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Epileptic Disorders

ORIGINAL ARTICLE

Expert opinions on pediatric EEG training for non-epilepsy specialists in sub-Saharan Africa

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Abstract

Ideally, pediatric electroencephalograms (EEGs) should be performed by accredited neurophysiology technologists and interpreted by specialists trained in epileptology However, low- and middle-income countries (LMICs) lack such specialists.

Aim: To collate expert consensus on essential curriculum content for non-epilepsy specialists in EEG interpretation and safe post-training practice.

Method: A qualitative study on pediatric EEG training curricula needs was designed in collaboration with an adult education specialist. Data were collected via interviews from 15 epilepsy experts with training experience across high- to low-income settings. Thematic analysis was used to identify sub-themes. The experts voted on the key statements in a two-round Delphi to ascertain consensus.

Results: Twelve aspects of pediatric EEG training were identified and categorized thematically: relevance; exposure to pediatrics; focus on pediatrics; barriers; resource-limited setting; entry skills; best pedagogy; assessment; critical skills; reinforcement of skills; training model; and recommendations.

Conclusion: This study was driven by the inadequate access to training in pediatric EEG for non-epilepsy specialists, which is further exacerbated by the lack of epileptologists and neurophysiologists. The outcomes from the expert consensus opinions promoted consolidation, adaptation, and evolution of existing models that are viable for practice and to be used worldwide. The Delphi consensus demonstrated alignment among regionally located specialists towards the promotion of effective and maintained training for non-epilepsy specialists, as well as highlighting barriers that should be considered and addressed.

KEYWORDS

EEG Curricula, EEG training, non-epilepsy specialists, paediatric, safe practice

For affiliations refer to page 386.

1 | INTRODUCTION

Sub-Saharan Africa (SSA) has the highest burden of neurological diseases and prevalence of people with epilepsy.[1] This is especially relevant in pediatrics, where the incidence of neurological diseases is the highest in SSA compared to other regions of the world.[2]

There is a significant shortage of neurologists and neurophysiologists.[3] Access to electroencephalography (EEG) and the skills needed for interpretation are scarce in resource-limited countries (RLCs).[2,4] This diagnostic tool is often used inappropriately by clinicians without the expertise to interpret the results. Our group has explored pediatric EEG training programs for non-epilepsy specialists.[5] Training this group is critical to improve epilepsy care in settings with limited resources, where epilepsy specialists (i.e. epileptologists) are lacking.

In SSA, people with epilepsy are initially seen by primary health care providers. Various models have explored methods to improve the diagnosis of epilepsy, enabling care at the entry point by primary care practitioners.[6–8] Artificial intelligence EEG (AI-EEG) was used by McInnis et al. to assist healthcare workers lacking epilepsy training.[9,10] A systematic review assessed qualitative and quantitative aspects of curricula, teaching methods, and effective educational EEG programs for non-experts to screen adult EEG patterns for critically ill patients.[11] The report concluded that different point-ofof-care providers can be educated.[12–14]

This qualitative research drew on the skills of experts embedded and invested in the field of EEG training from diverse regions. It is important to understand the ideal requirements and to critique existing training guidelines for EEG for both specialists and non-epilepsy specialists in low-income (LIC) and high-income countries (HIC) as seen in Table 1. Our belief is that it is possible to train any motivated and capacitated doctor at this level of practice working in a setting where they are managing children with seizures. This information will be used to strengthen an existing pediatric EEG training program [affiliated to the African Pediatric Fellowship Program (APFP)] for clinicians across sub-Saharan Africa. Further, it is envisioned to be an aid for other regions that could gain from using or adapting the model.

In this study, we sought to gain expert consensus via a Delphi process on the essential components of an educational curriculum needed to effectively educate non-epilepsy specialists on the interpretation of pediatric EEG. Specific aims were to:

- Identify level for effective and safe practice for non-epilepsy specialists
- Identify and describe support for the role of non-epilepsy specialists in EEG practice.

