Mammography and Breast Ultrasonography Services in Ghana, Availability, and Geographic Access

Matthew D. Price, MD MPH[1,2]; Meghan E. Mali, MD, MS[1,3]; Florence Dedey, MBChB, FWACS[4]; Klenam Dzefi-Tettey, MBChB, FWACS, FGCP[5]; Yao Li, PhD[6,7]; Cameron Almeida, BS[8]; Kirstyn E. Brownson, MD[1,3,9]; Raymond R. Price, MD[1,3,10]; and Edward Kofi Sutherland, MD, MPH[1,7,11]

DOI https://doi.org/10.1200/GO.24.00218

ABSTRACT

PURPOSE Breast cancer is the leading type of cancer diagnosed and the second leading cause of cancer-related death in Ghana. Mammography and ultrasound have proven benefits in the early detection of breast cancer. This study evaluates mammography, breast ultrasound, and radiology work force availability throughout Ghana.

METHODS A survey was administered to all hospitals in Ghana from November 2020 to October 2021. Mammography, breast ultrasound services, and the number of radiologists were assessed. For mammography, the number performed per month, cost incurred by the patient, where images were read, and how long it took to receive reports were also assessed. Health Facilities Regulatory Authority records on diagnostic centers were obtained to identify additional in-country breast imaging services.

RESULTS Three hundred and twenty-eight of 346 hospitals participated in the survey (95%). Only 21 hospitals reported on-site mammography. One hospital reported performing >100 mammographies per month. The average cost to the patient ranged from 100 to 500 Cedis ($17-87 US dollars [USD]), although three hospitals performed mammography at no cost. An additional 10 mammography machines were identified at diagnostic centers throughout the country, with 41.3% of the female population living within 1 hour of mammography services. There were 135 hospital-based breast ultrasound services identified with 69.5% of the female population living within 1 hour of these services. There were an additional 190 ultrasound machines at diagnostic centers. There were 96 in-country radiologists identified.

CONCLUSION Although there is limited availability and utilization of mammography in Ghana, there is more readily available ultrasonography. A focus on increasing breast cancer early diagnostic capabilities with breast ultrasound should be prioritized in addition to further expansion of the radiology workforce.

Accepted July 29, 2024
Published August 29, 2024

JCO Global Oncol 10:e2400218

INTRODUCTION

Breast cancer is a significant health challenge in Ghana, with increasing incidence and mortality among women.[1-3] Late-stage presentations, related to limited access to screening, diagnostic, and treatment services, and cultural perceptions surrounding the disease exacerbate the burden of breast cancer in the country.[4-6] Despite efforts to raise awareness and improve health care services, breast cancer remains the leading cancer-related diagnosis and the second leading cause of cancer-related death.[7] Most women with breast cancer in Ghana present in advanced stages, with nearly 90% presenting with axillary lymph node involvement.[8] Those in Ghana who are diagnosed early in the disease course have been shown to have similar outcomes to those in high-resourced settings; however, with the majority presenting at a late stage, the overall 5-year survival for those with breast cancer in Ghana is 48%.[8]

Detecting breast cancer early along with timely intervention and treatment is key for improved morbidity and mortality.[9] Many high-resourced countries have achieved significant improvements in breast cancer survival because of utilization of breast cancer screening through mammography with resultant earlier detection rates.[9-11] Most international guidelines, in high-resourced settings, recommend biennial or annual mammographic screening for women age 40-74 years.[10] However, women in Ghana are a decade younger on

CONTEXT

Key Objective

This study aims to evaluate the availability and capacity of breast cancer imaging modalities, including mammography and ultrasonography, across hospitals and diagnostic centers across Ghana.

Knowledge Generated

This study reveals a significant shortfall in mammography services, with only 6% of hospitals offering on-site mammography and a total of 31 mammography machines identified throughout the country when including those from hospitals and diagnostic centers. Ultrasonography was found to be much more widely available with 41% of hospitals offering this service for breast cancer diagnostics and 69.5% of the female population living within 1-hour travel radius of breast ultrasonography services.

Relevance

These findings highlight the need for enhanced breast imaging services in Ghana, particularly the potential for increased utilization of ultrasonography for early breast cancer diagnosis. Improving access and affordability of these services could lead to earlier detection and better outcomes for patients with breast cancer in Ghana.

average at diagnosis than women in other high-resourced settings, indicating a need for altered guidelines where resources allow.[12]

The application of mammography and breast ultrasonography in Ghana faces logistical, economic, and even ethical challenges, including limited equipment, trained personnel, and limited treatment options once a diagnosis is made.[13-15] Despite this, ultrasound has emerged as a valuable alternative to mammography with similar diagnostic sensitivity and specificity.[13,16,17] The availability, geographic access, and use of mammography and ultrasonography at hospitals and diagnostic centers throughout Ghana is not well documented in the literature.

This study aims to assess the availability and capacity of mammography and breast ultrasonography nationwide throughout Ghana in addition to other imaging modalities important in the workup of breast cancer such as magnetic resonance imaging (MRI) and computed tomography (CT). The geographic availability of hospital-based mammography and ultrasonography has been published previously, but this study seeks to provide a more comprehensive and detailed assessment of these imaging modalities by including the services provided at non–hospital-based diagnostic centers.[14] Additionally, we provide an in-depth assessment of the usage of mammography services, the process and timeline for patients to receive their reports, and the number of radiologists throughout the country.

