The Status of Specialist Neurosurgical Training in Nigeria: A Survey of Practitioners, Trainers, and Trainees

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■ OBJECTIVE: **Despite the well-known neurosurgical workforce deficit in Sub-Saharan Africa, there remains a low number of neurosurgical training programs in Nigeria. This study sought to reassess the current status of specialist neurosurgical training in the country.**

■ METHODS: **An electronic survey was distributed to all consultant neurosurgeons and neurosurgery residents in Nigeria. Demographic information and questions relating to the content, process, strengths, and challenges of neurosurgical training were explored as part of a broader survey assessing neurosurgical capacity. Descriptive statistics were used for analysis.**

■ RESULTS: **Respondents identified 15 neurosurgical training centers in Nigeria. All 15 are accredited by the West African College of Surgeons, and 6 by the National Postgraduate Medical College of Nigeria. The average duration of core neurosurgical training was 5 years. Some identified strengths of Nigerian neurosurgical training included learning opportunities provided to residents, recent growth in the neurosurgical training capacity, and satisfaction with training. Challenges included a continued low number of training programs compared to the population density, lack of subspecialty training programs, and inadequate training infrastructure.**

■ CONCLUSIONS: **Despite the high number of neurosurgery training centers in Nigeria, compared to other West African countries, the programs are still limited in number and capacity. Although this study shows apparent trainee satisfaction with the training process and contents, multiple challenges exist. Efforts at improving training capacity should focus on continuing the development and expansion of current programs, commencing subspecialty training, driving health insurance to improve funding, and increasing available infrastructure for training.**

Key words
- Challenges
- Neurosurgery
- Nigeria
- Training
- Workforce

Abbreviations and Acronyms
FWACS: Fellow of the West African College of Surgeons
LMIC: Low- and Middle- Income Country
NPMCN: National Postgraduate Medical College of Nigeria
SSA: Sub-Saharan Africa
WACS: West African College of Surgeons

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INTRODUCTION

An estimated 22.6 million patients worldwide require neurosurgical care each year, with more than half requiring operative neurosurgery.[1,2] The estimated neurosurgical case deficit globally is 5.2 million cases annually, with nearly 2 million from Africa.[1,2] An additional 23,318 neurosurgeons are needed globally to cover this burden, 8420 of which should be in the African region.[1,2] However, in 2020, there were only 1974 neurosurgeons serving 1.3 billion people in Africa.[3] Considering changes in population along with changes in the workforce, it is estimated that Africa will need an exponential neurosurgical workforce growth rate of 15.87% annually to meet the continent's neurosurgical care needs by the year 2030.[3] Because the neurosurgical workforce depends on the number of neurosurgeons completing training and joining clinical and/or academic practice, increasing opportunities in neurosurgical training will be necessary to ameliorate the unmet burden of neurosurgical disease.[3-15]

As of the year 2018, there were 11 fully-accredited and 4 partially-accredited neurosurgical training centers in Nigeria, overseen by the West African College of Surgeons (WACS) and/or the National Postgraduate Medical College of Nigeria (NPMCN).[3,5,16-19] Global partnerships focusing on neurosurgical training, like the partnership between the University of Nigeria Teaching Hospital and the Swedish Neurosurgical Society, also contribute to neurosurgical education in the country.[3,5,7,20] There are also foreign fellowships that some Nigerian neurosurgeons have utilized for the purposes of sub-specialization.[3] In addition to training to expand the specialist neurosurgical workforce, nonneurosurgery trainees are trained to provide some basic neurosurgical care through a 3-month rotation in neurosurgery during their residency rotations.[6,16,21]

Admission into specialist neurosurgical training programs in Nigeria requires possession of a Bachelor of Medicine, Bachelor of Surgery degree or equivalent, completion of a 1-year preregistration house job/internship, mandatory service in the National Youth Service Corps for Nigerians, and passing scores on a postgraduate entrance exam.[6,22] Once accepted into surgical residency, neurosurgical training in Nigeria typically lasts 6–7 years. Training begins with a 24–36 month rotation in the surgical specialties, including general surgery, trauma/accident and emergency, anesthesia, orthopedics, intensive/critical care, and rural surgery in addition to elective rotations in neurosurgery, cardiothoracic surgery, pediatric surgery, burns and plastic surgery, and urology.[6,14,16] This is followed by a membership (Part I) examination in which a candidate must obtain a "Pass" grade before they can be considered for a subsequent 48 months or more of dedicated neurosurgical training.[14,16] Apart from dedicated exposures to neurosurgical subspecialties, neurosurgery trainees also have rotations in neurology, neuropathology, anesthesia/intensive care, and neuroradiology.[16] Completion of training requires passing a final/exit fellowship (Part II) examination and completing a dissertation.[6,8,19,22,23] For the WACS program, all training sites are located at level 1 trauma centers where at least 1 neurosurgeon, 2 radiologists, 2 anesthesiologists, 2 intensivists, and 4 trauma registry staff are employed, with various prescribed lengths of post-specialization experiences to qualify as independent trainers.[5,16,24,25]

Neurosurgical training in Sub-Saharan Africa (SSA) currently faces challenges in the limited number of training programs and skewed geographic distribution of these very few programs.[3-9,14,15] Less than half of SSA countries could boast at least one neurosurgery training program, and the median program density is 0.06 training programs per 1 million inhabitants.[6] Although the West African subregion is the most populous in Africa, only 6 out of the 16 countries had at least one neurosurgical training program in 2021.[3,5,6] In fact, Nigeria had the third highest number of neurosurgical training programs in Africa, and the highest number in West Africa, accounting for over half of the neurosurgical training centers in this subregion.[3,5,6] Nevertheless, Nigeria's neurosurgical training program density of 0.05 per 1 million inhabitants is still lower than the median across Africa, emphasizing the need to increase the training opportunities available in the country.[6] This is vital in the face of the challenges in neurosurgical training that are prevalent in most SSA countries, including geographic disparities in training program location, insufficient infrastructure, limited access to research, and lack of subspecialty training.[3,6]

Therefore, to better understand the challenges faced by Nigeria, and identify solutions to address them, this study sought to reassess the current state of the nation's neurosurgical training, including perceptions of the strengths and challenges of neurosurgical education in Nigeria by neurosurgery practitioners, trainers, and trainees.

