diagnosis, treatment, and follow-up

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of patients with new diseases as well as existing ones across almost all subspecialties of medicine [1]. The contribution of imaging departments to health care delivery has grown proportionately with the fast-paced advancement seen in health-related technology. Improving knowledge through sub-specialization and attempts to incorporate machine learning and artificial intelligence models in routine radiology practice hold a lot of promise for the future of the specialty with respect to providing evidence-based care for clients [2, 3].

Despite these global developments, most African countries including Ghana are yet to catch up fully with the current imaging trends, though they have seen significant growth and increased relevance in patient management over the last decade [4]. This deficiency is observed with respect to the availability of human resources and radiological equipment [5].

According to international guidelines reviewed, an estimate of 100–120 radiologists is acceptable for a million population. Countries such as Germany and the United States of America have enough radiologists to meet this requirement [6]. On the contrary, most African countries are far from reaching this goal. This shortage is intense in Ghana and was estimated by Edzie et al. from data collected in 2019 to be less than two radiologists for every million Ghanaians which is at least 50 times worse than the recommended numbers [6]. Moreover, there are insufficient subspecialists in interventional radiology, pediatric radiology, female imaging, and neuroradiology. Nigeria has a worse situation as 250–300 radiologists were reported to serve a population of over 174 million people [7].

The cause of this relatively low number of radiologists in Ghana is multifactorial and includes issues relating to government policy, medical education system, and socioeconomic factors. Interventions of the government of Ghana and the Ministry of health are skewed toward attaining universal primary health care and preventive medicine with less focus on specialized and curative care [8]. Even in specialized care, priority is given to specialties such as obstetrics and gynecology as well as child health, because these areas align directly with the country's goals of reducing infant and maternal mortality. However, it has to be mentioned that radiological services even form the backbone for providing adequate maternal and child health services, since radiologists are vital in the monitoring of both early and late diseases including pregnancy complications as well as neonatal illnesses associated with prematurity, intrauterine growth restriction and congenital anomalies. Thus, sufficient radiologic monitoring of pregnant women and their unborn babies at all levels of health care also contributes to a reduction of infant and maternal mortality and brings countries closer to achieving sustainable development goals. Moreover, radiologists provide immense support for screening and diagnostic services in almost every clinical discipline to improve the health and well-being of people.

Currently, training to become a radiologist in Ghana involves enrolling in a 4-year residency program which a doctor qualifies for after meeting all requirements such as a 2-year mandatory housemanship after medical school and 2–3 years of work in a district, regional or teaching hospital as a medical officer. Most doctors after this long route of medical training may opt for a shorter residency program even if they decide to specialize at all. Radiology has informally been reported in Ghana as a specialty with a few entrants but a relatively high attrition rate. Though this claim needs further investigation to bring clarity, the structure of the residency program is such that candidates who fail one of the many examinations are delayed thus, further prolonging the 4-year program. Most of the remaining specialties conduct a final exit exam which is at the end of a 3-year residency program and many doctors find this arrangement more convenient.

There are three accredited radiology training centers in the country. These include the Korle-Bu Teaching Hospital, 37 Military Hospital, and Komfo Anokye Teaching Hospital. Two of these centers are located in the Greater Accra Region (the capital city), whereas the Komfo Anokye Teaching Hospital is sited in the Ashanti region. The limited number of training sites coupled with few specialists account for the low intake and subsequent low output seen in the field.

The rural areas in Ghana are disadvantaged in terms of health outcomes mostly because of a lack of adequate health infrastructure and human resources [9]. This human resource challenge is seen among all cadres of health workers [10, 11]. The scarcity of radiologists in Ghana may affect rural dwellers disproportionately, because it compounds their existing socio-economic and infrastructural challenges. Although attempts are being made to improve the number of radiologists in Ghana, there is a lack of data on the density and regional distribution of radiologists in Ghana for planning. Consequently, this study was undertaken to assess the density and distribution of radiologists across all 16 regions in Ghana to generate reference information for planning and policy formulation to encourage radiology specialization and in designing systems to improve the dissemination of radiological services across all the regions in Ghana.