METHODS

Study Design

A cross-sectional study design using both primary and secondary data was used. For primary data collection, a comprehensive, in-person survey was carried out in hospitals across Ghana from November 2020 through October 2021, with 94.8% of hospitals participating. The survey's focus was on the availability of breast and cervical cancer services as outlined in the National Comprehensive Cancer Network's Framework for Resource Stratification and included a subsurvey on mammography services.[18] This paper focuses on the mammography subsurvey in addition to breast ultrasonography and the other breast cancer imaging modalities identified. The survey was a collaboration between the Ensign Global College in Ghana, the Ghana Health Service (GHS), and the University of Utah Center for Global Surgery, and has been described in detail previously.[14,15,19]

To outline the landscape of breast imaging services more fully throughout Ghana, secondary data on locations of diagnostic centers with equipment providing services for ultrasonography and mammography nationwide were extracted from the database of the Ghana Health Facilities Regulatory Agency between May 7 and 31, 2020.

The GHS Ethics Review Committee provided institutional review board (IRB) approval for this study, and further administrative approval was obtained from each of the teaching hospitals who participated. Additionally, IRB approval was waived by the Johns Hopkins School of Public Health on November 28, 2022, for the use of existing deidentified data and not involving human subjects research.

Mammography Personnel and Services

The number of radiologists at each hospital was identified and we additionally ascertained whether or not mammography was available on site to patients. If mammography was offered on-site, the hospital respondents were then asked to complete the mammography subsurvey (Fig 1). The

1. Does your hospital have on-site mammography? (Y1, Y0, N)
2. Does the hospital keep records of the mammograms they perform?
3. Number of mammograms per month that the facility performs:
   a. 1-10
   b. 11-30
   c. 31-100
   d. ≥100
4. Is mammography free for the patient? (Y1, Y0, N)
5. If mammography is not always free for the patient, how much does it cost?
   a. <100 Cedi
   b. 100-500 Cedi
   c. ≥500 Cedi
6. Does insurance cover part or all of the cost? (Y1, Y0, N)
7. Which insurance?
   a. National Health Insurance Scheme (NHIS)
   b. Private
   c. Other
8. If NHIS, is mammography 100% covered (free to the patient)? (Y1, Y0, N)
9. Who interprets mammograms?
   a. Outside facility
   b. In-house nonradiologist (such as a surgeon)
   c. In-house radiologist
   d. Other
10. If mammogram interpretation is at an external facility, list facility name and location (including country if appropriate).
11. How long does it take for the patient to receive their reports?
    a. <2 weeks
    b. 2 weeks to 1 month
    c. ≥1 month

FIG 1. Subsurvey questions pertaining to mammography services. N, not available; Y0, sometimes available; Y1, usually available.

subsurvey asked if mammography was usually available, defined as >80% of the time in the year preceding the survey, or only sometimes available, defined as <80% of the time in the year preceding the survey. The subsurvey also queried if the hospitals kept records of the mammographies performed, the number performed each month, if mammography services were usually free to patients (using the same >80% or <80% threshold as mammography availability), sometimes free, and if not free or only sometimes free, if insurance helps cover the cost. Further questions included who interprets the mammographic images and how long it takes for patients to receive their results.

The total number of mammography machines throughout the country was assessed by combining the total number identified in the nationwide hospital-based survey and those identified from the diagnostic center records. Diagnostic center records did not include frequency of use, cost to the patient, or any of the other components of the hospital-based subsurvey on mammography.

Using a published algorithm, which recommends a minimum of 1.2 fully functional mammography machines per every 10,000 women older than 40 years for adequate population-based screening, we estimated the number of additional mammography machines needed in Ghana to scale up a potential future national breast cancer screening program.[20,21]

Additional Breast Imaging Services

Other modalities of breast imaging, including breast ultrasound, MRI, and CT scans for distant metastatic disease assessment, were identified. The hospital-based primary data collection specifically identified if ultrasound machines were used for dedicated breast and axillary imaging. However, the diagnostic center data only provided counts and locations of additional ultrasound, MRI, and CT machines. We were unable to ascertain if these services were available for breast-specific imaging or for other purposes at individual diagnostic centers.

Geospatial Mapping

Population counts were generated using the age and sex structure data provided by the WorldPop Hub.[22] We accessed the Ghana total female population estimates for the year 2020, which detail the total number of females of any age per grid square.[23] Travel radius for health care access was computed by using the Service Area analysis feature of ArcGIS Pro 3.1 to estimate the 1-hour travel radius for three categories of health care facilities: (1) hospitals and diagnostic centers equipped with mammography, (2) hospitals offering ultrasound services, and (3) a combination of 1 and 2, meaning hospitals providing either mammography or ultrasound and diagnostic centers with mammography. Service areas were delineated to illustrate the extents of

accessibility via road networks. Our estimations leveraged comprehensive street data that incorporate static travel times, on the basis of historical average speeds for automobile traffic allowing for our analysis results to remain consistent across different times of the day.[24]

RESULTS

Mammography

Of the 328 hospitals that participated in the survey, 21 (6%) reported on-site mammography. At 17 (81%) of these sites, mammography services were reported as being usually available and four (19%) were only sometimes available (Table 1). All hospitals kept records of mammographies done. Only one hospital reported performing over 100 mammographies per month, while six (29%) performed 31-100, six (29%) performed 11-30, and eight (38%) 1-10 mammographies/month. Mammography was usually free to the patient at three (14%) hospitals, sometimes free at one (5%) hospital, with the other 17 (81%) reporting mammography was not free for patients and would cost 100-500 Ghana Cedis ($17-$85 US dollars [USD]—at the time of the survey). Most hospitals (n = 17, 80%) reported insurance would not cover the cost of mammography and the few instances where insurance would cover, two (10%) hospitals reported private insurance would cover mammography services and two (10%) hospitals reported the National Health Insurance Scheme (NHIS) would cover the cost of mammography services.