METHODS

Study Design and Tool Development

An 83-question, five-section online survey was developed and distributed to all Nigerian neurosurgeons and residents between May 7, 2022, and June 30, 2022 as described in the accompanying Methods manuscript in this issue.[26,27] This manuscript, however, focuses solely on the results of the analysis of the 27-question training assessment section. The section aimed to determine the availability and distribution of neurosurgical residency programs in Nigeria, evaluate their content and processes, and assess the perceptions of neurosurgeons and residents on the utility and functionality of the programs. Additional information on the existing neurosurgical programs was obtained through a gray literature search and review of the training program websites.

Ethical Statement

Ethical approval was obtained from Duke Health Institutional Review Board (Pro00110539) and University of Ibadan/University College Hospital, Ibadan, Ethics Committee (University of Ibadan /EC/22/0078). The study participants also completed an online informed consent and were allowed to enroll in a collaborative authorship list.

Data Analysis

Demographic details of survey participants and their institutions were descriptively analyzed. For the section on neurosurgical training, we evaluated the availability, nature, and process of neurosurgical training at the individual level for all the participants

that indicated that their institutions were involved in neurosurgical training. The findings are presented in descriptive statistics.

RESULTS

Survey Respondents

As described in the accompanying methods manuscript in this issue,[26] 149 respondents completed the survey, including 141 (94.6%) males. The mean age was 41.8 ± 6.9 years, with the majority (85; 57.1%) in the 40–49 years age group. Seventy-three consultants reported practicing as specialist neurosurgeons for 0.5–30 years (mean 6.7 ± 6.0 years). A total of 127 respondents (85.2%), comprising 69 consultants and 58 residents, completed the training assessment component of the survey.

Preneurosurgery Educational Experiences of Survey Respondents

Of all 149 survey respondents, 11 (7.4%) received a premedical bachelor's degree or diploma; all from Nigerian institutions (Table 1). 130 respondents (87.2%) reported their basic medical education; 126 (84.5%) obtained their degrees (Bachelor of Medicine, Bachelor of Surgery) in Nigeria, while 4 (2.7%) obtained their degrees from foreign institutions in Minsk, Belarus, Varna Bulgaria, and Havana Cuba. The duration of medical training ranged from 3 to 10 years (mean 6.5 ± 1.1), with the majority of the respondents (75; 50.3%) spending 6 years in training and 22 (14.8%) spending 7 years. Another 17 (11.4%) respondents had additional postgraduate qualifications; 10 (6.7%) were from Nigeria, and 7 (4.7%) were from foreign institutions in Cuba, UK, and US. Thirteen (8.7%) had Masters-level degrees in fields such as anatomy, clinical research, global health, health education, and medical emergency, while 2 (1.3%) had a Ph.D. Six (4.0%) respondents reported having preneurosurgical residency training; 4 (2.7%) in Nigeria, and 2 (1.3%) abroad in Cuba and UK. These training experiences lasted between 3 and 6 years and were mainly in General Surgery (4; 2.7%).

Neurosurgical Training of Consultant Neurosurgeons

Of the 69 consultants who reported their neurosurgery residency training institutions, 37 trained in more than 1 institution (Table 2). Most (63; 91.3%) obtained their full training in Nigeria, while 6 trained abroad at institutions in Cuba, Ghana, Japan, South Africa, and the UK. The total duration of the training, post basic medical degree, to qualify as a neurosurgeon, was 6–12 years (mean 7.9 ± 1.3), with most respondents spending 8 (28; 40.6%) or 7 years (19; 27.5%) in training. Most respondents (48; 69.6%) reported possessing the Fellow of the West African College of Surgeons alone, while 4 (5.8%) had other foreign specialist qualifications (Doctor of Medical Science. Japan, Fellow of the College of Surgeons of South Africa, Fellow of the Royal College of Surgeons, and Cuban Specialist Certificate). Only 11 consultants (15.9%) reported having postresidency subspecialty training certifications, all from foreign institutions: 2 each from India, Israel, and the UK, and one each from Germany, Netherlands, and the US. Most lasted 1 year (7, 77.8%), but were generally between 1 and 4 years (mean 1.2 ± 1.2). The specialty training areas of respondents are reported in Table 2.

Training of Neurosurgery Residents in Nigeria

Of the 58 neurosurgery resident doctors who reported their training institutions, all (100%) were training in Nigerian institutions, as listed in Table 3. Their program durations ranged between 6 and 8 years (mean 7.1 ± 0.3), with most (49; 84.5%) being 7 years. Forty-six respondents (79.3%) were senior residents, and 7 were junior residents (12.1%). The most common level of training was Year 5 (11), followed by Year 4 (10), with a mean level of 5.6 ± 2.1 Years. Eleven (19.0%) had exceeded the mean duration of required training of 7 years and were in their eighth (7), ninth (3), and 10th (1) years of training. Of all the residents, most (37; 63.8%) hoped to obtain the FWACS certification alone, while 13 (22.4%) will obtain both the FWACS and FMCS certifications.

Additional Neurosurgical Training

Thirty-four respondents (22.8%) reported undergoing additional training as observers, 32 (21.5%) as short-term non-fellowship trainees, 9 (6.0%) as visiting surgeons, and 8 (5.4%) as laboratory research trainees. Most of the observerships (31) were in 23 foreign institutions in 10 countries (mostly in the US - 10 institutions, 11 observers), and only 3 were in two Nigerian institutions (National Hospital Abuja: 2 observers and University College Hospital Ibadan: 1 observer). The highest number of observerships (5) was at the Hospital da Restauração, Recife, Brazil. These observerships lasted between 1 and 12 months (mostly 1–3 months [16], and 4–6 months [11]), and were focused on general neurosurgery (13), pediatric neurosurgery (5), and vascular neurosurgery (5). Most of the short-term training (30) was in 24 foreign institutions in 15 countries (mostly in India - 5 institutions, 7 trainees, and the UK - 5 institutions, 5 trainees), and only 2 were in two Nigerian institutions (Lagos University Teaching Hospital Lagos and Wellington Neurosurgery Clinic, Abuja). The greatest number of short-term training opportunities (3) were at the World Federation of Neurosurgical Societies Regional Reference Center at Hopital des Specialites, Rabat, Morocco. These training opportunities lasted between 1 and 12 months, mostly 4–6 months (16) and 1–3 months (7), and were focused on general neurosurgery (10), spinal neurosurgery (7), and neuro-oncology and skull base/pituitary neurosurgery (4 each). Visiting surgeon fellowships were mostly (7) in 7 foreign institutions in 6 countries (mainly in the US - 2 institutions, 2 fellows), and only 2 were in Nigerian institutions (General Ahmadu Rimi Specialist Hospital Katsina and Obafemi Awolowo University Teaching Hospital Complex Ile-Ife: 1 each). These visiting fellowships lasted between 1 and 12 months (mostly 1–3 months and 4–6 months, 3 each), and were mainly focused on skull base and vascular neurosurgery (3 each). The laboratory research fellowships were mostly (6) in 6 foreign institutions in 3 countries (mainly in the US - 4 institutions, 4 fellows), and 2 were in Nigerian institutions (ESUT Enugu and UI Ibadan: 1 each). Laboratory fellowships lasted between 1 and 24 months (mostly 24 months [3] and 1–3 months [2]) and were mainly focused on vascular neurosurgery (2).