Methods

Study design

A cross-sectional design was chosen for this study and data were conveniently sampled from the register of the Medical and Dental Council of Ghana.

Study setting

The study was conducted in Ghana, a low-middle income country in West Africa with a total population of about 31 million according to the 2021 population and housing census. There are 16 regions, 6 of which are newly created from the previous 10 regions in the country. The country boasts of 1 quaternary hospital, 5 teaching hospitals, and a regional hospital in each of the previous 10 regional capitals. There are also several district and community hospitals as well as private facilities and Community-Based Health Planning and Services (CHPS Compound) facilities.

Study participants and size

The study gathered data on the distribution of radiologists across all regions in Ghana. Here, secondary data on all radiologists registered with the Medical and Dental Council of Ghana (MDCG) as of December 2022 were collected. The MDCG is the legal body that regulates medical doctors' practice in Ghana. Hence, the professional records of all radiologists, totalling, 93 on the register were reviewed. This information was confirmed with records from the Ghana Association of Radiologists, which is the society radiologists in Ghana belong to. The population and land area data were also collected from the National Statistical Service of Ghana for each of the regions in the country.

Study variables

The variables assessed in the study were the density and distribution of radiologists across all 16 regions in Ghana to generate reference information for planning and policy formulation to encourage radiology specialization and in designing systems to improve the dissemination of radiological services across all the regions in Ghana. In particular, the study accessed data on gender, staff distribution, age, location, the number of people radiologists were serving, and the number of radiologists per 5000 square kilometers.

Data from the registers were entered into Microsoft Excel version 23 for management and scrutiny. After ensuring that the current data were appropriately entered, they were then transferred to the Stata statistical software version 15 for analysis.

Data analysis

The Stata statistical software version 15 was used to process and analyze the data collected using descriptive statistics. The number of radiologists per 1,000,000 population as well as the number of radiologists per 5000 square kilometers (km^2) of land area was computed for all 16 regions to further explain the distribution and how it affected access.

Radiologists sampled were categorized by sex and plotted on a map to give more detail on the distribution of radiologists by sex in the country. The presence of a radiologist in a region may not translate directly into improved accessibility of the basic radiological services as this also depends on the availability of functioning equipment, work output of radiologists, affordability of services, and the peculiar health needs of a population. This is a limitation which requires further investigation in subsequent studies.

Ethical approval for this study was waived by the Euracare Ethics and Research Protocol Committee (Ref Number EADHC 1010/20–21).

Results

There were 93 radiologists in the country. The majority of radiologists in Ghana were male and they formed 65% (60/93) of all the radiologists in the country. Approximately one-third ($n=33$, 35%) of the radiologists were female.

Figure 1 shows the uneven distribution of the few radiologists in the country. The Northern half of the country is least served. There were 3 radiologists in the Northern region. There were 2 radiologists stationed in Ho, the capital town of the Volta region. The Eastern region had 4 radiologists.

The Western and Central regions had one and five radiologists, respectively, and their services could extend to cover the remaining regions where there was no radiologist.

The Bono East, Bono, and Ashanti regions are located in the central parts of Ghana and had 2, 3, and 19 radiologists, respectively. The Ashanti region which is the second most populous region had a relatively better share of the nation's radiologists. The Greater Accra region which is the smallest region had the highest number of radiologists. These 54 radiologists served the most populous region in the country. There were more radiologists in the Greater Accra region than in the rest of the 15 regions in the country. There was no radiologist in 7 out of the 16 regions in the country and these regions included Ahafo, North East, Oti, Savannah, Upper East, Upper West, and the Western North regions.

The proportion of female radiologists stationed within the Greater Accra and Ashanti regions was 87.9% (29/33). The Bono, Eastern, Northern, and Western regions had one female radiologist each. The regional distribution of female radiologists in Ghana is also presented in Fig. 2.

The frequency of radiologists and population in the 16 regions in Ghana can be found in Table 1, while the distribution of radiologists per 1,000,000 population in the 16 regions in Ghana is presented in Fig. 3.

