BIRGIT ERTL-WAGNER, MD

Radiology Education in Africa: Analysis of Results From 13 African Countries

Bhavya Rehani, MD, Isaiah Brown, MS, Shebani Dandekar, MS, Benjamin Sarkodie, FWACS, Gladys Mwango, MMed, Madan M. Rehani, PhD, Lawrence Lau, MBBS, Yi C. Zhang, MD, William P. Dillon, MD

INTRODUCTION

Rapid innovation in radiology has led to continual advances in subspecialty knowledge, with significant implications for radiology teaching. Radiology training programs around the world face a challenging task in both teaching a common knowledge base across all the imaging modalities and in imparting deep subspecialty knowledge within each imaging domain.

There is a lack of literature about the radiology education infrastructure in Africa. This gap in the literature can be challenging for radiologists who would like to collaborate, contribute, and learn from differences, similarities, and challenges in radiology education systems outside their countries. There is a wide range of training infrastructure and assessment methods across the globe with respect to preclinical qualifications, radiology residency structure, on-call requirements, access to teaching, and certifying national or board examinations [1]. Learning about variations in residency training may encourage exchange of comparative experiences to better prepare trainees for an ever-evolving practice environment.

The aim of our study is to analyze country-specific data in Africa about radiology residency and subspecialty education, research needs, and opportunities to collaborate.

METHODS

This study is a part of a worldwide survey on radiology education that spans countries in Africa, Asia, Latin America, and Europe [2-4]. For each continent, a comprehensive radiology survey (Table 1) was created to analyze the radiology educational infrastructure. The 14-item survey was distributed via e-mail to members of the International Society of Radiology, national radiology societies, radiologists, and medical physicists. Reminders to complete the survey were sent, and the results were analyzed over a period of 4 months (January to April 2016).

To check the accuracy of information submitted, we contacted radiologists and representatives of national radiology and neuroradiology societies by e-mail to validate the responses and answer specific discordant questions. The discordance rate was 38% (5 of 13 countries) for at least one question. If there were discrepancies among multiple responses from any given country, we contacted all respondents by e-mail to clarify their responses. Descriptive statistics such as percentage and range calculations were used to analyze and summarize data.

A total of 43 responses were received from 13 countries. Multiple radiologists in Africa forwarded the survey to their contacts and colleagues in different countries, so an accurate estimate of number of surveys that were sent out or response rate cannot be reliably made.

Each survey consisted of questions assessing medical school, internship, radiology residency, fellowships and subspecialties, medical physics, research, and accreditation, along with supplemental questions specifically targeted to their specific audiences.

Radiology Residency

Apart from the overall infrastructure of radiology residency and subspecialty training, we also asked respondents about access to radiology residency programs by asking about the number of radiology residency programs in the country.

Subspecialty Residency Training

Subspecialty fellowship program availability and type of fellowship training were assessed.

National or University-Based Board-Certifying Examination and Research

The type of national or university-based board-certifying examination was questioned. Research requirements to finish residency training were assessed.

1546-1440/16/$36.00 ■ http://dx.doi.org/10.1016/j.jacr.2016.08.012

Table 1. List of survey questions

a. How long is medical school in your country excluding internship?
b. Is internship required in your country?
c. How long is the radiology residency/post-graduate training in your country including internship in number of years?
d. Please provide the number of radiology residency programs in your country (rough estimate if exact figure is not known):
e. Is subspecialty radiology fellowship training available in your country?
f. Which subspecialty fellowship trainings are available in your country?
g. Are there research requirements for radiology residents/trainees to finish training?
h. If there is a research requirement to finish training, please explain. Otherwise, please skip this question.
i. What kind of national certifying examination or university based examination is required for residents to be certified in radiology?
j. How many MRI scanners are available in your country?
k. What percentage of radiology/medical imaging procedures is done by nonradiologists?
l. Is there a degree option like MSc in medical physics in your country?
m. Who teaches medical physics to radiology residents in your country?
n. Are radiology residents formally examined for medical physics?

Medical Physics

The availability of medical physics degrees, medical physicists for education, and national radiation safety programs were queried.

RESULTS

Medical School, Internship, and Radiology Residency

Respondents from countries in Africa surveyed in our study reported a minimum of 5 years of medical school training. The average length of radiology residency programs, including internship, was 5 years. Nearly all of the respondents (92%) reported that internships are required in their countries (Table 2).

