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RESEARCH ARTICLE

Development and Implementation of a Global Pediatric Oncology Surgery Fellowship Curriculum: A Consensus-Driven and Collaborative Effort to Address Workforce Challenges

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ABSTRACT

Background/Purpose: Pediatric cancer is a major global health challenge, with an estimated 400,000 new cases diagnosed each year. Access to specialized surgical care is particularly limited in low- and middle-income countries (LMICs), where a shortage of trained pediatric surgical oncologists exacerbates treatment disparities. This study aimed to develop a comprehensive global curriculum for pediatric surgical oncology to enhance training and improve patient outcomes.

Methods: A mixed-method approach was adopted for the development and implementation of the curriculum. A consensus-driven curriculum was created through a Delphi process involving pediatric surgical oncology program directors from diverse regions. A series of voting rounds established essential competencies, with a threshold of 70% agreement required for inclusion. The curriculum incorporates both online modules and hands-on training, emphasizing regional needs and mentorship.

Results: The Delphi panel included a diverse group of pediatric surgical oncology program directors, with consensus reached on a comprehensive checklist of competencies after three rounds of voting. The curriculum was piloted in Africa, Southeast Asia, and Latin America, ensuring local relevance and sustainability through collaborations with national cancer institutes and ministries of health.

Conclusions: This innovative curriculum aims to transform pediatric surgical oncology education, fostering a global community of practice. By addressing training gaps in LMICs, it seeks to enhance the quality of care for pediatric cancer patients and strengthen healthcare systems worldwide.

1 | Introduction

Pediatric cancer is a major global health challenge, with approximately 400,000 new cases diagnosed each year [1]. The field of pediatric surgical oncology faces substantial disparities in access to care and specialized services, particularly in low- and middle-income countries (LMICs) [1–3]. These challenges are exacerbated by a critical shortage of trained pediatric surgical oncologists, which hampers the delivery of effective treatment and negatively impacts patient outcomes [1–7].

In response to this urgent need for enhanced training in pediatric surgical oncology, a collaborative initiative was launched to develop an international pediatric oncology surgery fellowship program that includes building a standardized comprehensive global curriculum. This effort employs a consensus-driven approach, engaging experts from diverse regions to ensure that the curriculum addresses a wide range of educational needs and cultural contexts. By incorporating insights from established directors of pediatric surgical oncology programs and current fellows enrolled in this global program, the development process aims to identify essential competencies tailored to the unique challenges faced by LMICs.

The curriculum is designed to provide foundational knowledge and skills in pediatric surgical oncology, while also fostering a sense of community and shared purpose among trainees across the globe. This global network of professionals will promote the exchange of best practices, mentorship, and resource-sharing, ultimately supporting the creation of sustainable pediatric oncology surgery programs tailored to local contexts.

The primary objective of this study is to present the framework and anticipated outcomes of the curriculum, highlighting its potential to transform pediatric surgical oncology education and practice globally. A central focus of this initiative is the creation of an international talent pipeline for pediatric surgical oncology, with particular emphasis on supporting trainees from resource-limited settings. This pipeline will be supported by an international network offering mentorship, professional development, and skill enhancement for fellows.

The core learning outcomes of the fellowship are designed to ensure that, by the end of the two-year program, fellows will demonstrate proficiency in key onco-surgical principles, including proper staging, achieving complete resections, and comprehensively documenting surgical findings. Fellows will also be expected to contribute actively to multidisciplinary teams, especially in tumor board discussions, to improve clinical decision-making. A further key objective is for fellows to engage in healthcare system improvement by identifying gaps in care, developing quality improvement initiatives, and implementing effective solutions. By addressing both technical skills and leadership development, the curriculum aims to equip fellows not only with expertise in pediatric surgical oncology but also with the ability to drive sustainable advancements in cancer care in their home countries.

2 | Method

2.1 | Mixed-Method Approach Was Adopted for Development and Implementation of the Curriculum

2.1.1 | Curriculum Development

A panel of experts, comprising directors of pediatric surgical oncology fellowship programs from six continents, collaborated to draft a consensus-based curriculum focused on key goals and competencies. This panel of experts was identified through the International Society of Pediatric Surgical Oncology (IPSO) collaborative network. Additionally, a second panel of current fellows of the global pediatric surgical oncology program contributed trainee perspectives. Fellows were prioritized for selection from regions that are less resourced in childhood cancer treatment, aiming to enhance the capacity of pediatric oncology surgical care in LMICs.