The Greater Accra, Ashanti and Bono regions had 9.9, 3.5, and 2.5 radiologists per 1,000,000 population, respectively. Eight regions had less than one (1) radiologist per 1,000,000 population. In the Western region, there was 1

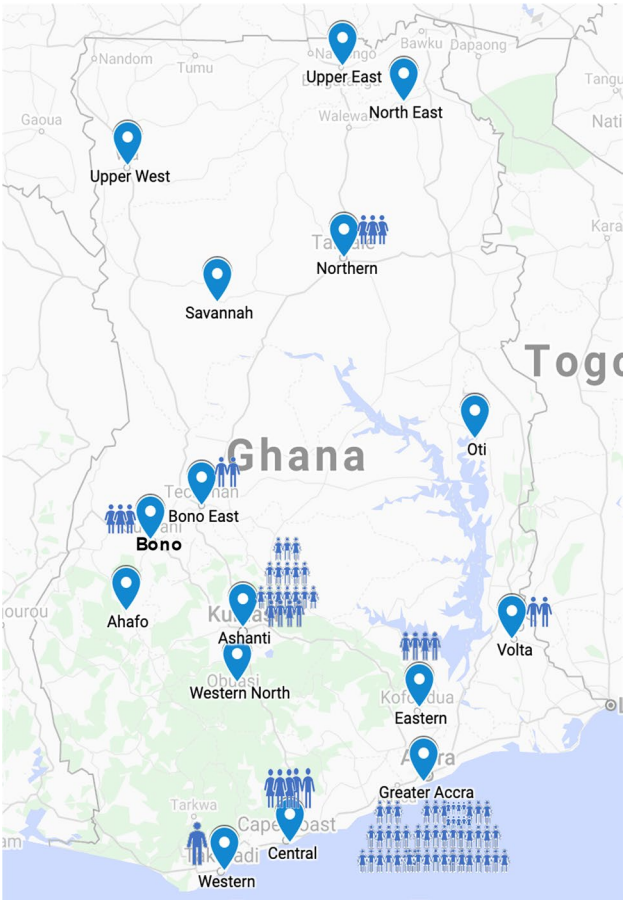

Fig. 1 Regional distribution of radiologists in Ghana (December 2022)

radiologist serving a population of over 2 million people (6.7% of the national population). Using the national figures in the evaluation showed that there were 3 radiologists per million people in Ghana.

There were only five radiologists with a sub-specialty (Fig. 4) at the time of writing this article. These included one neurointerventional radiologist, one diagnostic neuroradiologist, two interventional radiologists, and one pediatric radiologist. Only the pediatric radiologist was female. Moreover, all the radiologists with sub-specialty were located in the capital, Accra, except the two interventional radiologists; one was in the Ashanti region, and the other was in the central region of Ghana.

Estimation of the regional density of radiologists per 5000 square kilometers indicated that the Greater Accra region again had the best density with 83.2 radiologists. The Ashanti region which is eight times as large as the Greater Accra region had 3.9 radiologists per 5000 square kilometers. The Central region with a total land area of 9826 square kilometers had 2.5 radiologists per 5000 square kilometers. The remaining regions had from 0 to 2 radiologists per 5000 square kilometers. The national density of radiologists revealed that there were 1.9 radiologists per 5000 km^2 in Ghana. Only 3 of the 16 regions in the country had better distribution of radiologists per 5000 km^2. The distribution of radiologists per 5000 square kilometers in the 16 regions of Ghana is presented in Table 2.