Nearly all hospitals with mammography (n = 19, 90%) reported that patients received reports of their mammogram findings in under 2 weeks, while two (10%) hospitals noted that it could take up to 1 month for patients to receive their report. Just over half (n = 11, 52%) of the hospitals had on-site interpretation of mammographic images by a radiologist, while eight (38%) reported interpretation by radiologists at outside facilities, and two (10%) reported interpretation was done in house by nonradiologists, such as the in-house surgeons. Of the eight hospitals with off-site interpretation of mammograms, half (n = 4, 50%) would send their imaging for interpretation to a major teaching hospital in Accra, and the other half sent to off-site radiology consulting groups.

An additional 10 in-country mammography machines were identified at diagnostic centers, making a total of 31 in-country mammography machines (Table 2). In total, 41.3% of the female population lived within 1 hour of mammography services (Fig 2). Excluding other significant resources that would be needed to conduct appropriate mammography diagnostic services, an estimated 437 fully functioning mammography machines would be needed to run a successful national mammography screening campaign, indicating a shortfall of 406 mammography machines.[20]

Breast Ultrasound

Diagnostic breast ultrasound was available at 135 (41%) of the 328 hospitals that participated in the survey (Table 1). Confirmed breast ultrasound services were within 1 hour of travel time for 69.5% of the female population in Ghana. Axillary ultrasound imaging was available at 108 (33%) hospitals. Another 43 hospitals reported on-site ultrasound machines that were not used for breast or axillary imaging. An additional 190 ultrasound machines were identified at diagnostic centers throughout the country, but whether they were used for breast- or axillary-specific imaging is unknown (Table 2). When evaluating all mammography services and confirmed breast ultrasound imaging locations, 70.0% of the female population lived within 1 hour of a location that can provide breast imaging. With 69.5% already shown to have access to ultrasound within 1 hour, this indicates that mammography alone only adds 0.5% of further coverage (Fig 3).

MRI

A total of 11 MRI machines were identified throughout Ghana. Of these, seven were identified in the hospital-based survey and four via diagnostic center records. These machines were located in the Greater Accra (n = 7, 64%), Ashanti (n = 2, 18%), Northern (n = 1, 9%), and Eastern (n = 1, 9%) regions.

CT Scan

CT scanners were highly concentrated in the Greater Accra region where 14 (52%) of the 27 total CT machines were located. CT scanners were also more commonly located in hospitals (n = 19, 70%) than in diagnostic centers (n = 8, 30%). Outside the Greater Accra region, the geographic spread of CT scanners in Ghana were as follows: five (19%) in the Western region, three (11%) in the Ashanti region, two (7%) each in the Eastern and Bono regions, and one (4%) in the Central region.

Distribution of Radiologists

There were 96 in-country radiologists identified, with three radiologists for every 1,000,000 persons (Table 3). The majority of radiologists were concentrated in the Greater Accra and Ashanti regions, although the greatest concentration per population size was in the Western and Western North regions. The Upper East, Upper West, Oti, Savannah, North East, and Ahafo regions had no radiologists.

DISCUSSION

This study provides critical insights into the state of breast cancer diagnostic imaging capacity in Ghana and highlights the resource limitations and access disparities. Our findings underscore a significant shortfall of mammography services

TABLE 1. Distribution of Hospital-Based Mammography and Breast Ultrasound Service Availability in Ghana by Regions

Region	Female Population (% of total)	Hospitals Surveyed (% of total hospitals)	Hospital-Based Mammography	Breast Ultrasound	Breast and Axillary Ultrasound
Ashanti	3,139,126 (20)	70 (21)	2	36	35
Greater Accra	2,625,568 (17)	88 (27)	13	36	25
Eastern	1,584,298 (10)	34 (11)	—	5	2
Central	1,448,002 (9)	21 (6)	1	7	4
Western region	1,026,668 (7)	18 (6)	1	14	13
Northern	995,839 (6)	13 (4)	—	1	1
Volta	989,043 (6)	16 (5)	2	5	3
Upper East	583,896 (4)	11 (3)	—	2	1
Bono	542,959 (4)	11 (3)	2	8	7
Bono East	540,577 (4)	12 (4)	—	8	4
Upper West	421,450 (3)	8 (2)	—	3	3
Western North	370,656 (2)	10 (3)	—	7	7
Oti	361,045 (2)	6 (2)	—	—	—
Savannah	307,584 (2)	3 (1)	—	—	—
North East	305,454 (2)	4 (1)	—	1	1
Ahafo	276,091 (2)	3 (1)	—	2	2
TOTAL	15,518,259	328	21	135	108

with only a small percentage of hospitals and diagnostic centers providing access to mammography. Breast ultrasonography is more widely available in Ghana, however, offering a potential opportunity for leveraging this modality to shorten the amount of time it takes for a woman to be diagnosed with breast cancer. Additionally, this study identifies the number and geographic spread of radiologists throughout the country, showing they are heavily skewed toward urban areas.