The curriculum development process began with a scoping exercise, which included a literature review and discussions with the expert panel. This led to the creation of 34 potential competency items covering various aspects of pediatric surgical oncology. To ensure a comprehensive and evidence-based curriculum, these competencies underwent a modified Delphi voting process, with three response options: "Disagree," "Neutral," and "Agree." Votes categorized as "Neutral" or "Disagree" were included in the denominator. A preestablished consensus threshold of ≥70% agreement was set, but achieving this threshold did not end the voting process. Each item required consensus across at least two rounds to be included in the final curriculum checklist. This iterative process allowed panelists to reconsider their positions based on feedback from previous rounds.

In the first round, panelists were allowed to suggest new items for consideration, offer free-text comments to justify their votes,

and propose modifications to item wording. After each round, panelists received anonymized voting results and qualitative comments to reassess their positions. Items not reaching consensus in the initial two rounds were revised or excluded based on panelist feedback. Any substantially altered items were treated as new and subjected to additional rounds of voting. All wording changes were documented, and panelists received summaries of modifications after each round.

Items achieving consensus after two rounds were included in the checklist, while those with unstable agreement—achieving consensus in one round but falling to disagreement in another round—were revised based on qualitative feedback and brought back for a third round of voting.

To assess significant changes in voting behavior across rounds, McNemar's test was applied. This statistical test is designed to evaluate changes in categorical outcomes, particularly when participants make binary decisions at two different time points. In this case, it was used to analyze how panelists' votes shifted between rounds, specifically looking for changes in agreement or disagreement regarding the inclusion of specific competencies.

The analysis focused on binary responses from panelists for each competency item across voting rounds. By comparing the proportions of agreement and disagreement, McNemar's test identified statistically significant shifts in the panel's collective opinion. This provided insights into the stability of the panel's consensus and the effectiveness of revisions in fostering agreement.

Additionally, the results were compared between two groups—directors of pediatric surgical oncology programs and current fellows—to ensure both trainers' and trainees' perspectives were incorporated.

2.1.2 | Curriculum Implementation

The curriculum implementation began with a needs assessment, which included a literature review [2, 3] and consultations with key stakeholders, such as local surgeons, regional program directors, and fellows from the participating regions. Additionally, a more comprehensive multiregional assessment was conducted using the Paediatric Oncology Facility Integrated Local Evaluation-Surgical Tool (PrOFILE-ST) to evaluate healthcare service delivery [8–10]. However, the results of this assessment, currently under review for publication, fall outside the scope of this study and are not included in the discussion.

The program was piloted in regions with significant needs, particularly in Africa, Southeast Asia, and Latin America (Figure 1), with faculty members drawn from leading pediatric cancer surgeons at regional reference centers (Figure 2).

During the pilot phase, the focus was on building the program's structure and initiating training. In Year 1, key personnel from participating institutions were identified, and roles and responsibilities were clarified to ensure smooth collaboration. Establishing partnerships with national cancer institutes and local cancer surgery leadership was prioritized, with a focus on selecting surgeon candidates committed to improving local capacity for pediatric cancer surgery.

A harmonized selection tool was used across all sites to ensure fairness and transparency in trainee selection. The selection process involved program faculty, local supervising surgeons, and representatives from national cancer institutes or pediatric oncology units. Selection criteria included the candidate's academic qualifications, commitment to the field, local support, potential for retention, and ability to contribute to the sustainability of pediatric surgical oncology programs in their home institution (see Appendix 1 for the detailed scoring system). This collaborative approach ensured that selected candidates were well-supported, academically prepared, and positioned for success in both the program and their local healthcare settings. Financial support for the program was secured through partnerships with governmental and nongovernmental organizations, ensuring ongoing training and development.

A key component of the program's sustainability is local ownership. By engaging local institutions, including national cancer institutes, regional mentors, universities, accreditation bodies, and ministries of health, the program is deeply integrated into the local healthcare infrastructure. This collaborative model fosters long-term responsibility and commitment to the program's success.

In Year 1, the first trainee began foundational training through online sessions, e-learning platforms, and local mentorship in collaboration with regional mentors. In Year 2, the trainee advanced to 12 months of hands-on training at a regional center under direct mentorship. Simultaneously, a second fellow from a different region began their foundational year, allowing the program to expand while maintaining high-quality, individualized education for each participant.

By Year 3, the program was set to expand further, adding five new training sites, thereby broadening its reach and impact. This expansion will strengthen the international network of pediatric surgical oncology training centers, supporting long-term growth and sustainability.