Discussion

The northern, upper east, and upper west regions of Ghana are among the most deprived areas in the country [12, 13]. The Ghana Poverty Mapping (GPM) report used the poverty line ofGH₵1314 to categorize people living in poverty. With a population of 2,445,061, northern region has 44.2% of the people living below the poverty line. This is followed by the upper east region which has 46% of the population (1,034,688) living below the poverty line. Out of 688,328 people in the upper west region, 69.4% live below the poverty line (Ghana Statistical Service, 2015). There is often a lack of medical equipment including radiological machines in these deprived communities, as the priority of policymakers remains the provision of basic amenities, such as safe drinking water, roads, schools, and basic health care and not the provision of sophisticated and specialized equipment such as those required for the day-to-day work of a radiologist. There is a consequent lack of appetite for radiologists to move to such areas. Without basic medical care in rural communities, radiological services may never become well established. This, however, does not remove the need for such services, since the occurrence of diseases is independent of the availability of medical specialists.

To improve radiological services in these deprived areas, other specialties must be enhanced and equipped with adequate specialists, since radiologists depend on requests from colleague doctors in these other fields [3]. These non-radiology specialists are required to make initial diagnoses and request radiological procedures to confirm or rule out their suspicions.

Similar to the northern parts of Ghana, the Oti region which has comparable demographic characteristics suffer the same shortage. People in these deprived and poor areas may not be able to afford sophisticated investigations such as magnetic resonance imaging (MRI) and computed tomography (CT) scans as can their urban counterparts. Empowering the people economically is as crucial as making available radiological services.

Most of the country's development is around the central and southern parts. This somehow compares with the distribution of radiologists in this study. The Eastern, Ashanti, Bono, and Bono East regions are better off economically compared to the northern regions and have more development in terms of social amenities available to them in