Mammography is a standard breast cancer screening tool in many high-resourced countries, contributing to earlier detection of breast cancer and improved survival.[10] In Ghana, a population-based breast cancer screening program, with mammography, is currently unrealistic because of the limited availability and use of this service. Although a fully functional mammography machine in the United States has been shown to perform around 500 mammographies per

TABLE 2. Distribution of Diagnostic Center Breast Imaging Services Throughout Ghana by Regions

Region	Female Population (% of total)	Diagnostic Centers (% of total)	Mammography	Ultrasound[a]
Ashanti	3,139,126 (20)	29 (18)	4	44
Greater Accra	2,625,568 (17)	60 (38)	5	67
Eastern	1,584,298 (10)	15 (9)	1	15
Central	1,448,002 (9)	10 (6)	—	11
Western region	1,026,668 (7)	11 (7)	—	11
Northern	995,839 (6)	6 (4)	—	7
Volta	989,043 (6)	5 (3)	—	5
Upper East	583,896 (4)	2 (1)	—	4
Bono	542,959 (4)	11 (7)	—	12
Bono East	540,577 (4)	5 (3)	—	6
Upper West	421,450 (3)	3 (2)	—	5
Western North	370,656 (2)	2 (1)	—	2
Oti	361,045 (2)	0 (0)	—	—
Savannah	307,584 (2)	0 (0)	—	—
North East	305,454 (2)	1 (1)	—	1
Ahafo	276,091 (2)	0 (0)	—	—
Total	15,518,259	160	10	190

[a]Diagnostic center data do not distinguish if the ultrasounds available are used for breast imaging or other imaging.

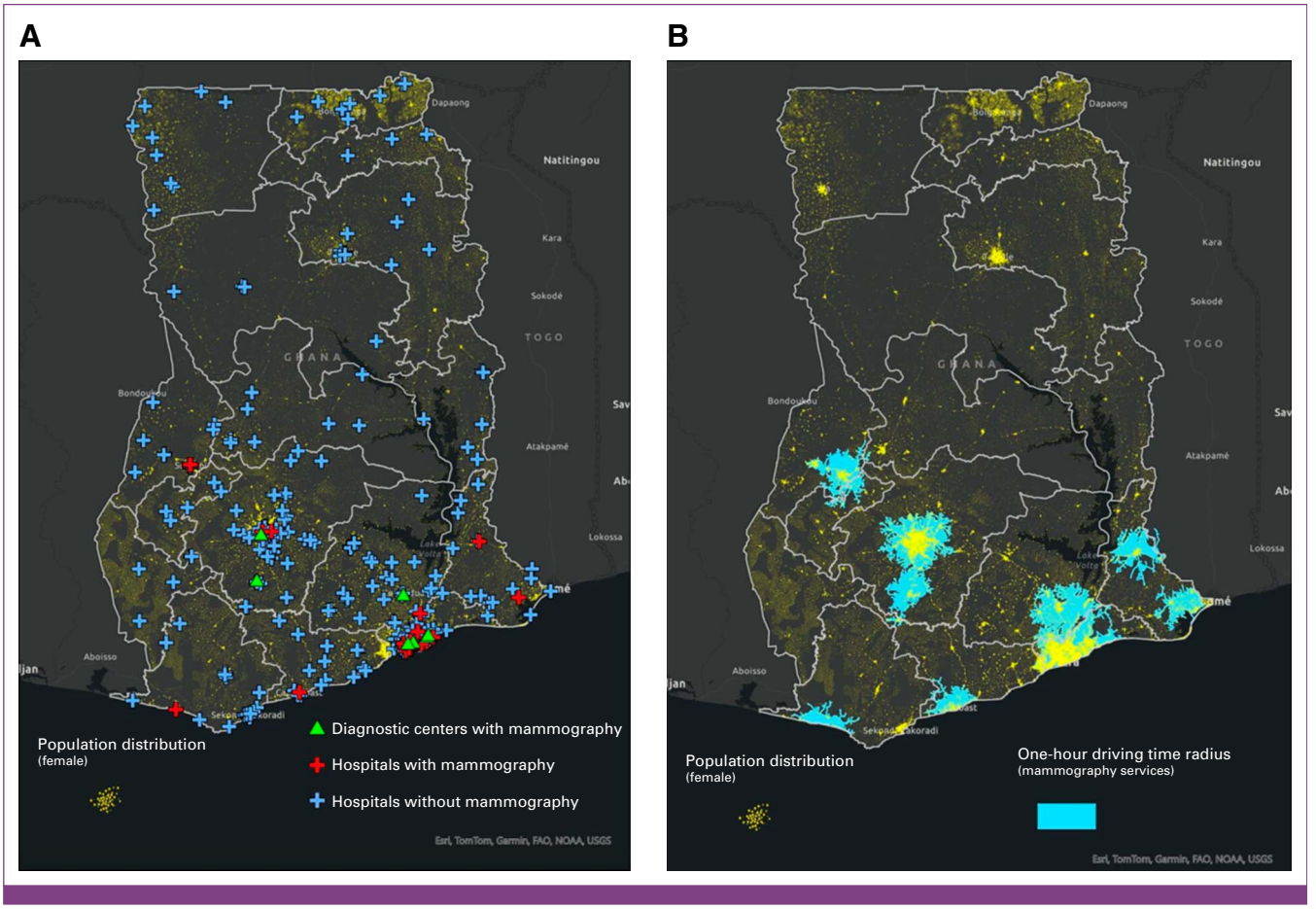

FIG 2. Nationwide mammography coverage in Ghana. (A) Geographic location of hospitals and diagnostic centers with mammography and hospitals without mammography services. (B) Assessment of 1-hour drive time to mammography services.