Key points

- Access to training of non-epilepsy specialists (Table 1) in pediatric EEG promotes better care for people with epilepsy.
- Pediatric EEG training models are needed that are effective, affordable and sustainable in the African setting, as well as in other LMICs.
- Effective examples are evident via the training and education for pediatric EEG interpretation in SSA via the African Pediatric Fellowship Program.
- Delphi stage one and two statements (Table 4) demonstrated strong consensus in training recommendations across regions and experts.
- Adequate support and investment in EEG services are necessary at the individual, institutional, and national levels.

2 | METHODOLOGY

2.1 | Data gathering, ethics and procedures

Experts with high-level EEG practice and skills were identified across all six World Health Organization Regions (WHO) to provide a broader insight into the challenges of delivering ideal pediatric epilepsy care in different regions. Fifteen out of sixteen clinicians with expertise in the field of neurophysiology from high- to low-income countries agreed to participate in the project. The experts had expertise in the fields of epileptology, pediatric neurology, adult neurology, and neurophysiology (clinical physiology) (Table 2). All experts were experienced in training. Demographic participant data were extracted from pre-supplied curriculum vitae, and interview questions were sent in advance to permit consideration and time to prepare for the responses. The participants were asked to consider their own range of experiences, as a trainee, as well as their current trainees needs. A qualitative study consisting of 11 key questions on pediatric EEG was designed with the support of an adult education specialist. These key questions related to gaps in training and knowledge identified through a systematic review,[5] a survey on EEG services in SSA,[4] and the relevance of a pediatric online tool[15] done by the same authorship team. All experts were asked the same 11 open-ended questions and, in closing, were asked if they would like to expand on any of their answers (File S1). A qualitative approach to the data analysis was adopted to address how the concept of training for non-epilepsy specialists is understood. A thematic analysis enabled the uncovering of shared

TABLE 1 Terminology applied to clinician roles in Low- vs. High-Income Countries.

	Low income country	High income country
Pediatrician	**Specialist**	**Primary care physicians**
Epileptologist/epilepsy specialist (adult or paediatric)	Adult or child neurologist with 1–2 years of epilepsy training	Adult or child neurologist with 1–2 years of epilepsy training
Non-specialist	Medical officer	Physician who is not an epilepsy specialist including those trained in general medicine, internal medicine, pediatrics and adult or child neurology when no additional training in EEG beyond that encompassed in core training has been completed
Healthcare practitioners	Medical officer Clinical officer	Physician Physician assistant Nurse practitioner

[a]To acknowledge that there are regional variations in entry point, focus and duration in training but the end point would be specific expertise at high level in epileptology.

TABLE 2 Demographics of experts and focus area of interest i.e. education and/or advocacy.

Participant	Continent	Region	Expert	Profession	Gender
1.	South America	UMIC	Education	Pediatric Neurologist	Female
2.	South America	UMIC	Education	Pediatric Neurologist	Male
3.	North America	HIC	Education	Pediatric Neurologist	Male
4.[a]	North America/Africa	HIC/LMIC	Education	Pediatric Neurologist	Female
5.	North Africa	LMIC	Advocacy/education	Pediatric Neurologist	Female
6.	Asia	UMIC	Advocacy/education	Epileptologist	Male
7.	South Asia	LMIC	Education	Adult Neurologist	Male
8.	East Asia	HIC	Education	Pediatric Neurologist	Male
9.	Africa	LMIC	Education	Adult Neurologist	Female
10.	Africa	LIC	Advocacy/education	Adult Neurologist	Female
11.	Europe	HIC	Education	Epileptologist	Male
12.	Africa	LMIC	Education	Adult Neurologist	Female
13.[a]	North America/Africa	HIC/LMIC	Education	Adult Neurologist and Epileptologist with Fellowship Training in Pediatric Epilepsy	Female
14.	North America	HIC	Education	Pediatric Neurologist and Epileptologist with Fellowship training in Pediatric Epilepsy	Male
15.	Europe	HIC	Education	Clinical Physiologist	Female

Abbreviations: HIC, high income country; LIC, low-income country; LMIC, low middle income country; UMIC, upper middle-income country; USA, United States of America.