The curriculum is implemented using an innovative hybrid model that creates a collaborative international multicenter network. This approach differs from traditional single-center twinning methods and aims to establish a sustainable educational framework for pediatric surgical oncology in LMICs.

The program faculty comprises experienced pediatric oncosurgeons from both LMICs and high-income countries (HICs). This diverse expertise enhances the training experience through relevant cultural and clinical perspectives. The curriculum is tailored to regional needs, ensuring that mentorship is provided by leading local surgeons and regional experts during the first year. The second year focuses on advanced hands-on training at regional reference centers under direct mentorship.

Online live sessions cover foundational knowledge, surgical techniques, and case discussions, with interactive elements to encourage active learning. The e-learning platform offers

FIGURE 1 | Map showing local collaborating training sites.

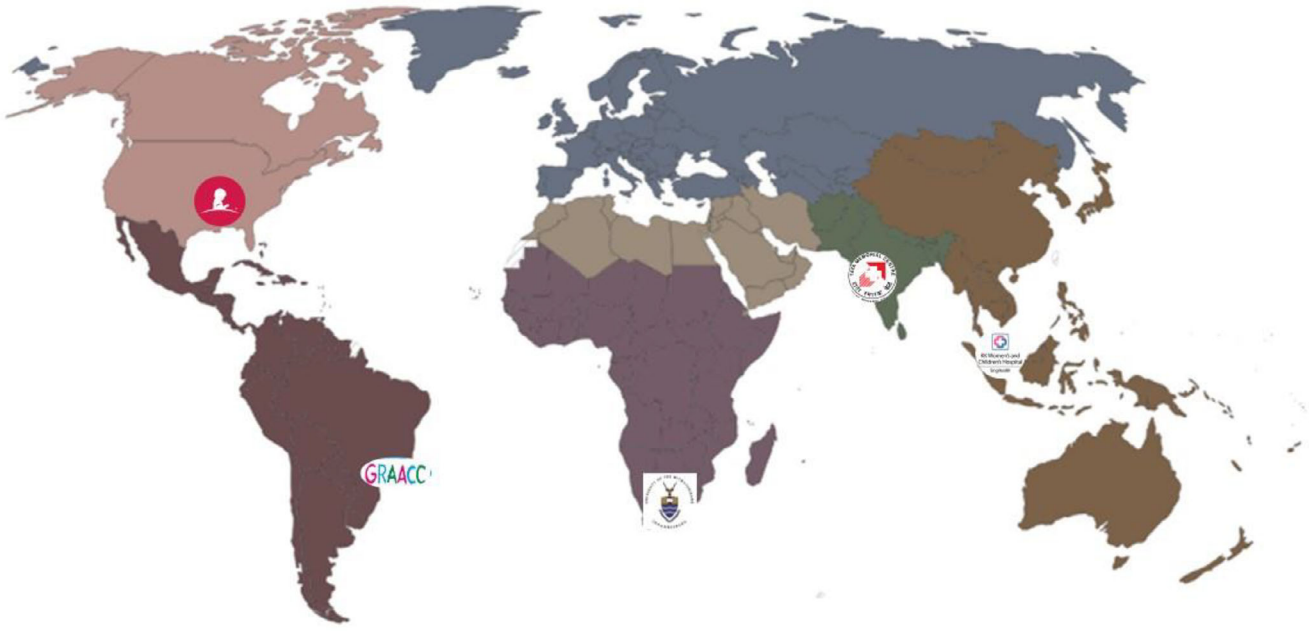

FIGURE 2 | Map indicating locations of regional reference centers.

recorded lectures, scientific papers, and operative videos, all aligned with key curriculum topics for further study. In-person training takes place at reference regional centers, where fellows participate in supervised surgeries and multidisciplinary case discussions, receiving real-time feedback from mentors.

2.1.3 | Evaluation and Feedback

The evaluation of the pediatric onco-surgical curriculum was conducted using a comprehensive framework based on Kirkpatrick's four-level model, a widely established approach for assessing the effectiveness of training programs. This model evaluates four key areas: trainee satisfaction, knowledge and skills acquisition, application of knowledge in clinical settings, and patient outcomes.

2.1.3.1 | Level 1: Trainee Satisfaction. The first level of evaluation assessed trainee satisfaction and the extent to which the curriculum met the needs of both the trainees and the local institutions. Feedback was collected through surveys, interviews,

and focus groups to ensure the curriculum was responsive to the needs of participants and aligned with institutional goals.