month, only one of the 21 hospital-based mammography machines in Ghana performed more than 100 per month.[20,21] There are many factors that may contribute to the limited use of mammography, including patient-centered factors such as lack of social support, limited understanding of the benefits of mammography screening, and perceived or real financial burden. There are also system-level factors including, but not limited to, proximity to services, availability of trained personnel, and functional equipment.[25] Although our study does show that 41.3% of women live within 1 hour of mammography services in Ghana, further work is needed to identify the specific reasons the available mammography machines are not more frequently used. Importantly, before initiation of any population-based screening program in Ghana, sufficient treatment services must be available so that the increased number of patients who are diagnosed through asymptomatic screening have pathways to obtain treatment.[26] Although treatment pathways exist in Ghana, further work is needed to scale up treatment capacity and access before initiating population-based screening as has been done in other settings.[15,27]

Breast ultrasound is much more widely available, and increased utilization of breast and axillary ultrasound in Ghana could result in a shorter time to breast cancer diagnosis. Mammography has long been the gold standard for breast cancer screening and diagnosis; however, two meta-analyses in 2018 and 2023 compared the two breast imaging modalities and found similar sensitivity and specificity between mammography and ultrasound when it comes to diagnostic imaging with the recommendation of using breast ultrasound for early diagnosis in resource-constrained settings.[13,16] This is not the case for screening of asymptomatic women, in which mammography has outperformed ultrasound. Even in high-resourced settings, breast ultrasound is often preferred as the initial imaging modality for diagnostic workup of a clinical breast concern over mammography in younger women as younger women tend to have more dense breasts, which can decrease the sensitivity of mammography.[10,28] In Ghana, this should be further considered when establishing diagnostic imaging guidelines as women in Ghana tend to be diagnosed on average a full decade earlier than women in high-resourced settings.[12,29-31] Although we show that 69.5% of women in Ghana live within an hour of the 135 hospitals that offer breast ultrasound, there were an additional 233 ultrasound machines across the country that may or may not also be used for breast imaging. Even if breast ultrasonography is more readily available, patients still may encounter barriers to early breast cancer treatment that need to be addressed such as lack of

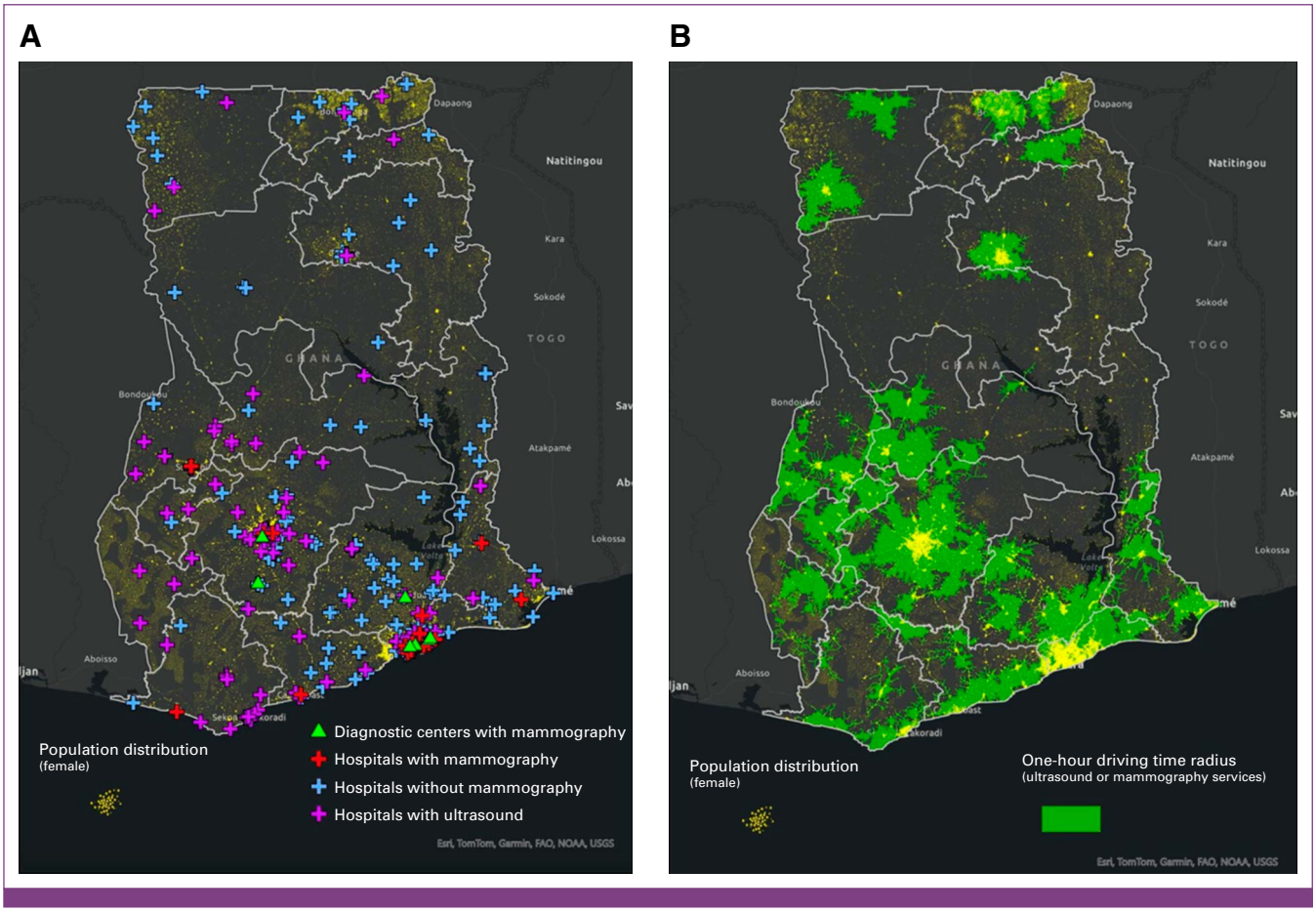

FIG 3. Nationwide breast imaging coverage (mammography or ultrasound) in Ghana. (A) Geographic location of hospitals and diagnostic centers with mammography or breast ultrasound services and hospitals without mammography services. (B) Assessment of 1-hour drive time to mammography or breast ultrasound services.