[a]Collaboration work in African region.

understandings from participants, which was further focused and returned to the group via a Delphi process.

Interviews were performed over May–June 2023 via an online platform, lasting 20–30 min. All 15 experts consented to the interview and to collaborate on manuscript preparation. Interviews were recorded and transcribed verbatim by a trained transcriber. All names were de-identified. A two-stage Delphi method was adopted to explore consensus of the themes derived, i.e., where there was over 80% agreement. All data were stored securely. The study was approved by the ethics committee of the UCT, Cape Town, South Africa (481/2018).

2.2 | Findings and discussions

This section addresses the themes arising from the 11 questions, from which we identified, analyzed, and

interpreted data patterns of meaning that arose with each question. The 11 questions were analyzed using a thematic analysis that enabled identification of various themes.

2.3 | Experts' demographics (Table 2)

Forty percent of the experts $n=6$, either worked in Africa $n=4$ or had significant collaboration with Africa $n=2$. Of the 15 experts $n=7$ (47%) were pediatric neurologists, $n=4$ (27%) epileptologists, $n=5$ (33%) adult neurologists, and $n=1$(7%) clinical physiologists (neurophysiologist). Whilst all were committed to high-level service provision in the field of epilepsy, there were additional focus areas of work such that twelve (80%) were involved in teaching electrophysiology, and $n=3$ (20%) were advocates on the subject. We recognized advocacy as a key role for respondents who had promoted the safe and effective utilization of the resource of EEG.

2.4 | Findings

Twelve main themes relating to the questions were identified (Table 3) with common sub-themes reoccuring illustrated in the interview quotes (File S2). These key themes were converted into statements which were re-presented to the experts in a two stage Delphi survey.

2.5 | Delphi process

Overarching themes and sub-themes were identified (Table 3) from the extracted interview responses (File S2). The main researchers (VK,JW) generated the consensus statements. This process was independent of the respondents to avoid bias. Experts responded to a two-stage Delphi method. In the first stage of the Delphi process, the group reached consensus on the following statements. It is relevant for non-epilepsy specialists to be trained to perform and interpret pediatric EEGs. Non-epilepsy specialists need access to epilepsy specialists and to be trained to ensure consistency in practice. Training on pediatric EEG is necessary for any clinician whose practice includes the treatment of children with epilepsy. Pediatric EEG training should be a separate and standalone area of study. Barriers to providing adequate pediatric EEG services in LMICs are compounded by inadequate training resources for non-epilepsy specialists. In the setting of a lack of access to technologists, nurse training should be considered. In the setting of a lack of access to epileptologists, clinicians involved in the care of children with seizures should be encouraged to access training. Not only online but also face-to-face teaching with clinical application is required. Training skills should be maintained and reinforced. Assessment of skills is required. Members of the group emphasized the lack of capacity for dedicated time to establish required skills, and consensus was not reached (73%) that non-epilepsy specialists can be trained in pediatric EEG at a basic level.

On the first round, a consensus (with >80% agreement considered consensus) was reached for 21 of the 22 statements.[16] These statements, the percentage consensus, and the key comments from the experts are relayed in Table 4. The only statement that did not reach consensus (73%) pertained to entry skills and the ability to train individuals. In the second stage of the Delphi process, we addressed this statement by examining perspectives from individuals, institutions, health or government levels, and exploring the concept of task sharing. The second stage Delphi explored solutions and reached consensus that individuals should be invested in developing and maintaining EEG skills, that institutional support should ensure adequate infrastructure, and that national or regional policy should be in agreement with service need. Ultimately, all experts reached consensus on the four statements regarding the success and sustainability of non-epilepsy specialists. Barriers acknowledged by the expert group emphasized the challenges of busy and inadequately supported clinicians already committed to multiple service needs, leading to attrition of the EEG service and individual skill maintenance.

3 | DISCUSSION

This study explored expert consensus on the relevance, need and potential for the training of non-epilepsy specialists in EEG interpretation. Whilst the study provides valuable insights into the training of non-epilepsy specialists, the study is limited and does not cover all possible variables. The important findings related to some of the themes are highlighted below.