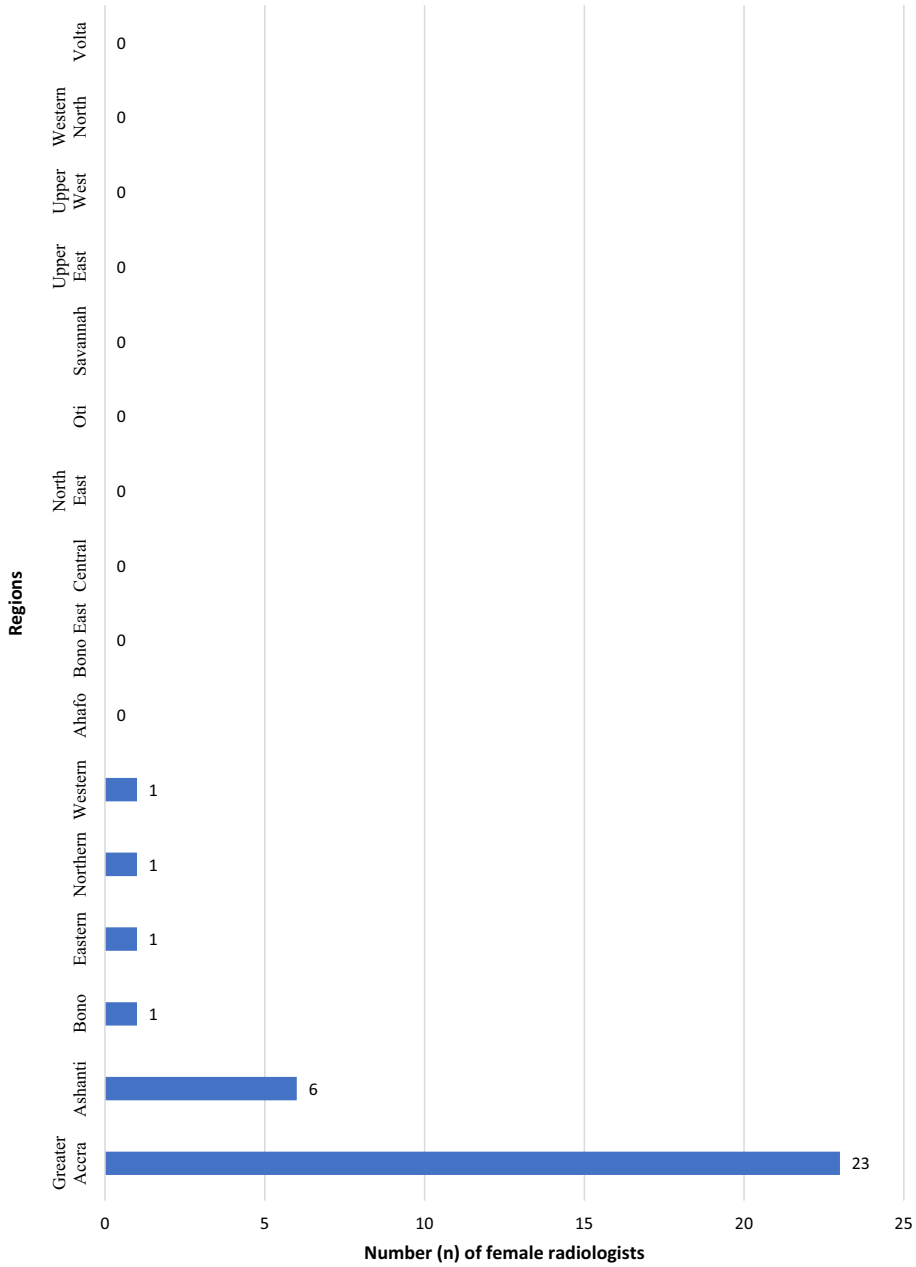

Fig. 2 Regional distribution of female radiologists in Ghana (December 2022)

addition to a higher number of radiologists. Most of the radiologists serve the population from the regional capitals which commonly hold the regional hospitals. The Ashanti region is economically empowered and has seen a good share of social development.

The Greater Accra region is the most developed region in Ghana and has the highest number of radiologists. Apart from two interventional radiologists stationed outside this region, the other three radiologists with subspecialties, such as neurointerventional radiologists, diagnostic neuroradiologist, interventional radiologists, and a pediatric radiologist, are all within the capital, which also has at least three (3) medical schools. This finding demonstrates that sub-specialty radiology services in the country are also not evenly distributed. Many factors could account for this, but radiologists, like most doctors, are attracted to developed areas of the country where social amenities are not challenging to come by. In such developed regions, radiologists have access to private practice to support the low income provided to them by the government. Most of the technology required to adequately practice radiology exists in developed regions.[1] Radiologists may select stations that are well equipped to support the improvement of the skills they acquired during training.

Male radiologists were more than female radiologists in Ghana by a ratio of approximately 2:1. There was also

Table 1 Frequency of radiologists and population in the 16 regions in Ghana (December 2022)

Regions	Number of radiologists		Population of region	
	Frequency	%	Frequency	%
National median	1.5			
Ahafo	0	0	564,536	1.8
Ashanti	19	20.4	5,432,485	17.6
Bono East	2	2.2	1,203,306	3.9
Bono	3	3.2	1,208,965	3.9
Central	5	5.4	2,859,821	9.3
Eastern	4	4.3	2,917,039	9.5
Greater Accra	54	58.1	5,446,237	17.7
North East	0	0	658,903	2.1
Northern	3	3.2	2,310,943	7.5
Oti	0	0	747,227	2.4
Savannah	0	0	649,627	2.1
Upper East	0	0	1,301,221	4.2
Upper West	0	0	904,695	2.9
Western	1	1.1	2,057,225	6.7
Western North	0	0	880,855	2.9
Volta	2	2.2	1,649,523	5.4
Total (*n*)	93	100	30,792,608	100

only female radiologist with sub-specialty, within the area of pediatric radiology. This low number in female radiologists could be because of the relatively long training period but must be separately investigated. Women have a biological clock and cater for the home in ways most Ghanaian men do not and these may contribute to their relatively low numbers in a field as demanding as radiology. To improve the rural number of radiologists, however, training more females, unfortunately, may not cause drastic change, since this study has indicated that the female radiologists in the country are based in and around the developed cities. This claim is supported by Bowman et al. who found that female health workers prefer to work in urban centers [9, 14].

The Greater Accra region took over from the Ashanti region as the most populous region according to the latest population census. Though more than half of the country's radiologists are located in the Greater Accra Region, they are still inadequate for the size of the population as only ten radiologists were matched to approximately 1 million population. In the Ashanti region, approximately four radiologists catered for a million population. These two regions have tertiary facilities that require them to extend services to nearby regions.