TABLE 3. Distribution of Radiologists Across Ghana

Region	Population (% of total)	Radiologists (% of total)	Radiologist Per Million Population
Ashanti	6,352,774 (20)	26 (27)	4.1
Greater Accra	5,318,674 (17)	28 (29)	5.3
Eastern	3,154,986 (10)	2 (2)	0.6
Central	2,784,282 (9)	3 (3)	1.1
Western region	2,101,432 (7)	17 (18)	8.1
Northern	1,999,079 (6)	4 (4)	2.0
Volta	1,897,386 (6)	3 (3)	1.6
Bono East	1,118,344 (4)	2 (2)	1.8
Upper East	1,116,908 (4)	0 (0)	—
Bono	1,088,238 (4)	3 (3)	2.8
Upper West	803,893 (3)	0 (0)	—
Western North	774,716 (2)	8 (9)	10.3
Oti	738,791 (2)	0 (0)	—
Savannah	627,997 (2)	0 (0)	—
North East	609,895 (2)	0 (0)	—
Ahafo	569,476 (2)	0 (0)	—
Total	31,056,972	96	3.0

knowledge about breast cancer signs and symptoms, and financial and health system barriers to initiating treatment. Additionally, use of breast ultrasonography may be limited by the availability of trained specialists who can perform and interpret this image. One notable challenge to increased utilization of breast ultrasound is that a diagnostic breast ultrasound can take more than 15 minutes to perform, whereas mammography takes <2 minutes.

An important component to all imaging modalities is skilled interpretation of images. Our study identified 96 radiologists across Ghana, validating the findings of a recent publication that assessed the records of the Medical and Dental Council of Ghana.[32] Although most radiologists were concentrated in urban areas, in this specialty, it is possible for images to be read from external remote locations. This is evident in our study with one third of hospitals sending their mammographic images to external locations for a radiologist to read. Even with the utility of reading images remotely, having only three radiologists per one million population demonstrates a significant shortfall. The West African College of Surgeons (WACS) and the Ghana College of Physicians and Surgeons (GCPS) are the two colleges that train radiologists in Ghana. WACS was established in 1960 and covers the West African subregion. Training of radiologists started in Ghana in 1999 and examinations were held in Nigeria. The GCPS was established locally in Ghana in 2003, and training started in 2004, resulting in increased enrollment and an increasing number of radiologists.[33] General diagnostic radiology training takes a minimum of 4 years to complete with the option of pursuing 2-3 years of fellowship training in general radiology or currently available subspecialties such as interventional radiology, breast imaging, pediatric radiology, and neuroradiology. Another component important to successful imaging is skilled technicians in obtaining the images to be read. The ultrasound or mammography technician workforce was not assessed as part of the survey and should be a focus of future works.

One key finding of our study is that in most cases, mammography was not free for patients. In fact, only two hospitals reported that the NHIS would cover the cost of mammography. The NHIS in Ghana rolled out in 2004 with the aim of providing universal health coverage.[34,35] Services for breast cancer are reportedly included in the coverage provided by the NHIS.[34] However, to receive health coverage from the NHIS, individuals must first enroll in the program annually by paying a premium of 30 Ghana Cedis ($5 USD) or by contributing to the Social Security and National Insurance Trust.[35] Because of the financial burden of these premiums, lack of knowledge on how to enroll, and a multitude of other factors, the most recent estimates show that only around 39% of the population in Ghana are enrolled in the NHIS.[35,36] Those who are successfully enrolled often encounter difficulties with services not being covered. Even when insurance does cover part of a service, there generally remained a fee for service.[37] Further work is needed to ensure that services are not only available to patients, but affordable. Once a mammogram is performed in Ghana, patients receive their results in under 1-2 weeks, which is similar with timing seen in high-resource settings.

There are several notable limitations to this study. First are the potential changes in the landscape since these data were collected. Health service availability and the distribution of health care professionals are dynamic, underscoring the need for ongoing monitoring and research to keep up to date with the evolving trends and needs. Additionally, we make an assessment of the number of mammography machines that would be needed for population-based screening in Ghana. A more appropriate assessment could be the number of diagnostic services that would be needed, but we were unable to identify a similar published algorithm for the number of necessary diagnostic services. Additionally, the number of needed diagnostic services can be harder to assess as it can vary by population demographics and needs. This paper also only focuses on imaging modalities needed in the diagnosis of breast cancer. Other necessary aspects of obtaining a diagnosis include excisional or core needle biopsy and pathologic review.[14]

In conclusion, this study provides a comprehensive assessment of the availability of breast cancer imaging services in Ghana. We illustrate the profound shortage of mammography services, yet concurrently spotlight ultrasonography as a viable, more accessible alternative for imaging the breast and diagnosing breast cancer. Although screening mammography remains an ideal, it is not currently feasible on a wide scale in Ghana because of multiple socioeconomic and systems challenges. The number and geographic distribution of radiologists further complicates this issue. This research further highlights the underutilization of the NHIS and the cost barriers for patients, calling for a reinforced strategy to integrate breast cancer services into the national coverage in a way that is financially accessible. This study advocates for a recalibrated focus on breast ultrasound utilization, improved insurance coverage, and further training of radiology professionals to advance toward a more equitable and effective pathway for early diagnosis of breast cancer in Ghana.