Neurosurgery Training Centers

Seventy-two respondents reported that their primary health institutions were involved in neurosurgical residency training. Five other respondents noted their institution's involvement in other

Table 1. Educational Experiences of Survey Respondents Prior to Neurosurgical Residency

Level of Training	Training Experience	Count	Percent
Premedical training	Pre-medical degree from Nigeria	11	7.4%
Medical training (n = 130; 87.2%)	Medical training in Nigeria (MBBS or MBChB or MBBCh or BMBCh)	126	84.5%
	Medical degree from foreign institution (MD)	4	2.7%
Postgraduate training (n = 17; 11.4%)	Postgraduate training from Nigeria	10	6.7%
	Postgraduate training from foreign institution	7	4.7%
Postgraduate qualification (n = 17; 11.4%)	Master's degree	13	8.7%
	Ph.D	2	1.3%
	Others	2	1.3%
Pre-neurosurgical training (n = 6; 4.0%)	Pre-neurosurgical residency in Nigeria	4	2.7%
	Pre-neurosurgical residency abroad	2	1.3%

forms of neurosurgical-workforce training, such as training neurocritical care (intensive care unit) and anesthesia nurses (2), subspecialty nonfellowship training (1), neurosurgery observerships (1), and wet-lab training for basic neurosurgical skill acquisition (1). Survey respondents identified 15 WACS neurosurgical training centers, with 10 having full accreditation and 5 having partial accreditation. There were 6 NPMCN training sites, with 3 full and 3 partial accreditations (Table 4). On average, there were 3 neurosurgery residency training positions under the NPMCN and WACS programs, respectively, each year; and an average of 6 neurosurgery residents at each institution. The median number of residents in each level of training is shown in Figure 1.

Resident Training Experience

On average, residents gained their first neurosurgical operative experience at 1.4 years of training, functioned as the first assistant in a neurosurgical case at 1.7 years of training, and operated as the primary surgeon at 2.7 years of training (Figure 2). Residents worked an average of 88 hours per week during their training and had an average of 11 overnight calls per month.

Neurosurgical Subspecialty Exposure and Training

The top 3 subspecialties that residents were exposed to were general neurosurgery, pediatric neurosurgery, and neuro-oncology, as shown in Figure 3. Of 72 respondents who described the other clinical specialties that neurosurgery

Table 2. Neurosurgical Training Experiences Reported by Consultant Neurosurgeons Who Completed the Survey

Aspect of Neurosurgical Training	Participant Response	Count	Percent
Neurosurgical residency (n = 69)	Completed training in Nigeria	63	91.3%
	Completed training abroad	6	8.7%
Training qualification (n = 69)	FWACS alone	48	69.6%
	FMCS alone	3	4.3%
	Both FWACS and FMCS	11	15.9%
	Foreign specialist qualification	4	5.8%
	Not stated	3	4.3%
Subspecialty qualifications (n = 11, 15.9%)	Skull base/Pituitary surgery	3	4.3%
	Spinal neurosurgery	2	2.9%
	General neurosurgery	2	2.9%
	Combined spinal/general neurosurgery	1	1.4%
	Microneurosurgery	1	1.4%
	Pediatric neurosurgery	1	1.4%
	Vascular neurosurgery	1	1.4%

FWACS - Fellow of the West African College of Surgeons

Table 3. Reported training Experience of Neurosurgical Residents

Aspect of Neurosurgical Training	Participant Response	Count	Percent
Training location (n = 58)	UCH Ibadan	11	19.0%
	OAUTHC Ile-Ife	6	10.3%
	NH Abuja	5	8.6%
	JUTH Jos	4	6.9%
	UNTH Enugu	4	6.9%
	AKTH Kano	3	5.2%
	FMC Owerri	3	5.2%
	LUTH Lagos	3	5.2%
	NAUTH Nnewi	3	5.2%
	UDUTH Sokoto	3	5.2%
	ABUTH Zaria	2	3.4%
	BUTH Ilishan-Remo	2	3.4%
	Others*	9	15.5%
Expected certification (n = 58)	FWACS alone	37	63.8%
	FMCS alone	3	5.2%
	Both FWACS and FMCS	13	22.4%
	Not stated	5	8.6%

*Others: ESUTH Enugu, FETH Gombe, ISTH Irrua, LASUTH Ikeja, UATH Abuja, UBTH Benin, UITH Ilorin, UPTH Port-Harcourt, UUTH Uyo.

residents are exposed to, the most common were Neurology (52, 72.2%), Emergency/Trauma (49, 68.1%), Neuropathology (47, 65.3%), Anesthesia/intensive care unit (46, 63.9%), Neuroradiology (45, 62.5%), and General surgery (44, 61.1%) Table 5. A 1-year subspecialty training opportunity in minimally invasive spine and peripheral nerve surgery was identified at EuraCare/RNZ Neuroscience, Lagos, led by Professor OAR Sulaiman, a Canadian- and US-trained neurosurgeon. However, the program is not formally accredited by either WACS or NPMCN.