Considering standards set by high-income countries, the Greater Accra and Ashanti regions need at least ten times more radiologists to adequately serve their population. The remaining 14 regions had less than three radiologists per million population. A thoughtful policy is required to improve the situation. Heavy workload posed by the shortage of radiologists could lead to delayed diagnosis, increased reporting errors, and reduced work output due to exhaustion and radiologist burnout. Screening and emergency facilities may also be severely affected by the unavailability of radiologists. Advancement in radiology-related research might stagnate due to the inadequate number of radiologists, because patient care must be prioritized.

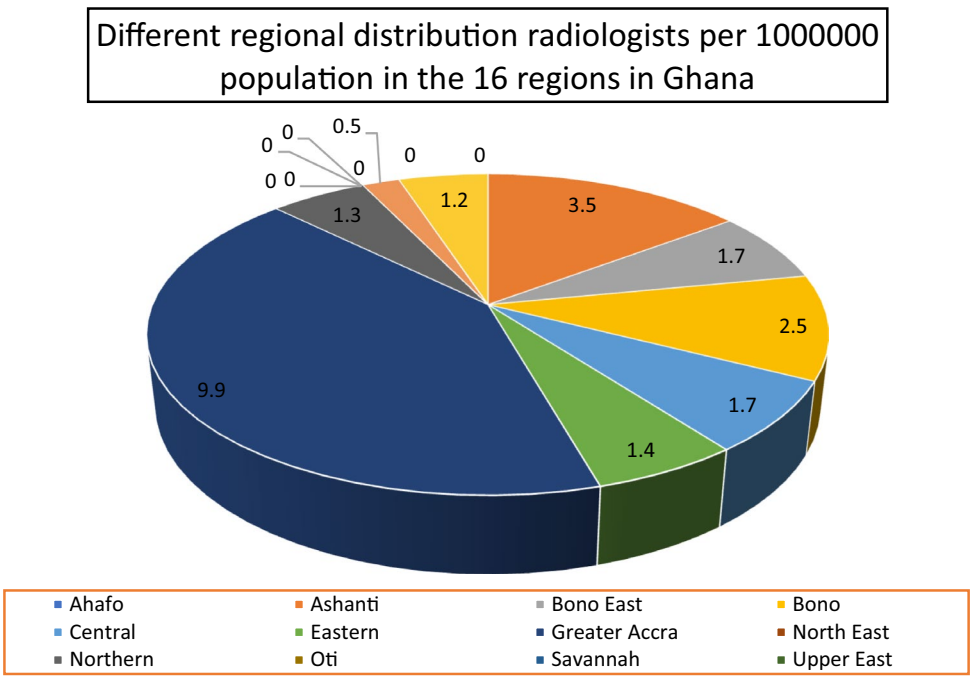

Fig. 3 Regional distribution radiologists per 1,000,000 population in the 16 regions in Ghana

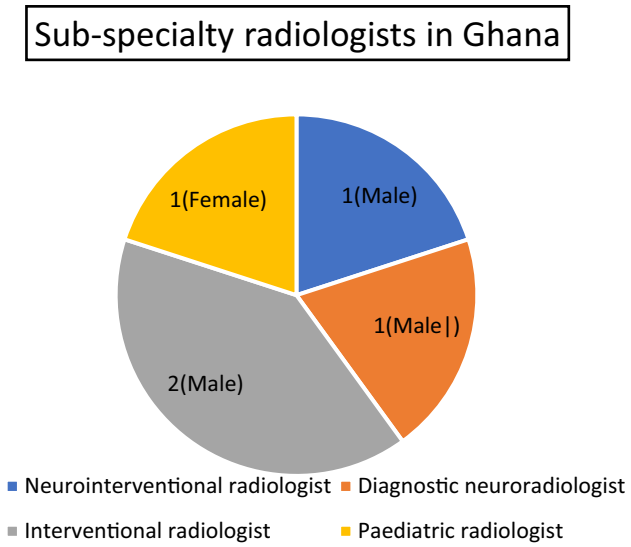

Fig. 4 Sub-specialty radiologists in Ghana

Table 2 Radiologists per 5000 square kilometer in the 16 regions of Ghana (December 2022)