2.1.3.2 | Level 2: Knowledge and Skills Acquisition. The second level focused on measuring the acquisition of knowledge and skills. Pre- and post-assessments and mentor evaluations were used to assess trainees' progress throughout the curriculum. This allowed for the measurement of both theoretical knowledge and practical competencies before and after program completion.

2.1.3.3 | Level 3: Application of Knowledge in Clinical Practice. The third level evaluated the transfer of acquired knowledge and skills into clinical practice. This was achieved through direct observation and mentor feedback on trainees' clinical decision-making, communication, and leadership in managing complex pediatric oncology cases. The ability to apply learned concepts in real-world scenarios was critical to assessing the effectiveness of the curriculum.

2.1.3.4 | Level 4: Patient Outcomes. The fourth level examined the broader impact of the curriculum on patient outcomes. Key metrics, including survival rates, complication reduction, and long-term career progression of trainees, were tracked. Data from national cancer institutes and pediatric oncology units were used to evaluate the impact of the program on pediatric cancer care and its sustainability over time.

2.2 | Ongoing Monitoring and Summative Evaluation

To ensure continuous improvement and trainee development, quarterly reviews were conducted by program faculty. These reviews monitored the progression of trainees toward mastering the curriculum's competencies and assuming increasing responsibilities. At the end of the two-year fellowship, a summative evaluation was performed to assess overall development, including clinical and surgical skills, leadership abilities, and the trainees' capacity to lead pediatric surgical oncology initiatives in their home institutions. This evaluation was based on a structured framework adapted from the Accreditation Council for Graduate Medical Education (ACGME) competencies (see Appendix 2 for details).

3 | Results

The Delphi panel included a diverse group of participants from various geographical regions, with 17 out of 20 (85%) program directors of pediatric surgical oncology fellowships worldwide completing three rounds of iterations, maintaining a 94% retention rate (Table 1). The preliminary draft checklist for voting included 34 items identified through a literature review and initial discussions with the expert panel. After two rounds, 30 items achieved stable agreement, while one item was removed based on consensus. Three items that did not reach consensus were revised based on feedback and reevaluated in Round 3. Ultimately, 33 items were accepted after all three rounds of voting, with detailed results summarized in Table 2. McNemar's test revealed no significant differences in the proportion of agreement between the rounds or between the two groups (directors and fellows).

TABLE 1 | Panel demographics.

Panel's demographics	$N = 17$
Gender	
Female	5 (29.4%)
Male	12 (70.6%)
Geographic location	
Africa	1 (5.9%)
Asia	2 (11.8%)
Europe	4 (23.5%)
North America	2 (11.8%)
Oceania	1 (5.9%)
South America	7 (41.1%)
High-income countries	7 (41.1%)
Low- and middle-income countries	10 (58.9%)

The needs assessment identified critical gaps in pediatric surgical oncology training across the selected pilot sites, with a particular emphasis on the need for specialized training opportunities and mentorship.

The pilot phase of the program commenced in 2022 with its launch in Sudan, followed by Peru in 2023. In 2024, the program expanded to Uganda, Ethiopia, Pakistan, Bangladesh, and Nepal. Currently, seven fellows are enrolled, with one from each participating country. During the first year of training, fellow salaries were funded by their respective national cancer institutes or ministries of health. For the regional training year, funding was secured through philanthropic foundations and corporate sponsorships. One challenge encountered during the regional training year involved securing health insurance coverage, which was successfully addressed due to the flexibility of the health systems in certain LMICs.

Unfortunately, the program's implementation in Sudan was interrupted by the outbreak of civil war, which led to the closure of the National Cancer Institute and the displacement of millions of people. This conflict forced the suspension of the program after the first year. Despite this setback, the fellowship continued as planned at other pilot sites, with educational sessions proceeding in Peru, Uganda, Pakistan, Nepal, Bangladesh, and Ethiopia (Figure 1) (Appendix 3).

Initial meetings with health ministry officials in Sudan and Peru were pivotal in establishing a formal framework for the fellowship program, leading to the formation of a dedicated task force. This task force, in collaboration with national cancer institutes and local chief surgeons, played a critical role in the program's successful launch, ensuring it received the necessary resources and alignment with national health priorities.

For subsequent site launches, it was determined that direct engagement with health ministries was no longer necessary.

TABLE 2 | Competencies included in the curriculum as identified by experts' consensus.