Education Methods and Expectations

Our participants reported numerous methods for the training of neurosurgery residents, as shown in Figure 4. The following training activities were reported to be conducted with residents at least weekly at most institutions: neurosurgery clinics, elective operations, consultant-led ward rounds, neurosurgery grand rounds, journal clubs, didactic/formal lectures, tutorials/seminars/conferences, morbidity and mortality meetings, neuroradiology meetings, neuropathology meetings, and neurology/neuroscience meetings. However, most institutions conducted resident-led ward rounds about four times per week, while resident-led teaching of interns, medical students, and others was conducted about twice a week.

Of 56 respondents who reported training competencies in their center, the majority noted that history taking/clerkship (55, 98.2%), neurological examination (55, 98.2%), surgical skills (55, 98.2%), communication (54, 96.4%), formulating a diagnosis (54, 96.4%), formulating a treatment plan (54, 96.4%), interpreting neuroimaging (54, 96.4%), leadership (54, 96.4%), ethical decision-making (53, 94.6%), case presentation (53, 94.6%), and research (53, 94.6%) were the main expected competencies. The median number of research outputs expected from residents before graduation, reported by the respondents, was Thesis/Dissertation, publication of three peer-reviewed manuscripts, and at least two abstract/poster presentations.

Perception of Neurosurgical Training

Figure 5 summarizes participants' perceptions of a series of statements concerning the current state of neurosurgical training. Most participants did not agree that medical school prepares residents adequately for neurosurgery training (35.2% disagreed, and 31.5% were neutral). A majority of participants reported that the duration (79.6%) and rigor (61.1%) of neurosurgery training at their institution was adequate. Most respondents thought that the subspecialty neurosurgery rotations at their institutions (59.3%) and the nonneurosurgery specialty rotations at their institutions (66.7%) were adequate. Opportunities for rotations at other training centers in Nigeria were reported to be present by 64.2% of participants, while opportunities to complete rotations abroad were reported by 59.6% of participants. There was variation in the perception of the adequacy of the amount of clinical skills training and operative experience at participant's centers, however, most participants agreed that the amount of supervision by consultants in their center was adequate (77.3%). Most participants agreed that neurosurgery residents are adequately

Table 4. Overview of Neurosurgical Training Centers in Nigeria

Training Center	Current residents*	Region	WACS Accreditation status[17]	WACS Allotted positions[17]	NPMCS Accreditation status[18]	NPMCS Allotted positions[18]	Total Allotted Positions
JUTH Jos	4	NC	Full	3	-	-	**3**
NH Abuja	10	NC	Partial	4	Full	2	**6**
UATH Abuja	5	NC	Partial	3	-		**3**
UITH Ilorin	5	NC	Full	3	Partial	3	**6**
ABUTH Zaria	7	NW	Partial	4	-	-	**4**
AKTH Kano	3	NW	Partial	3	-	-	**3**
UDUTH Sokoto	6	NW	Full	6	Partial	4	**10**
Memfys Enugu	8	SE	Full	2	Full	3	**5**
NAUTH Nnewi	3	SE	Partial	2	-	-	**2**
UNTH Enugu	10	SE	Full	3	Partial	4	**7**
UBTH Benin City	6	SS	Full	4	-	-	**4**
LASUTH Lagos	2	SW	Full	2	-	-	**2**
LUTH Lagos	5	SW	Full	4	Full	2	**6**
OAUTHC Ile-Ife	5	SW	Full	3	-	-	**3**
UCH Ibadan	15	SW	Full	6	-	-	**6**
TOTAL	**94**			**52**		**18**	**70**

*Survey data.

exposed to leadership and management skills (73.6%), communication and presentation skills (83.0%), ethics training (67.9%), and research (58.5%) in their centers. Most participants agreed that neurosurgery training in their center adequately prepares residents for their exit examinations (66.0%).

There was no consensus on whether formal/didactic lectures and progress tracking/feedback were adequate. The majority of participants agreed that the training program curriculum at their institution is clear on training objectives, skills, and competencies (53.8%) and that the preset year/level training goals are clear and adequate (49.1%). The majority of participants agreed that access to technology and the internet (49.1%) and access to neurosurgical textbooks and journals (55.8%) is adequate. Regarding workload, a majority of participants agreed that the weekly work hours for neurosurgery residents in their center were adequate (55.8%). Finally, most participants agreed that upon graduation, trainees from their institution feel competent to practice neurosurgery independently (73.6%).

Challenges to Neurosurgical Training

The most common challenges affecting neurosurgical training identified by survey respondents were related to lack of established subspecialty training (81.5%), lack of technologically advanced equipment (77.8%), and inadequate remuneration of trainers and trainees (74.1%). Other challenges are shown in Table 6. Participants described some additional challenges as well. One participant noted that there were ***"a lot of logistic challenges"*** at their institution, and another mentioned the "need for accreditation" of their center for neurosurgical training. One participant stated that the field needed "better remuneration commensurate with the workload." A different participant stated that they experienced "resistance to progress from [their] colleagues." "Funding" was also reported to be an issue by 1 participant, at national and local levels. Finally, three participants mentioned the need for "subspecialty training in neurosurgery/"

Strengths of Neurosurgery Training

The most commonly reported strengths of neurosurgery training in Nigeria were the clinical learning opportunities for residents (92.3%), independent operative experience for residents with adequate supervision (78.8%), and resident's involvement in research (71.2%). Other strengths of training are shown in Table 7.

Suggested Interventions. Participants described infrastructure and equipment (38.9%) and workforce training and education (37.5%) as short-term (1–3 years) areas of intervention that would benefit neurosurgical training in their institutions. Intermediate-term (3–5 years) areas for intervention suggested by survey respondents included allied workforce training and education (27.8%), and infrastructure and equipment (27.8%). When asked about the long-term (>5 years) areas of intervention that would benefit neurosurgical training in their institutions, participants indicated that allied workforce training and education (23.6%), and infrastructure and equipment (23.6%) were the most important.