AFFILIATIONS

[1]Center for Global Surgery, The University of Utah, Salt Lake City, UT
[2]Department of Surgery, The Johns Hopkins University School of Medicine, Baltimore, MD
[3]Department of Surgery, The University of Utah School of Medicine, Salt Lake City, UT
[4]Department of Surgery, University of Ghana Medical School, Accra, Ghana
[5]Department of Radiology, Korle Bu Teaching Hospital, Accra, Ghana
[6]Department of Geography & Earth Sciences, The University of North Carolina at Charlotte, Charlotte, NC

[7]Department of Epidemiology, The Johns Hopkins Bloomberg School of Public Health, Baltimore, MD
[8]University of Alabama Birmingham School of Medicine, Birmingham, AL
[9]Huntsman Cancer Institute, Salt Lake City, UT
[10]Intermountain Health, Salt Lake City, UT
[11]Ensign Global College, Kpong, Ghana

CORRESPONDING AUTHOR

Edward Kofi Sutherland, MD, MPH; e-mail: sutherlandmd@yahoo.com.

PRIOR PRESENTATION

Presented in part at the 14th African Organization for Research and Training in Cancer (AORTIC) International Conference on Cancer, Africa, Dakar, Senegal, November 4, 2023.

SUPPORT

Supported by the University of Utah Center for Global Surgery through the Gardner & Holt Grant with no specific grant or award number. Additional funding included the National Cancer Institute (NCI) Grant No. T32CA126607 (M.D.P.).

AUTHOR CONTRIBUTIONS

Conception and design: Matthew D. Price, Meghan E. Mali, Raymond R. Price, Edward Kofi Sutherland
Financial support: Edward Kofi Sutherland
Administrative support: Klenam Dzefi-Tettey, Raymond R. Price, Edward Kofi Sutherland
Collection and assembly of data: Matthew D. Price, Meghan E. Mali, Klenam Dzefi-Tettey, Raymond R. Price, Edward Kofi Sutherland
Data analysis and interpretation: Matthew D. Price, Florence Dedey, Yao Li, Cameron Almeida, Kirstyn E. Brownson, Raymond R. Price, Edward Kofi Sutherland
Manuscript writing: All authors
Final approval of manuscript: All authors
Accountable for all aspects of the work: All authors

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

The following represents disclosure information provided by authors of this manuscript. All relationships are considered compensated unless otherwise noted. Relationships are self-held unless noted. I = Immediate Family Member, Inst = My Institution. Relationships may not relate to the subject matter of this manuscript. For more information about ASCO's conflict of interest policy, please refer to www.asco.org/rwc or ascopubs.org/go/authors/author-center.
Open Payments is a public database containing information reported by companies about payments made to US-licensed physicians (Open Payments).

Meghan E. Mali
Employment: The University of Utah Hospital

Cameron Almeida
Consulting or Advisory Role: Inland Empire Health Plan

Kirstyn E. Brownson
Consulting or Advisory Role: ImpediMed

Raymond R. Price
Honoraria: Johns Hopkins Hospital

No other potential conflicts of interest were reported.

ACKNOWLEDGMENT

The authors acknowledge the following persons and institutions for their immense contributions toward the success of the project: Dr Alberta Biritwum-Nyarko and Mrs Irina Ofei, both of the Ghana Health Services; the Director General of the Ghana Health Services, Dr Patrick Kuma Aboagye; the Health Facilities Regulatory Agency, Ghana; the Ensign Global College; Dr Moustafa Moustafa; Dr Ousman Sanyang; Dr Grace Ayensu-Danquah; and Mr Jonathan Nellermoe.