	Competencies	Directors' Round 1 ($N = 17$)	Directors' Round 2 ($N = 16$)	Fellows' Round 1 ($N = 7$)	Fellows' Round 2 ($N = 6$)
Foundational curriculum					
1	Formulating Pediatric Cancer Care Management Plan	16 (94%)	16 (100%)	7 (100%)	6 (100%)
2	Assessing Therapy Response	16 (94%)	15 (94%)	7 (100%)	6 (100%)
3	Executing Surgical Treatment Strategy	15 (88%)	15 (94%)	7 (100%)	6 (100%)
4	Effective Communication with Patients and Families	17 (100%)	15 (94%)	7 (100%)	6 (100%)
5	Collaborative Care for Safe and Optimal Treatment	16 (94%)	16 (100%)	7 (100%)	6 (100%)
6	Applying Change Management and Quality Improvement Principles in Team Leadership	15 (88%)	13 (81%)	6 (86%)	6 (86%)
7	Pediatric Cancer Patient Advocacy	13 (76%)	13 (81%)	7 (100%)	6 (100%)
8	Enhancing Patient Care Through Personal Learning and Knowledge Sharing	15 (88%)	15 (94%)	6 (86%)	5 (83%)
9	Prioritizing Patient Care and Maintaining Work–Life Balance for Well-being	11 (64%)	14 (88%)	6 (86%)	6 (86%)
Advanced curriculum					
1	Advancements in Vascular Access Techniques	17 (100%)	15 (94%)	6 (86%)	6 (100%)
2	Advancements in Wilms Tumor Surgery with Intravascular Thrombus	17 (100%)	16 (100%)	7 (100%)	6 (100%)
3	Advancements in Bilateral Wilms Tumor Nephron-Sparing Surgery	16 (94%)	13 (81%)	7 (100%)	6 (100%)
4	Advancements in Resection of Neuroblastoma Encasing Midline Vessels	16 (94%)	16 (100%)	7 (100%)	6 (100%)
5	Principles of Vascular Repair and Reconstruction	17 (100%)	16 (100%)	7 (100%)	6 (100%)
6	Advancements in Complex Hepatic Resection	12 (70%)	11 (69%)	7 (100%)	6 (100%)
7	Advancements in Pancreatic Tumor Resection	16 (94%)	13 (81%)	7 (100%)	6 (100%)
8	Advancements in Complex Sarcoma Resection	16 (94%)	16 (100%)	7 (100%)	6 (100%)
9	Advancements in complex body wall resection and reconstruction	13 (76%)	16 (100%)	7 (100%)	6 (100%)
10	Principles of Ureteric and Bladder Reconstruction with Urinary Diversion	11 (64%)	14 (88%)	7 (100%)	6 (100%)
11	Advancements in Retroperitoneal Lymph Node Dissection	17 (100%)	14 (94%)	7 (100%)	6 (100%)
12	Advancements in Complex Germ Cell Tumor Resection	17 (100%)	14 (94%)	7 (100%)	6 (100%)

(Continues)

TABLE 2 | (Continued)

	Competencies	Directors' Round 1 ($N = 17$)	Directors' Round 2 ($N = 16$)	Fellows' Round 1 ($N = 7$)	Fellows' Round 2 ($N = 6$)
13	Advancements in Fertility Preservation Techniques	16 (94%)	14 (88%)	7 (100%)	5 (83%)
14	Advancements in Complex Mediastinal Tumor Resection	16 (94%)	16 (100%)	6 (86%)	6 (100%)
15	Advancements in Cytoreductive Surgery Techniques	12 (70%)	13 (81%)	6 (86%)	6 (100%)
16	Advancements in Metastatic Disease Resection	17 (100%)	16 (100%)	7 (100%)	6 (100%)
17	Advancements in Minimally Invasive Cancer Surgery Techniques	15 (88%)	13 (81%	7 (100%)	6 (100%)
18	Advancements in Resection of Rare Tumors Part 1[a]	14 (82%)	14 (88%)	6 (86%)	6 (100%)
19	Advancements in Resection of Rare Tumors Part 2[b]	14 (82%)	13 (81%)	6 (86%)	6 (100%)
20	Advancements in Image-Guided Tumor Resection	17 (100%)	15 (94%)	7 (100%)	5 (83%)
21	Multidisciplinary Surgical Collaboration Across Specialties	17 (100%)	16 (100%)	7 (100%)	6 (100%)
22	Surgery in Neutropenic and Bone Marrow Transplant Patients	16 (94%)	16 (100%)	7 (100%)	6 (100%)
23	Principles of Palliative Surgery	17 (100%)	16 (100%)	7 (100%)	6 (100%)
24	Emergency and Adjunct Procedures in Pediatric Cancer Care	12 (70%)	13 (81%)	7 (100%)	6 (100%)

[a]Thyroid cancer, melanoma, and pleuropulmonary blastoma.