Finally, survey respondents recommended that the top subspecialty areas for development were vascular neurosurgery

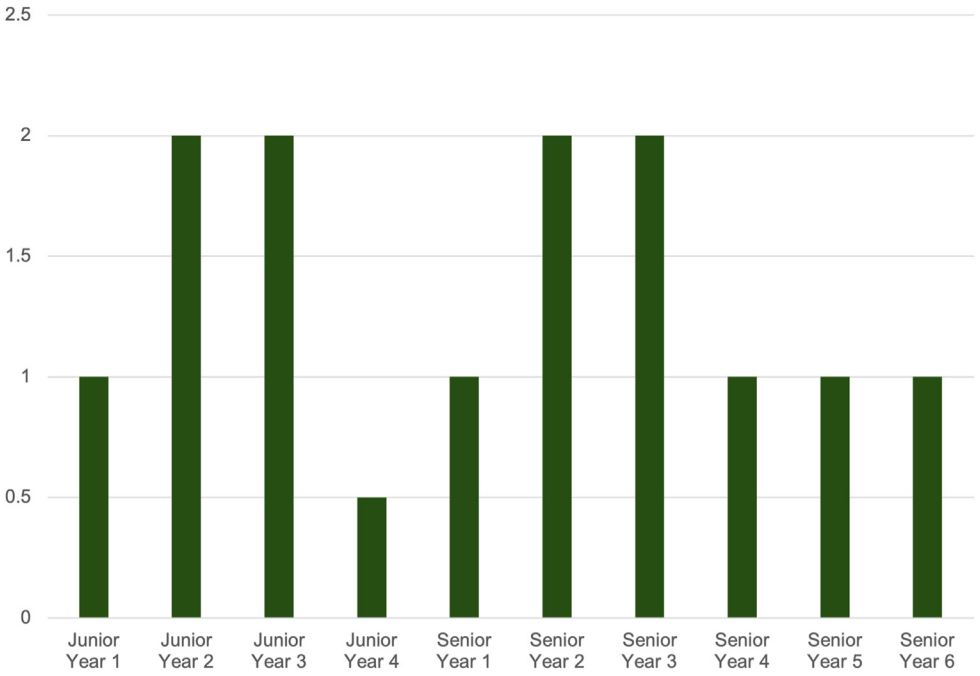

Figure 1. Median number of neurosurgical residents in each year of training across all institutions.

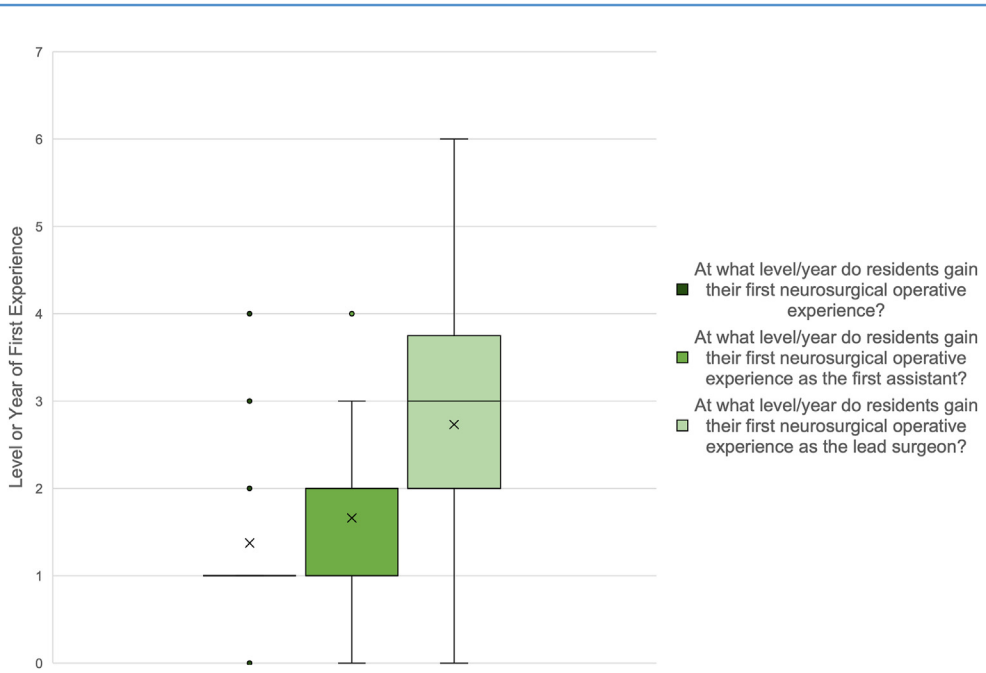

Figure 2. Average level or year that neurosurgery residents obtain their first operative experiences.

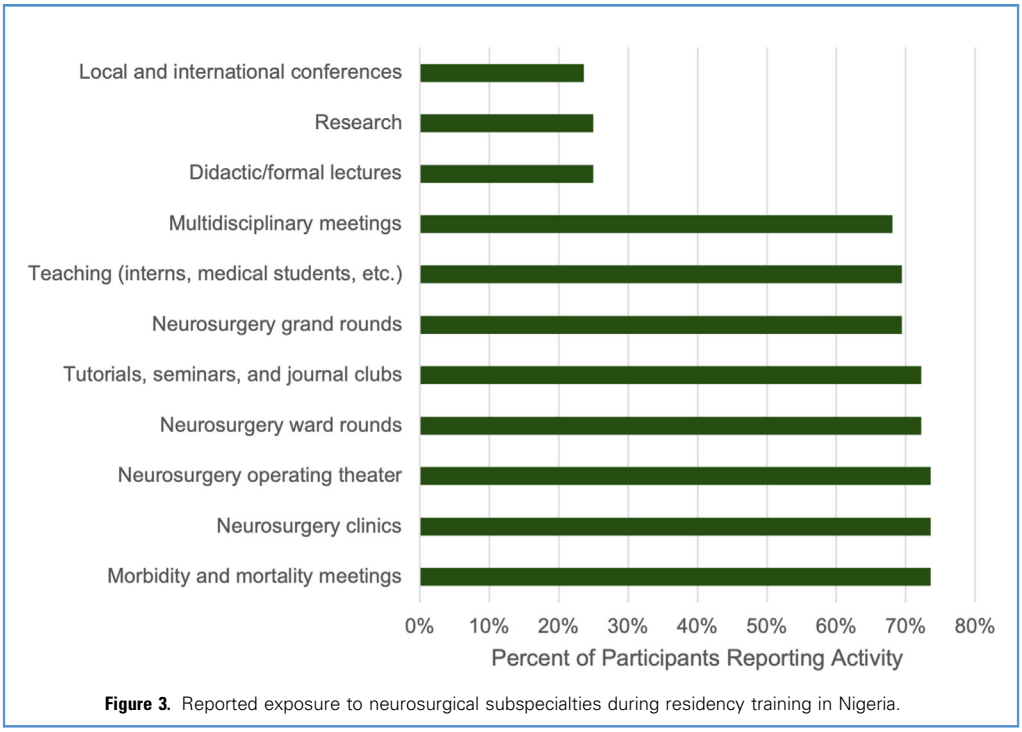

Figure 3. Reported exposure to neurosurgical subspecialties during residency training in Nigeria.