The number of radiology residency programs varied by country, but the majority of the countries (62%) had fewer than five radiology residency programs. Most countries (85%) had research requirements to complete their radiology residencies.

Subspecialty Residency Training

Subspecialty fellowship training is offered in only 2 of the 13 surveyed countries (Table 3). Ethiopia's subspecialty program is a pediatric radiology fellowship as a result of a partnership between the Department of Radiology at Addis Ababa University, the Radiological Society of Ethiopia, and the Children's Hospital of Philadelphia under the auspices of the World Federation of Pediatric Imaging. South Africa offers fellowships in interventional and pediatric radiology.

National or University-Based Board-Certifying Examination

Of the African countries that responded to the questions regarding national or university examinations in our survey, all countries reported that there are both oral and written board-certifying examinations (Table 4).

Table 2. Medical school, internship, and residency questions and responses

Country	a. Length of Medical School (Excluding Internship)	b. Internship Requirement	c. Length of Radiology Residency (Internship Included)	d. Number of Radiology Residency Programs
Algeria	≥7	No	4	6-10
Egypt	5	Yes	4	6-10
Ethiopia	6	Yes	4	1-5
Ghana	6	Yes	5	1-5
Kenya	6	Yes	6	1-5
Nigeria	6	Yes	5-6	11-20
Rwanda	6	Yes	—	0*
Senegal	≥7	Yes	≥7	6-10
Seychelles	—	Yes	—	—
South Africa	5	Yes	6	6-10
Tanzania	5	Yes	4	1-5
Uganda	5	Yes	3	1-5
Zambia	≥7	Yes	—	1-5

*Rwanda is developing its first radiology residency program, which was scheduled to begin in September 2016.

Table 3. Subspecialty and fellowship questions and responses

Country	Subspecialty Available?	Neuroradiology	Interventional	Musculoskeletal	Chest	Abdomen	Nuclear Medicine	Ultrasound	Breast Imaging	Pediatric
Algeria	No									
Egypt	No									
Ethiopia	Yes									Yes
Ghana	No									
Kenya	No									
Nigeria	No									
Rwanda	No									
Senegal	No									
Seychelles	No									
South Africa	Yes		Yes							Yes
Tanzania	No									
Uganda	No									
Zambia	No									

Medical Physics Education

Medical physics degrees are offered in 4 of 13 African countries surveyed (Algeria, Ghana, Nigeria, and South Africa) (Table 5). There is active involvement of medical physicists in educating radiology residents in roughly half of the countries (54%), and radiologists teach medical physics in fewer than a quarter of the countries (23%). Only one African country reported that both radiologists and medical physicists teach medical physics. Every country does not have a formal method of assessing medical physics in the radiology certifying examination. However, it was observed that the certifying examination for radiology included both written and oral components in most of the countries (85%) where radiology residency exists. However, the surveyed countries do not have a uniform method of assessing medical physics. The examination in medical physics consists of both written and oral components in a majority of the countries (85%).

DISCUSSION

Radiology training in Africa varies significantly from country to country. The courses and training required to obtain a medical degree take a minimum of 5 years to complete in Africa, compared with 4 years in the United States. Radiology residency programs in the African countries were on average 5 years long, compared with 4 years in the United States. The stark contrast lies in the number of residency programs available in African countries in comparison with the United States. Of the countries that responded to our survey, nearly two-thirds had fewer than five residency programs for radiology. This is substantially less than what is available in the United States, where there are 185 diagnostic

Table 4. Certification and research questions and responses

Country	g. Research Requirement for Residency	h. If Yes, Describe Research Requirement	i. Type of Certifying Examination Required (Written, Oral, or Both)	j. Number of MRI Scanners	K. Percentage of Radiology Procedures by Nonradiologists
Algeria	Yes	—	Both	—	—
Egypt	Yes	It is required for MSc or MD trainees in the university sector only	Both	Difficult to estimate	10%-15%
Ethiopia	Yes	—	Both	—	—
Ghana	Yes	—	Both	—	—
Kenya	Yes	The research projection is part of the postgraduate program and should have been completed, accepted and passed by both the internal and external examiners	Both	51-100	—
Nigeria	Yes	—	Both	—	—
Rwanda	Yes	—	Both	—	—
Senegal	Yes	—	Both	—	—
Seychelles	—	—	—	—	—
South Africa	Yes	Graduates are required to fulfill the research requirements of the MMed degree of the university running the training course	Both	>100	0%-5%
Tanzania	Yes	Residents do dissertation	Both	<5	0%-5%
Uganda	Yes	—	Both	—	—
Zambia	—	—	—	—	—

radiology residency programs accredited by the ACGME. However, there are efforts to improve the number of radiology residency programs in some of the African countries surveyed. Rwanda is currently developing its first radiology residency program for six residents at King Faisal Hospital. This program was expected to begin in September 2016.