3.1 | Relevance (lack of experts)

This was driven by the fact that there are limited numbers of epileptology experts and EEG training programs in high and low income countries. There was consensus from the experts of the inevitable adverse healthcare consequences from inadequate training.[17]

Themes	Sub-themes	Number of agreements $N=15$
Q1. Relevance	Lack of training	5
	Neurophysiologists	4
	Lack of experts	7
Q2. Exposure to pediatrics	Lack of training	5
	EEG interpretation	11
	Collaboration	3
	Neurophysiologists	1
Q3. Focus on pediatrics	Lack of training	13
	EEG interpretation	5
Q4. Barriers	Lack of experts	9
	Lack of training/exposure	8
	Non-specialists	2
Q5. Resource limited setting	Non-specialist	15
	Epileptologist	7
	Lack of experts	6
	Neurophysiologist	4
	Technician/telemedicine	3
Q6. Entry skills	Non-specialists	11
	Epileptologist	2
	Misuse EEG	1
Q7. Best pedagogy	Apprenticeship	12
	Combination of training	9
Q8. Assessment	Continuous assessment	10
	Combination of assessments	7
	Collaboration	1
Q9. Critical skills	EEG interpretation	13
	Lack of experts	1
Q10. Re-inforcement of skills	Continuous assessment	7
	Collaboration	5
Q11. Training model	Lack of training	6
	Misuse EEG	2
	Apprenticeship	5
	Collaboration	1
	Continuous assessment	2
Q12. Recommendations	EEG interpretation	4
	Misuse EEG	4

TABLE 3 Themes and sub-themes relating to interview questions. Demonstrating the 12 main themes relating to the responses from the participants as well as common sub-themes that emerged from the analysis. For example, relevance of the need for EEG training was strongly emphasized with sub-themes focused on the lack of access to training was raised by 5 of the 15 experts.

3.2 | Exposure to pediatrics (lack of training)

Speciality training is often not available, or sparse, in resource limited settings.[3] Neurologists and child neurologists have limited time in their training to reach high levels of EEG interpretation skills.[5,18] Additional time for training in these areas is especially important in LMICs, where these trainees may be the only clinician available to report EEGs.[19] As such fellowships are required to gain competency in interpretation of EEGs.

3.3 | Focus on pediatrics (lack of interpretation)

For an adult neurologist without substantial additional training, pediatric EEG patterns can be difficult to

TABLE 4 Delphi stage one and two statements and consensus.

Theme	Statement	Sub questions	Consensus %	Focused comments
Delphi round 1				
Relevance	In an ideal setting pediatric EEGs would be performed by accredited neurophysiology technologist and interpreted by epileptologists. However currently LMICs lack experts or specialists in the field of pediatric neurology and pediatric electrophysiology	**(a)** In order to meet the need for access to pediatric EEG, it is relevant for non-specialists to be trained to perform and interpret pediatric EEGs	87%	**Key message:** Emphasis that although non-epilepsy specialists can be trained to do the EEG, they still must have access to a specialist
		(b) The training should be at an adequate standard to ensure consistency in practice	100%	
Exposure to pediatrics	Training curricula and training programs should have time specifically focused on pediatric EEG for any clinician whose practice will include pediatric EEG in their future work		100%	
Focus on pediatrics	Training in pediatric EEG should be a separate and standalone area of study as the field carries unique aspects that are separate and different to adult EEG and require specific skills to be competent		80%	**Key message:** Pediatric neurology and by default pediatric neurophysiology in many parts of the world is still a new and evolving concept. Development of services is layered on the legacy of how services are constructed One person who disagreed with the statement explained that "a person should only learn pediatric EEG if this is an area of practice, however, everyone needs basic EEG training"
Barriers	Barriers to providing adequate pediatric EEG services in LMICs extend beyond the lack of specialists but also are compounded by the lack of adequate training resources for non- epilepsy specialists		80%	**Focused comments from the Delphi process:** "But the availability of pediatric epilepsy specialist is a good catalysing point"
Resource limited setting	The optimal healthcare practitioners to be trained in pediatric EEG skills in resource limited settings should align with the most equipped and best placed practitioners in the region	**(a)** In the setting of lack of access to technologists, training nurses should be considered	93%	
		(b) In the setting of lack of access to epileptologists, clinicians involved in the care of children with seizures e.g. pediatricians, child neurologists, general doctors should be encouraged to access training	87%	**Focused comments from the Delphi process:** There should be a standard qualification for non-epilepsy specialists. One expert was sceptical about training non-epilepsy specialists **Key message:** Although 87% of the group were in agreement with the statement, they really highlighted the fact it must be done properly and safely. You have to recruit the correct person to do it