Regions	Land size		Number of radiologists	Radiologists per 5000 km^2
	km^2	%		
Ahafo	5196	2.2	0	0
Ashanti	24,389	10.2	19	3.9
Bono East	23,248	9.7	2	0.4
Bono	11,113	4.7	3	1.3
Central	9826	4.1	5	2.5
Eastern	19,323	8.1	4	1.0
Greater Accra	3245	1.4	54	83.2
North East	9070	3.8	0	0
Northern	26,524	11.1	3	0.6
Oti	11,066	4.6	0	0
Savannah	34,790	14.6	0	0
Upper East	8842	3.7	0	0
Upper West	18,476	7.7	0	0
Western	13,842	5.8	1	0.4
Western North	10,079	4.2	0	0
Volta	9504	4.0	2	1.1
Total	238,533	100	93	1.9

Approximately two radiologists served a 5000 km^2 area in Ghana. This generally implies that many Ghanaians do not readily have access to a radiologist in a nearby town and have to travel tens of kilometers to receive care from radiologists within their zone.

The inhabitants of the Greater Accra region travel a relatively shorter distance to access radiological services as there were approximately eighty-four radiologists covering a zone of 5000 km^2. The populace of the Ashanti region has roughly four radiologists per 5000 km^2 which are only marginally higher than the average national figures. People in the northern parts of the country have it worse because of the large land size, poor infrastructural development, and scarcity of radiologists. The long distances traveled coupled with poor road infrastructure could affect health outcomes gravely.

While this work provides crucial information, a limitation is that it did not obtain more demographic information about these radiologists, such as age, professional background, and educational qualifications for analysis. The study also did not consider the ratio of radiologists to equipment as a factor due to a lack of data on the number of imaging equipment in the country.

Conclusions

There is a shortage of radiologists at all levels of the health care system in Ghana. The northern half of the country is worst affected by this shortage. This means that the available ones may be overworked as a small number caters for millions of Ghanaians. Actions are needed to address the situation to improve the accessibility of radiological medical resources and good health outcomes in different provinces. The government can achieve this by encouraging the training of more radiologists, with a focus on attracting candidates from rural areas. It can also develop policies to incentivize radiologists to work in underserved regions, possibly through financial or career advancement incentives. Moreover, addressing the gender disparity in radiology by promoting inclusivity and investigating factors discouraging female doctors from choosing radiology, and encouraging policies that promote gender diversity in medical specialties, will help increase the number of female radiologists in the country. There is also a need to conduct more research to uncover factors influencing the unattractiveness of radiology residency for some doctor.

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Authors' contributions BDS was involved in conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; resources; software; supervision; validation; visualization; roles/writing—original draft; writing—review & editing. BOB was involved in: formal analysis; methodology; software; supervision; validation; visualization; roles/writing—original draft; writing—review & editing. YBM was involved in: project administration; resources; software; supervision; validation; visualization; roles/writing—original draft; writing—review & editing. ET was involved in: methodology; validation; roles/writing—original draft; writing—review & editing. BBJ was involved in methodology; validation; roles/writing—original draft; writing—review & editing. EKB was involved in: validation; roles/writing—original draft; writing—review

& editing. KD-T was also involved in: methodology; validation; roles/writing—original draft; writing—review & editing. All authors read and approved the final manuscript.

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Availability of data and materials All data generated or analyzed during this study are included in this published article.

Declarations

Conflict of interest The authors declare that they have no competing interests.

Ethical approval and consent to participate Ethical approval for this study was waived by the Euracare Ethics and Research Protocol Committee (Ref Number EADHC 1010/20–21).

Consent for publication This article does not contain any individual person's data in any form. Consent for publication was included in the ethical approval (Ref Number EADHC 1010/20–21).

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