The countries with existing radiology residency programs in Africa have research requirements that include dissertations and examinations. National certifying examinations consist of both written and oral portions among the respondents in Africa, compared with the written computer-based initial certifying examination in the United States, which draws on fellowship training knowledge.

Subspecialty fellowship training programs are not readily available in Africa. Although 90% of radiology residents in the United States complete at least one fellowship after their residencies [5], subspecialty fellowship training is available in only two countries among those surveyed in Africa. This is an annual 1-week pediatric training course held in Addis Ababa, Ethiopia, under the auspices of the World Federation of Pediatric Imaging [6].

The Department of Radiology at Addis Ababa University and the Radiological Society of Ethiopia have been in partnership with the Children's Hospital of Philadelphia for 4 years in an outreach program aimed at establishing a pediatric radiology fellowship. South Africa offers

Table 5. Medical physics questions and responses

Country	l. Medical Physics Degree	m. Medical physics Taught by (Radiologist, Medical Physicist, or Both)	n. Formal Examination of Medical Physics
Algeria	Yes	Radiologist	▪ No
Egypt	No	Medical physicist	▪ Yes, there is a separate question paper on this subject. ▪ There is only a written examination.
Ethiopia	No	Medical physicist	▪ Yes, there is a separate question paper on this subject. ▪ The examination is both written and oral.
Ghana	Yes	Medical physicist	▪ Yes there is a separate question paper on this subject. ▪ The examination is both written and oral.
Kenya	No	Medical physicist	▪ Yes there is a separate question paper on this subject. ▪ The examination is both written and oral.
Nigeria	Yes	Medical physicist (60%) Radiologists (40%)	▪ Yes there is a separate question paper on this subject. ▪ The examination is both written and oral.
Rwanda	No	—	—
Senegal	No	Radiologist	▪ Yes there is a separate question paper on this subject. ▪ The examination is both written and oral.
Seychelles	No	—	—
South Africa	Yes	Medical physicist	▪ The examination was both written and oral earlier, but now only written.
Tanzania	No	Radiologist	▪ The examination is both written and oral.
Uganda	No	Medical physicist	▪ Yes there is a separate question paper on this subject. ▪ The examination is both written and oral.
Zambia	No	—	—

pediatric and interventional radiology fellowships. Among the respondents from other countries, there were many requests for the development of subspecialty programs.

Two respondents from Uganda separately shared their concerns: "There is a need for super specialization and also practical sessions. Some of our equipment is missing and the hands on sessions are not adequate. The qualified radiologists also need fellowships." The second respondent said, "There is plenty to learn from radiology education in my country. There is so much to do but with very little resources and equipment. There is probably so much that we are missing because of limited knowledge. Any efforts to boost knowledge are very welcome." A prior study from the Ernest Cook Ultrasound Research and Education Institute in Kampala, Uganda, reported that there have been inadequate imaging requisitions and imaging reports, related to inefficiencies in the imaging systems, financing, and health policy [7].

Although the problems in every country may be unique, a lack of resources and education seemed to be a common theme among the responses. A respondent from Kenya, in East Africa, stated that the "development of subspecialty programs is needed." However, this lack of resources and training is not localized to East Africa. A radiologist from the West African nation of Nigeria mentioned similar deficiencies and provided some insight into the issue: "Some of the training centers don't have CT or MRI and residents have to rotate to other centers. We are about to start subspecialty training. We would need assistance in this respect." It has been reported that the radiology residents were concerned about the lack of modern imaging tools, facilities at their centers, as well as opportunities for exposure overseas, and the likely impact of these on their training and the future of the specialty in Nigeria [8].

Although a lack of resources was a common theme, it is not the only

barrier to subspecialty training in the countries surveyed. A radiologist from Zambia said, "Subspecialty Program not yet started. Advanced Radiology is not yet well appreciated in our country. Deliberate policies are in place to train radiology students." Understanding the local barriers before donating resources and time is necessary for any humanitarian effort to improve subspecialty training in radiology.