(Continues)

TABLE 4 (Continued)

Theme	Statement	Sub questions	Consensus %	Focused comments
Entry skills	Non-epilepsy specialists with interest in the care of children with seizures can be trained in the field of pediatric EEG at a basic and non-invasive level		**73%**	**Focused comments from the Delphi process**: From two experts who disagreed with the statement, based on "Depends on how much time and effort is the individual prepared to devote to epilepsy and EEG" and "it depends on the type and duration of training. Agree that pediatricians could be trained in EEG interpretation but needs very careful training course". This question failed to reach 80% consensus and required a 2nd round of Delphi with questions adjusted according to group response **Key message**: The EEG trained pediatrician must be fully focused, dedicated, supported, and capacitated to enable full commitment. Consensus was not attained as some experts did not believe that this was a feasible goal given the competing demands on the time of a pediatrician in a LMIC setting
Best pedagogy	Whilst training should follow a flexible teaching method which is most viable for local region, face to face teaching or apprenticeship is required and not only on-line	**(a)** Training should have clinical application to reinforce knowledge translation and relevance	93%	**Focused comments from the Delphi process:** "For the exceptional candidate who has no in-person training option, there should still be a way to train" **Key message:** The aim of this process is to identify mechanisms to solve the paradigm in Africa where the challenges are huge, compounded by burden of disease and lack of resources
		(b) Training skills should be maintained and reinforced	100%	**Focused comments from the Delphi process:** "There should be a plan to provide intermittent long-term supervision. However, there should be an end goal. Thereafter, consultation when needed can be provided" **Key message:** Our Kenyan/South African bi-weekly meetings provide reciprocal educational gains for the trainees. Eventually when centres become established and should become the hubs for training i.e. there should be a progression in the stages of capacity. Entry point – establish a setup at centres providing a service, provide collaborative work together, evolves from training evaluation to stand alone facilities who provide support for other regions and expand the network!

TABLE 4 (Continued)

Theme	Statement	Sub questions	Consensus %	Focused comments
Assessment	Assessment of skills learnt is required. This should have a continuous assessment component to detect early training deficiencies and refocus attention to areas of training need	**(a)** An exit examination is also important to ensure consolidation of skills learnt over the training period	100%	
		(b) At the entry point a pre-skills assessment is needed to have insight into entry level of the trainee	100%	
		(c) A post-training assessment provides further information across skills progression	100%	
Critical skills	Critical EEG skills are basic EEG training on pattern recognition and interpretation but should include	**(a)** Insight into different patterns related to brain maturation and unique aspects of pediatric EEGs in general.	87%	**Focused comments from the Delphi process:** From one expert who disagreed with the statement, based on "critical skill is performing a good quality EEG first as interpretation is wasted if EEG recording is suboptimal"
		(b) Additional critical skills are the ability to undertake EEG practical activities from electrode placement to knowing how to record an artefact free EEG.	93%	**Focused comments from the Delphi process:** The same expert who disagreed above, based on "these are not additional skills they are the most important still. If this step is wrong, the rest is a waste of time"
Reinforcement of skills	It is important to establish methods for maintenance of skills	**(a)** This should be via theory assessments and case discussions	87%	**Focused comments from the Delphi process:** From one expert who disagreed with the statement, based on "I do not agree with maintaining skills through theoretical assessments; but I agree that this should be done via case discussion. but you put it together, so I chose to disagree"
		(b) but supported using mentorship and building collaborations with centres regularly training in EEG and providing clinical services for EEG in children	87%	