(58.9%), minimally invasive/endoscopic neurosurgery (52.1%), skull-base surgery (48.6%), neurotrauma and critical care (41.7%), neuro-oncology including pituitary surgery (33.3%), spinal and peripheral nerve neurosurgery (31.9%%), stereotactic and functional neurosurgery (31.9%), pediatric neurosurgery (26.4%), and general neurosurgery (22.2%).

DISCUSSION

This study reviewed the current status of neurosurgical training in Nigeria and sought to identify the strengths, challenges, and opportunities for growth. We found that the number of neurosurgery training sites was static between 2018 and 2022. There were 15 accredited training centers: 11 with full and 4 with partial WACS accreditations and 3 each with full and partial NPMCS accreditation.[3,5,16-18] In each program, there was an average of 6 neurosurgery residents.

Table 5. Other Clinical Specialties Where Neurosurgery Residents are Exposed

Clinical Specialty	Count (n = 72)	Percentage
Neurology	52	72.2%
Emergency/Trauma	49	68.1%
Neuropathology	47	65.3%
Anesthesia/ICU	46	63.9%
Neuroradiology	45	62.5%
General surgery	44	61.1%
Orthopedics	37	51.4%
Basic science	35	48.6%
Plastic surgery	35	48.6%
Others	4	5.6%

Training Duration

The respondents in this study reported that the average duration of neurosurgery training was 7 years. This is similar to the length of training for other neurosurgical residencies in Africa, which is 6 years on average but varies from 4 to 8 years,[8,14] as well as to the 7-year duration of training in the US.[28] However, there is more variation in training duration in Nigeria than in the US, where a standardized duration of training has been in place since 2014.[28] Training in Nigeria is slightly longer than in European countries, where neurosurgical training is typically 4–6 years, and in Latin American countries, where training duration is 5 years on average.[29] This may be due to differences in education requirements prior to neurosurgical residency in these countries.

Training Structure, Content, and Activities

Neurosurgical residency training in Nigeria follows a similar structure to other regional training programs, including the College of Surgeons of East, Central and Southern Africa program, with an initial period of general surgical training followed by specific neurosurgical training.[6,8,14,30] However, this format contrasts with the US, where residents begin their training directly in neurosurgery.[28] Educational activities in Nigeria

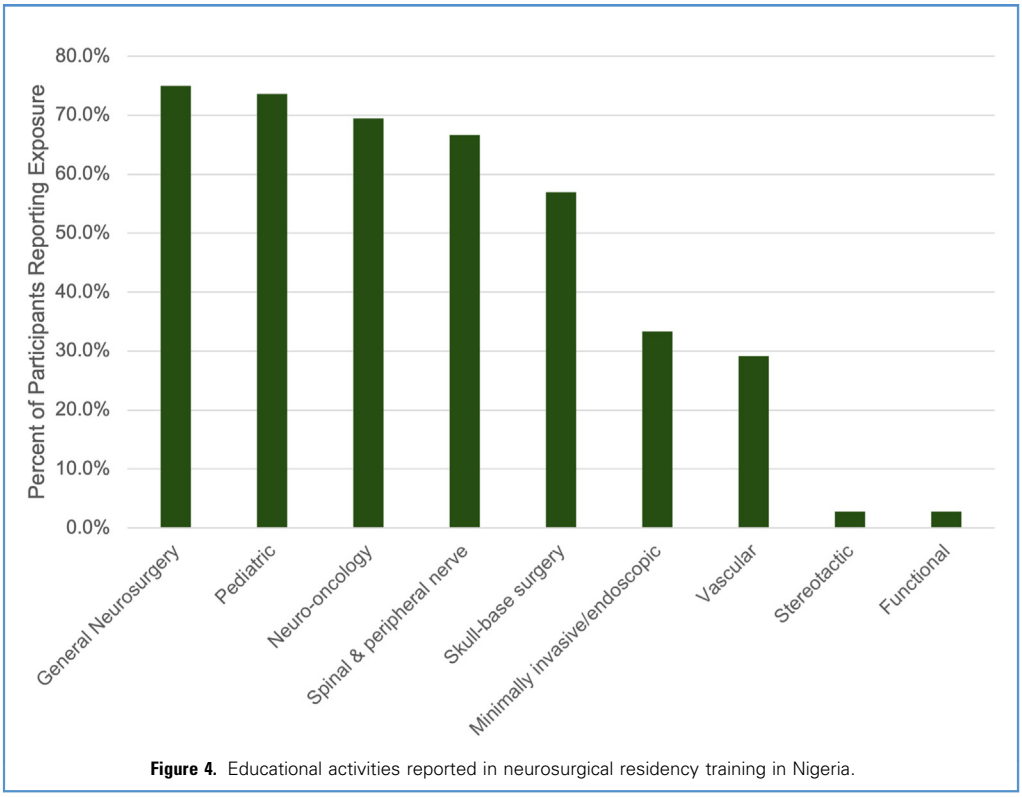

Figure 4. Educational activities reported in neurosurgical residency training in Nigeria.

include morbidity and mortality meetings, journal clubs, and didactic lectures, which are also utilized in the College of Surgeons of East, Central and Southern Africa program and are commonly used in other Low- and Middle-Income Countries (LMICs).[8,30] In addition, trainees are required to complete research activities during training, as is common in other training programs in Africa and around the world.[8,14,31] However, in many other countries, these research requirements exist at the institutional level rather than at the countrywide level leading to variation in research requirements across institutions.[31]

In this study, less than 50% of resident-doctor participants reported adequate exposure to vascular, minimally invasive, stereotactic, and functional neurosurgery. This portends a limited scope of subspecialty exposure, unlike what exists at the World Federation of Neurosurgical Societies Rabat Training Center, where trainees are exposed to a wider repertoire of subspecialty engagement.[8,14,31,32-34] Similarly, neurosurgical trainees in Europe and the US are exposed to all neurosurgical subspecialties and report varying case volumes by subspecialty.[28,35] Considering the timing of operative experience, the time to operate as the primary surgeon in Nigeria is much later than in Europe. A survey across European countries found that 89% of neurosurgical residents completed a case as the primary surgeon within the first year, while in Nigeria, this was done, on average, at 2.7 years of training.[36] However, Nigeria's timing was similar to that seen in Latin America, where residents took on an active role in operations at 2.3 years on average.[29]