There is a need to strengthen medical physics training for residents using standardized assessments such as oral and written examinations. With the increasing importance of radiation dose reduction, the need for medical physics will increase in significance. Currently, Ghana is the only country with a medical physics program accredited by the International Atomic Energy Agency. Medical physics practice and training in Ghana draw on a number of courses, fellowships, and workshops from the International Atomic Energy Agency to provide support for radiation oncology and medical imaging facilities in the country [9]. Their program has grown internationally, and they now host students from other African countries.

There is a critical need to address imaging requirements for African communities. However, the available interventions have not adequately catered to these immense imaging needs [10]. Our previous study, based at the University of Nairobi in Kenya, showed that virtual education could provide supplementary radiology training to address challenges in educational infrastructure [11]. Humanitarian teleradiology services such as the free Médecins Sans Frontières international program in Malawi can overcome geographic and economic barriers to access in developing countries, but such programs can face challenges in Internet speed, low bandwidth, and high Internet service charges [12].

Limitations of our study include a small sample size, respondent bias, and limited survey comprehension because of language barriers.

CONCLUSION

Our study provides country-specific data from Africa about radiology residency and subspecialty education, research needs, and opportunities to collaborate with our African radiology colleagues.

ACKNOWLEDGMENTS

The authors thank the International Society of Radiology for collaboration and the radiologists in Africa who participated in this survey.

REFERENCES

1. Willatt JM, Mason AC. Comparison of radiology residency programs in ten countries. Eur Radiol 2006;16:437-44.
2. Rehani B, Gao KT, Lau L, Rehani MM, Zhang YC, Dillon WP. Radiology education in Asia: differences, similarities, and opportunities. J Am Coll Radiol 2017;14:111-8.
3. Rehani B, Zhang YC, Rehani MM, et al. Radiology education in Europe: analysis of results from 22 European countries. World J Radiol 2017. In press.
4. Rehani B, Gao KT, Soto G, Lau L, Rehani MM, Dillon WP. Radiology education in Latin America. J Am Coll Radiol 2017;14. In press.
5. Kaplan DA. Is a double fellowship the new standard in radiology? Diagnostic Imaging. Available at: http://www.diagnosticimaging.com/practice-management/double-fellowship-new-standard-radiology. Accessed June 8, 2016.
6. World Federation of Pediatric Imaging. Addis Ababa, Ethiopia: pediatric radiology fellowship. Available at: http://www.wfpiweb.org/Education/WFPIEducationalInitiatives/Ethiopia.aspx. Accessed August 1, 2016.
7. Kawooya MG, Pariyo G, Malwadde EK, et al. Assessing the performance of imaging health systems in five selected hospitals in Uganda. J Clin Imaging Sci 2012;2:12.
8. Adeyekun A. Residents' perception of postgraduate radiology training in Nigeria. West Afr J Med 2010;29:314-7.
9. Amuasi JH, Kyere AK, Schandorf C, et al. Medical physics practice and training in Ghana. Physica Medica 2016;6:826-30.
10. Kawooya MG. Training for rural radiology and imaging in sub-Saharan Africa: addressing the mismatch between services and population. J Clin Imaging Sci 2012;2:37.
11. Radiology International Student Education Platform. Available at: http://www.risemed.org. Accessed June 8, 2016.
12. Andronikou S. Pediatric teleradiology in low-income settings and the areas for future research in teleradiology. Front Public Health 2014;2:125.

Bhavya Rehani, MD, Isaiah Brown, MS, Shebani Dandekar, MS, Yi C. Zhang, MD, and William P. Dillon, MD, are from the University of California, San Francisco, California. Benjamin Sarkodie is from the University of Ghana School of Medicine, Accra, Ghana. Gladys Mwango, MMed, is from the University of Nairobi, Nairobi, Kenya. Madan M. Rehani, PhD, is from the Department of Radiology, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts. Lawrence Lau, MBBS, is a consultant radiologist in Melbourne, Australia.

The authors have no conflicts of interest related to the material discussed in this article.

Bhavya Rehani, MD: Department of Radiology and Biomedical Imaging, University of California, San Francisco, 505 Parnassus Avenue, San Francisco, CA 94143; e-mail: bhavya.rehani@ucsf.edu.