TABLE 4 (Continued)

Theme	Statement	Sub questions	Consensus %	Focused comments
Training model	Training for non-epilepsy specialists should be standardised to ensure consistency.	**(a)** Quality of training models should be critiqued using monitoring and evaluation tools	93%	**Focused comments from the Delphi process:** "I think we have differing definitions of "specialist" here...In Zambia, a pediatrician is a specialist" and "However, these tools may vary depending on specific settings or regions and availability of resources"
		(b) Those providing pediatric EEG services should meet an adequate level of competency as approved by local authorities before being allowed to practice	80%	**Focused comments from the Delphi process:** "This assumes a local authority would have the technical expertise to make this determination. I believe this is better handled by a central authority unless the technical expertise clearly exists locally to make this evaluation"; "If there are no local standards then international validated standards should be followed" and "In LMICs, there is often a lack of local authority which is competent to do this" **Key message:** The one person that disagreed and emphasized local authority limitations. It may be idealist to expect local authority to be able to undertake this role. So, whilst an important approach to follow, if local authority isn't equipped to provide the competency assessment, then alternate options are needed e.g. international groups
		(c) Access to specialist training is still required, in addition to non-epilepsy specialists, to attain high level pediatric epilepsy and EEG services	93%	**Focused comments from the Delphi process:** "So high level services will not be available to everyone unless telemedicine comes into play" and "Fellowship trained Epileptologists are necessary to oversee EEG Training to non-epilepsy specialists and maintain EEG reporting standards" **Key message:** There is a need for specialists in resource limited environment. This speaks to the fact that if one tries to set up this kind entry level basic care safe practice service you should have an access point and somebody in the country who would lead it (Wilmshurst et al., 2016)

TABLE 4 (Continued)

Theme	Statement	Sub questions	Consensus %	Focused comments
Recommendations		**(a)** Clinicians training in child neurology in LMICs need to acquire more advanced pediatric EEG skills than their colleagues in resource-equipped settings. Skills include practical equipment related as well as interpretive, so that when they establish and build services in their home settings, they are equipped to do this	87%	
		(b) These trained clinicians should also take an advocacy role to raise awareness of the risks of misinterpretation and misuse of EEG in the hands of untrained practitioners in their local settings	100%	
Delphi round 2				
Expanded training requirements	What would be needed for a non-epilepsy specialist to be able to use, sustain and maintain EEG training skills?	**(a)** Individual perspective – the non-epilepsy specialist should want to train and have long term commitment for use and maintenance of skills	93%	**Focused comments from the Delphi process:** "The interest of the individual is very important" and "Also that the non-specialist should have a responsible number of epilepsy patients (otherwise if s/he sees only few patients, s/he might not be motivated to continue the training" **Key message:** Non-specialist healthcare providers should be invested in attaining and maintaining basic skills to be able to care for children with epilepsy and to optimise their use of EEG
		(b) Institution perspective – the centre/region should provide support for the operational infrastructure for the service delivery	100%	**Focused comments from the Delphi process:** "Institutions must provide the basic equipment and materials to operate and maintain an electroencephalography service, given that epilepsy is a public health problem with a high probability of control with an accurate diagnosis" and "Institutional involvement is important to give value to training and advancement in professional rank and to provide learners with the necessary equipment" **Key message:** Institutions investing in proper resources and professional training not only ensures better patient outcomes but also contributes to a more knowledgeable and skilled healthcare workforce

TABLE 4 (Continued)