Participants reported that residents work an average of 88 hours per week during training and take 11 call shifts monthly. While the duty hours in Nigeria are similar to that in other LMICs,[30] it contrasts with that in Europe, the US, and many other countries in the Western hemisphere. In Europe, the European Working Time Directive limits resident duty hours to an average of 48 hours per week,[37] and in the US, the Accreditation Council for Graduate Medical Education recommends that residents work less than 80 hours per week.[38] These differences in duty hours are important to note because longer work hours and more frequent call shifts were found to be associated with higher rates of burnout in a global survey.[39]

Perception of Neurosurgery Training

This study demonstrated high levels of satisfaction with neurosurgical residency training in most domains evaluated, including the duration and rigor of programs, opportunities outside of the primary training site, resources available, workload, and curriculum clarity. This is consistent with other LMICs, with prior surveys reporting the perceived adequacy of surgical exposure in neurosurgical residency.[36] Additionally, most respondents reported that trainees from their institution felt competent to practice independently after graduation. Nevertheless, in this study, some domains were not deemed adequate, including the quality of preparation for neurosurgical residency in the medical schools and the quality of didactic sessions and lectures that were being delivered to neurosurgery residents.

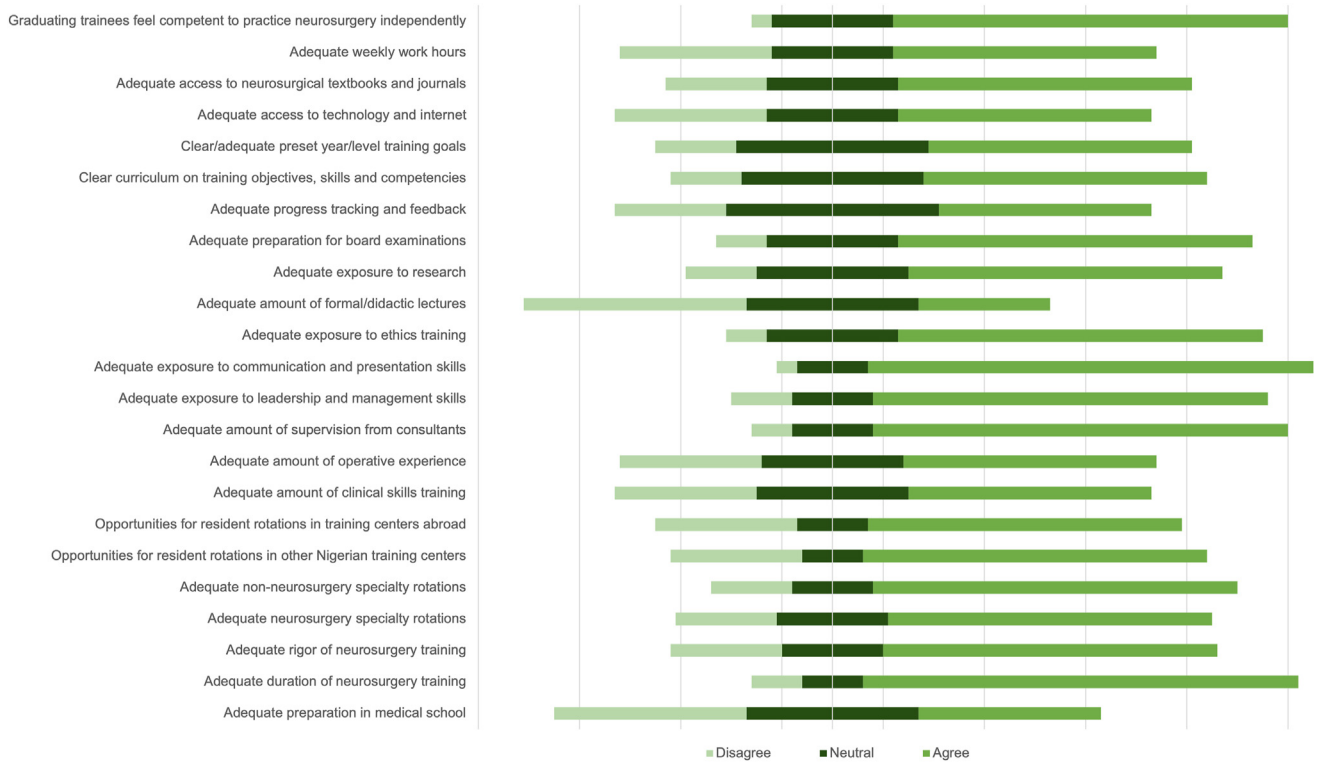

Figure 5. Participant opinions of neurosurgical training in their institution.

Strengths of Neurosurgery Training in Nigeria

The most common strengths of Nigerian neurosurgical training reported by respondents included the availability of opportunities for clinical learning, surgical operative experiences with adequate supervision, and the availability of clinical research. Other strengths identified in this study include higher training capacity than neighboring countries and resident-doctor satisfaction with the residency training. With up to 15 accredited neurosurgical training sites in Nigeria, the country has a relatively high number of training facilities compared to other countries in SSA. Historically, Nigeria has had the highest rate of growth of neurosurgical training centers in West Africa, with 0.07 new training sites created per decade.[5] Given how common it is for neurosurgical trainees in Africa to travel outside their home country for training,[8] Nigeria is well positioned to be a regional hub for neurosurgical training if growth in neurosurgical capacity can be maintained or even increased.