REFERENCES

1. Naku Ghartey Jnr F, Anyanful A, Eliason S, et al: Pattern of breast cancer distribution in Ghana: A survey to enhance early detection, diagnosis, and treatment. Int J Breast Cancer 2016:3645308, 2016
2. Der EM, Gyasi RK, Tettey Y, et al: Triple-negative breast cancer in Ghanaian women: The Korle Bu teaching hospital experience. Breast J 21:627-633, 2015
3. The World Health Organization International Agency for Research on Cancer: The Global Cancer Obseratory G. Ghana Cancer Statistics 2020. 2021
4. Asobayire A, Barley R: Women's cultural perceptions and attitudes towards breast cancer: Northern Ghana. Health Promot Int 30:647-657, 2015
5. Obrist M, Osei-Bonsu E, Awuah B, et al: Factors related to incomplete treatment of breast cancer in Kumasi, Ghana. Breast 23:821-828, 2014
6. Agbokey F, Kudzawu E, Dzodzomenyo M, et al: Knowledge and health seeking behaviour of breast cancer patients in Ghana. Int J Breast Cancer 2019:5239840, 2019
7. Globocan: Ghana source: Globocan incidence, mortality, and prevalence by cancer site. https://gco.iarc.fr/today/data/factsheets/populations/288-ghana-fact-sheets.pdf
8. Mensah AC, Yarney J, Nokoe SK, et al: Survival outcomes of breast cancer in Ghana: An analysis of clinicopathological features. OALib 03:1-11, 2016
9. Zurrida S, Veronesi U: Milestones in breast cancer treatment. Breast J 21:3-12, 2015
10. Ren W, Chen M, Qiao Y, et al: Global guidelines for breast cancer screening: A systematic review. Breast 64:85-99, 2022
11. Hooshmand S, Reed WM, Suleiman ME, et al: Screening mammography: Diagnostic efficacy-issues and considerations for the 2020s. Radiat Prot Dosimetry 197:54-62, 2021
12. Thomas AS, Kidwell KM, Oppong JK, et al: Breast cancer in Ghana: Demonstrating the need for population-based cancer registries in low- and middle-income countries. JCO Glob Oncol 10.1200/JGO.2016.006098
13. Sood R, Rositch AF, Shakoor D, et al: Ultrasound for breast cancer detection globally: A systematic review and meta-analysis. JCO Glob Oncol 10.1200/JGO.19.00127
14. Price MD, Rositch AF, Dedey F, et al: Availability and geographic access to hospital-based breast cancer diagnostic services in Ghana. JCO Glob Oncol 10.1200/GO.23.00231
15. Schoenhals S, Mali ME, Sutherland EK, et al: Geospatial availability of breast cancer treatment modalities and hypothetical access improvement in Ghana: A nationwide survey. PLoS One 18: e0291454, 2023
16. Tadesse GF, Tegaw EM, Abdisa EK: Diagnostic performance of mammography and ultrasound in breast cancer: A systematic review and meta-analysis. J Ultrasound 26:355-367, 2023
17. Omidiji OA, Campbell PC, Irurhe NK, et al: Breast cancer screening in a resource poor country: Ultrasound versus mammography. Ghana Med J 51:6-12, 2017
18. Network NCC. NCCN Framework for Resource Stratification for Breast Cancer. The National Comprehensive Cancer Network. http://nccn.org
19. Moustafa M, Mali ME, Lopez-Verdugo F, et al: Surveying and mapping breast cancer services in Ghana: A cross-sectional pilot study in the Eastern region. BMJ Open 11:e051122, 2021
20. Elkin EB, Ishill NM, Snow JG, et al: Geographic access and the use of screening mammography. Med Care 48:349-356, 2010
21. US Government Accountability Office (GAO): Mammography: Current Nationwide Capacity Is Adequat, but Access Problems May Exist in Certain Locations. 2006. https://www.gao.gov/products/gao-06-724
22. WorldPop: Open Spatial Demographic Data and Research. https://hub.worldpop.org/

23. Bondarenko M, Kerr D, Sorichetta A, et al: Estimates of Total Number of People Per Grid Square, Adjusted to Match the Corresponding UNPD 2020 Estimates and Broken Down by Gender and Age Groupings, Produced Using Ecopia.AI and Maxar Technologies Building Footprints. Southampton, United Kingdom, WorldPop, University of Southampton
24. ArcGIS Pro Online Network Coverage. 2024. https://doc.arcgis.com/en/arcgis-online/reference/network-coverage.htm
25. M Salama BM: Factors affecting mammography screening utilization among educated women in Al Beheira Governorate, Egypt. Indian J Community Med 45:522-525, 2020
26. Raghavan N, Jatoi I: Prioritizing mammography screening in developing countries: Are we putting the cart before the horse? Ann Surg Oncol 31:1430-1432, 2024
27. Mittra I, Mishra GA, Dikshit RP, et al: Effect of screening by clinical breast examination on breast cancer incidence and mortality after 20 years: Prospective, cluster randomised controlled trial in Mumbai. BMJ 372:n256, 2021
28. Butler RS: Invited commentary: The breast density dilemma–challenges, lessons, and future directions. Radiographics 35:324-326, 2015
29. Akakpo PK, Imbeah EG, Edusei L, et al: Clinicopathologic characteristics of early-onset breast cancer: A comparative analysis of cases from across Ghana. BMC Womens Health 23:5, 2023
30. Bureau USC: Median Age of Women in the United States. https://datacommons.org/place/country/USA?utm_medium=explore&mprop=age&popt=Person&cpv=gender,Female&hl=en
31. Worldometer: Ghana Demographics: Median Age. https://www.worldometers.info/demographics/ghana-demographics/#median-age
32. Sarkodie BD, Ohene-Botwe B, Mensah YB, et al: Density and regional distribution of radiologists in a low-income country: The Ghana situation. Chin J Acad Radiol 6:188-195, 2023
33. Brakohiapa W, Brakohiapa EKK, Asiamah S, et al: History of diagnostic radiology in Ghana. Postgrad Med J Ghana 12:23-31, 2023
34. Tuck CZ, Cooper R, Aryeetey R, et al: A critical review and analysis of the context, current burden, and application of policy to improve cancer equity in Ghana. Int J Equity Health 22:254, 2023
35. Kipo-Sunyehzi DD, Ayanore MA, Dzidzonu DK, et al: Ghana's journey towards universal health coverage: The Role of the national health insurance Scheme. Eur J Investig Health Psychol Educ 10: 94-109, 2019
36. Christmals CD, Aidam K: Implementation of the National Health Insurance Scheme (NHIS) in Ghana: Lessons for South Africa and low- and middle-income countries. Risk Manag Healthc Policy 13: 1879-1904, 2020
37. Boamah Mensah AB, Mensah KB, Aborigo RA, et al: Breast cancer screening pathways in Ghana: Applying an exploratory single case study methodology with cross-case analysis. Heliyon 8: e11413, 2022