Theme	Statement	Sub questions	Consensus %	Focused comments
		(c) Health policy/Government or Ministerial level – recognize and support the development and sustainability of this service, ultimately improving healthcare outcomes in children	93%	**Focused comments from the Delphi process:** "I agree with this statement, although sometimes government public policy is born because awareness and work were raised by the patient and medical community and not by the politicians in power" and "It is necessary to raise awareness between public health officials about the need to offer these services" **Key message:** Advocacy from patients, non-government organisations and the medical community can inspire public officials. Increased awareness amongst those officials can lead to proactive measures and policies that enhance service availability and quality
		(d) Task sharing – in settings which lack paediatric EEG specialists, provided points a-c are met, appropriately trained and supported non-epilepsy specialists can undertake paediatric EEG interpretation	80%	**Focused comments from the Delphi process:** "This is important in poor resource settings with no access to specialists" and "The interested person must demonstrate an update through virtual or in-person training in variable periods, for example every 3 years" **Key message:** Health systems can better meet the needs of their populations, even in contexts where resources are scarce by prioritizing accessibility to services and emphasizing continual professional education

interpret.[12] Interpretation of pediatric EEG requires instruction in and exposure to the different EEG changes that evolve during brain maturation and the abnormalities present in specific pediatric epilepsy syndromes.[20] Recognition of certain patterns is critical for appropriate management and to minimize neurological and developmental deficits for e.g. status epilepticus or developmental epileptic encephalopathy such as infantile epileptic spasms syndrome.

3.4 | Assessment

The value of continous assessment to maintain learned skills by having consistent supervision was also emphasized. Hosting bi-weekly EEG meetings was seen as a favorable collaboration for training, re-inforcement of knowledge and skills, for different levels of expertise. This practice is used in our center at the Red Cross War Memorial Childrens Hospital. Ongoing collaboration between training centres and partner sites is crucial.

3.5 | Barriers (lack of training)

Due to lack of neurology specialists in SSA, some experts were in favor of training non-epilepsy specialists who treat children with epilepsy in EEG interpretation while other experts doubted the feasibility that non-epilepsy specialists would be able/willing to invest the time needed for proper training to occur and for skills to be maintained. Most countries do not have the expertise to train non-epilepsy specialists and technicians, and widely accepted curricula for such training do not exist. One expert suggested training in their mother tongue as english is not very well understood for some regions in SSA. This would require qualified EEG trainers in those countries, which is currently lacking.

3.6 | Misuse of EEG

During the interviews from experts in Iraq, Tunsia, Colombia, India and Zambia, it was reported that misuse of EEGs is a common issue among non-neurology personnel particularly among practitioners who receive financial incentives based upon EEG completion. EEGs are performed unneccessarily on patients with no clinical indication for EEG, leading to misdiagnoses especially when the reader is not sufficiently skilled in pediatric EEG interpretation.

3.7 | Training model (apprenticeship)

Experts describe with clarity the importance of having both "apprenticeship as well as online resources," as the best pedagogy to learn pediatric interpretation. However, some SSA countries do not have the capacity to send physicians away to train for long periods of time and a hybrid method was suggested. The expressions of recommendations from some experts describe the importance of accessing early EEG training and emphasing the important for sub-Saharan African trainees, as time is limited during their registrarship.

3.8 | Entry qualifications, maintenance of skills, and infrastructure requirements

Whilst most of the experts agreed with the concept of training non-epilepsy specialists, they raised important issues around capacity, committment and sustainability. This question did not reach consensus in the first Delphi round. The second stage Delphi explored solutions to the challenges raised about sustainability of the training model concept, through different levels critical for the service to be functional. At the individuals level, this person must be invested and capacitated to not only complete the training program but also to continue to maintain the skills learnt. Further to ringfence clinical duty time to be involved in adequate numbers of EEG analyses, as well as engaging with colleagues in the same field to critique and compare quality of work undertaken. This could be supported either by regular meetings or online calls with specialists who may be located in other regions. The experts noted the huge workload burden carried by clinicians who may be responsible for diverse areas of healthcare delivery. That these individuals need to be officially identified for their allocated time and role in the EEG service so that they are not drawn into other areas of care. At the instutitional level, that the individual is based in, the centre should have identified the need for EEG services as a priority area and inline with this ensured infrastructure is adequate to develop, run and maintain an effective service with appropriate equipment and staffing. At a national level there should be policy support that EEG services are necessary to deliver high-quality care for children with epilepsy. There was consensus that if these three areas, individual, instutional and national policy, were met then the concept of training non-epilepsy specialists was viable.