Challenges of Neurosurgery Training in Nigeria and Opportunities for Growth

Despite its relative strengths, neurosurgical training in Nigeria faces multiple challenges that offer opportunities for growth. These challenges include geographic disparities in training location, lack of subspecialty training, and insufficient infrastructure, similar to other documented literature from Africa.[3,4,6,24,40,41] Although Nigeria has more training centers than its regional neighbors, the distribution is suboptimal, and the country's neurosurgery training facility to population ratio is still low. With a population in excess of 218 million in 2022,[42] Nigeria has only an approximate neurosurgical training facility density of 0.05 training centers per 1 million inhabitants. While not mentioned by our survey respondents, limited training availability in Nigeria may contribute to Nigerians leaving the country for training, putting them at risk for "brain drain," which is another challenge faced in medical education in Nigeria.[43]

There are geographic disparities in the distribution of existing neurosurgery training centers in the country.[24] Notably, the South-South region has only one training site, the University of Benin Teaching Hospital in Benin City, and there are no training sites in the North-East region. Given Nigeria's continued low neurosurgical training facility density, increasing the number of available training sites would be an important opportunity for workforce growth to address the country's neurosurgical burden of disease. Efforts to increase neurosurgical training opportunities can, therefore, focus on regions with lower numbers of training facilities, like the South-South and North-East regions. The efforts could benefit from collaboration with global partnerships or multinational organizations, along with transcontinental collaboration with other African countries to increase capacity at existing institutions and create new training programs, as has been previously noted.[3-5]

Another opportunity for the growth of neurosurgical training in Nigeria is the development of subspecialty training as trainees

Table 6. Challenges to Neurosurgical Training in Nigeria

Challenges to Neurosurgical Training	Count (n = 54)	Percentage
Lack of established subspecialty training	44	81.5%
Lack of technologically advanced equipment	42	77.8%
Inadequate remuneration of trainers and trainees	40	74.1%
Disruption in training curriculum due to industrial actions, etc	37	68.5%
Limited training facilities, including skills acquisition labs, etc	35	64.8%
Certification lacks automatic reciprocal recognition outside the West African region	35	64.8%
Lack of opportunities for international exposure through fellowships or externships	34	63.0%
Lack of formal competency assessment and feedback	28	51.9%
Training syllabus/curriculum not yet standardized	25	46.3%
Unstructured work hours and call schedules	23	42.6%
Limited training spaces	21	38.9%
Limited research opportunities	18	33.3%
Training faculty to resident ratio is not adequate	13	24.1%
Lack of mentorship	8	14.8%

Table 7. Strengths of Neurosurgical Training in Nigeria

Strengths of Neurosurgical Training	Count (n = 52)	Percentage
Clinical learning opportunities	48	92.3%
Independent operative experience for residents with adequate supervision	41	78.8%
Involvement in research	37	71.2%
Opportunities for residents to lead teams	32	61.5%
Collaboration with other institutions for training, research, and capacity building	28	53.8%
Long-standing history of training	27	51.9%
Experienced faculty/trainers	24	46.2%
International training opportunities	18	34.6%
Standardized training syllabus and certification	16	30.8%
Availability of subspecialty training	12	23.1%
Number of young consultant neurosurgeons	1	1.9%

currently have to travel abroad for these endeavors. Survey respondents identified subspecialty training opportunities in spine/peripheral nerve neurosurgery and minimally invasive/endoscopic neurosurgery as highly desirable. Interest in formalized, in-country subspecialty training development was highest in vascular neurosurgery, skull-base surgery, and neurotrauma/critical care. However, efforts to develop neurosurgical subspecialty training would need to consider the volume of cases, skills of neurosurgeons currently practicing in Nigeria, and the formulation of deliberate policies tapping into internal and external resources. Current subspecialty-trained neurosurgeons are limited in number and scope, so development may have to focus on areas like skull base neurosurgery and vascular neurosurgery, where there are acknowledged fellowship-trained neurosurgeons currently practicing in Nigeria.[24,25] In the same light, this study identified a nascent, although unaccredited, training opportunity in minimally invasive spine and peripheral nerve surgery in 1 unit in the country. Formalizing these opportunities through accreditation could be another strategy to increase the availability of these cadres of neurosurgical subspecialty practitioners in Nigeria. Added to these is the challenge of poor health funding which negatively impacts neurosurgery training. The health insurance policy only covers 5% of the population while the national health budget hovers around 5%[44-49]; these are too small to significantly impact neurosurgery.

Furthermore, inadequate infrastructure and equipment, common with most other SSA countries, present significant challenges for neurosurgical training in Nigeria.[3,4,40,41] In this study, infrastructure and equipment were among the most commonly reported challenges for neurosurgical training, and a significant area needing intervention in the short-, intermediate-, and long-term. While efforts could focus on developing general neurosurgical infrastructure in Nigeria, developing training-specific infrastructure and equipment will also be important. The use of webinars, telemedicine, wet/dissection labs, online modules, and simulation labs as education activities were infrequently reported. This is consistent with the limited use of skills labs and digital technologies in neurosurgical training in other LMICs.[8] Expanding access to technological learning tools, including digital teaching tools,[50] and training infrastructure like skills labs would be an important area of focus for improving neurosurgical education in Nigeria.

Limitations

There are a few limitations of this study that are important to consider. The survey data provide limited information on neurosurgical trainees' specific clinical/academic learning experiences and their perspectives on the training in Nigeria. Further qualitative research, which this study did not attempt, could add to the scope of its findings, and thereby provide a better understanding of trainee experiences. Additionally, this study evaluates neurosurgical training in Nigeria as a whole and does not assess the strengths and challenges for neurosurgical training at specific regional or institutional levels. Unique strengths, challenges, and opportunities for growth could exist at each individual level that were not identified in this study. Because this study was focused on specialist neurosurgical training, no datum was collected on other aspects of neurosurgical training or training for allied

workers. Further research would, therefore, be needed to understand the strengths, challenges, and opportunities for growth as seen by other neurosurgical workers.

CONCLUSION

Nigeria's 15 accredited neurosurgical training centers, overseen by the regional WACS and national NPMCN, have been the bastion of the recent surge in the neurosurgical workforce in the country. The strengths of neurosurgical training in Nigeria include wide learning opportunities for residents and the satisfaction of trainees with most aspects of neurosurgical training. However, the challenges facing neurosurgery training include the low density of training programs compared to the population, the absence of accredited subspecialty training programs, and limited infrastructure for training. Efforts to improve neurosurgical training could address these challenges by expanding training program capacity and creating new training programs in regions with low numbers, creating new subspecialty training programs or formalizing informal subspecialty training through accreditation, and supporting increased access to technological teaching tools and training infrastructure. These findings are pertinent for collaborative interventions focused on expanding the neurosurgical capacity in Nigeria.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

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