3.9 | Recommendations

Filling the gap in countries where resources are limited, was expressed as a stepping stone to address the lack of pediatric EEG training. There are few non-specialist curricula which have been critiqued, whilst some show similarities with key concepts taught, in general, pediatric EEG training is virtually non-existent in most programs.[5] The first and last authors via the APFP program are supporting the training of doctors in the clinical interpretation and analysis of EEGs, and nurses to perform EEGs and recognized urgent intervention findings, by expanding their pediatric EEG skills set and maintaining skills with bi-weekly EEG meetings. The online course established by the first author covers the key concepts for learning pediatric EEG interpretation. This curriculum content and teaching method is accessible and applicable within Africa and aimed to strengthen pre-existing local skills. The handbook supports this niche skills area; such that participants found the handbook to be useful, both for their clinical practice and for the accessibility of the knowledge contained in the book.[15] Future training will promote and engage with the primary care curricula of the International League Against Epilepsy (ILAE). This EEG curriculum is aligned with the implementation of the Intersectoral Global Action Plan for Epilepsy and other Neurological Disorders (IGAP) to promote pathways to care for people with epilepsy.[21] This re-enforces the training and education of pediatric EEG interpretation in SSA.

The Delphi process was impressive for the consensus reached on the different qualitative statements from the international panel. Our purpose was to create a global international consensus-based recommendation, illustrating opinion cohesion and further learnings and recommendations that came through, as explained by the experts. However, our question on entry skills failed to reach consensus of 80%. While the concept of training non-epilepsy specialists was accepted this response related to the conceptualization of how it would be implemented and sustained. In the current resource limited setting, there was appropriate concern that effective and sustained implementation would be challenging for the non-neurologist. The stage two Delphi which expanded on this and resulted in consensus on all four statements (Table 4). To date, our experience has been closely aligned with APFP work, specifically focusing on enhancing the skills of pediatricians and pediatric neurology trainees. It would be valuable to explore which other cadres could also benefit from such training, e.g., medical officers, psychiatrists, adult neurologists, neurosurgeons, etc. Expanding our focus might enhance overall interdisciplinary collaboration and improve patient care across different specialties.

3.10 | Strengths and limitations

The study had similar representation from resource equipped and resource limited countries. Interviewer bias was curtailed by the fact that the first author asked the same questions across different interviews. Only one participant failed to acknowledge the email invitation to participate in the study. The themes and sub-themes were arrived at by the first author and the adult education expert. The 15 experts interviewed had special interest either in education and/ or advocacy. There could be some bias in that the experts were indeed passionate and experienced in the field but the findings should ideally reflect common and broader acceptance and as such we cannot assume that the same views would be held by epileptology experts who do not have experience in LMICs.

4 | CONCLUSION

There is a dearth of pediatric EEG skilled specialists in sub-Saharan Africa. To address this issue, the experts supported adapting training for non-epilepsy specialists (Table 1) with a focus on pediatrics. The findings of this study address this gap and promotes continuous teaching collaborations as well as being innovative in developing such programs. The purpose of the article is not to delay diagnosis and treatment of epilepsy until an EEG is obtained, but rather to reinforce the importance of an EEG as an ancillary tool to describe an electroclinical condition or syndrome. Clinical skills remain the pillar of diagnosis in epilepsy. To reach a complete approach to epilepsy description, classification, follow-up and prognosis, a well done EEG is important, but it should not replace a clinical diagnosis. The consensus based stage one and two Delphi pecentages was successfully reached. These training recommendations are being incoporated into the EEG training program of the African Pediatric Fellowship Program which aims to provide sustainability to qualified pediatric neurologists and non-epilepsy specialists training in EEG. This EEG program works well under the APFP which typically trains pediatricans as the main group to benefit from the training but we believe that any doctor involved in the treatment of children with epilepsy would benefit from access to the curriculum. The culmination of this project would benefit epilepsy care for children in SSA as well as in other low and middle income countries.

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CONFLICT OF INTEREST STATEMENT

None of the authors has any conflict of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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