[b]Adrenocortical tumors, pheochromocytoma, and gastrointestinal stromal tumors.

Instead, ongoing collaboration with national cancer institutes and strong leadership from local surgical teams were sufficient to secure the program's support. This streamlined approach proved effective, enabling the program to expand without extensive government involvement. By leveraging established networks and local leadership, the program has maintained a focus on context-specific needs, further supporting its long-term sustainability.

In the second year, fellows rotate through regional reference centers in Brazil, South Africa, Singapore, and India, where they receive advanced mentorship and hands-on clinical experience. This rotation strengthens fellows' surgical skills by providing exposure to a broader range of pediatric cancer cases (Figure 2).

Although data on long-term career progression and the establishment of local programs are not yet available due to the short follow-up period, quarterly evaluations from local and regional mentors suggest that fellows are meeting milestones and progressing well. Feedback from satisfaction surveys has remained positive, though fellows have suggested improvements to the e-learning platform and requested more dedicated study time. Additionally, fellows have expressed interest in increasing the focus on ethics, leadership training, and research skills within the curriculum.

4 | Discussion

The successful development and consensus on key competencies for a global pediatric surgical oncology curriculum represents a significant step forward in addressing workforce challenges, particularly in LMICs. This collaborative effort has highlighted the importance of customizing educational frameworks to meet the specific needs of different regions while fostering a shared understanding of best practices in pediatric surgical oncology.

Achieving consensus on the competencies demonstrates a collective commitment to enhancing training standards and improving patient outcomes. By integrating input from both program directors and current fellows, the curriculum is designed to be both comprehensive and practical, effectively addressing the realities of clinical practice. This dual input—sourced from those responsible for training and those directly impacted by it—ensures that the competency selection is well-rounded and applicable. The curriculum offers a solid foundation, adaptable for global scalability while respecting regional differences in care delivery.

A notable strength of this initiative is its emphasis on contextual relevance. The curriculum development process incorporated input from diverse cultural, geographical, and socioeconomic

backgrounds, which is particularly crucial for LMICs. This approach ensures that the competencies trainees acquire are not only academically rigorous but also highly relevant to their local healthcare settings. Such contextual relevance is vital for the sustainable development of pediatric surgical oncology services, as it addresses local challenges while leveraging existing resources. Additionally, the model, which allows fellows to gain foundational training at home institutions before rotating to regional reference centers for advanced training, ensures that their expertise remains connected to both local and regional healthcare systems.

The hybrid learning model, combining both online and in-person components, further enhances accessibility and flexibility, facilitating broader participation across various regions. This model is especially advantageous in LMICs, where logistical barriers can hinder traditional training methods [4, 11–15]. By leveraging online platforms, the curriculum is able to reach a wider audience and foster a global community of practice, facilitating the exchange of knowledge and resources. Meanwhile, the in-person components ensure that trainees gain critical hands-on experience, especially in mastering surgical techniques that are central to pediatric surgical oncology practice [4, 11–13, 15].

Another vital aspect of the program is its focus on long-term sustainability and community ownership within LMICs. Embedding the fellowship within local pediatric cancer initiatives ensures that education and training continue even as external support evolves. This community-centric approach not only empowers local healthcare providers but also nurtures future leaders in pediatric surgical oncology. Ultimately, this approach strengthens local healthcare infrastructures by creating a network of trained professionals capable of leading and expanding pediatric surgical oncology services in their regions.

While this initiative has achieved significant milestones, several challenges remain. Ensuring consistent implementation across diverse contexts, addressing resource limitations, and maintaining participant engagement are key considerations. Future and ongoing efforts should concentrate on developing robust evaluation mechanisms to assess the curriculum's effectiveness and its impact on trainee outcomes and patient care.

It is also important to acknowledge the limitations of this initiative, particularly the short follow-up period, which currently restricts our ability to assess the long-term impact of the curriculum. The relatively brief evaluation timeframe limits our capacity to measure sustained effects on trainee outcomes, such as competence retention or the establishment of independent, sustainable pediatric surgical oncology programs within LMICs. Furthermore, the lack of longitudinal data hampers our understanding of how trainees will integrate into local healthcare systems and contribute to improvements over time.

To address this gap, long-term follow-up evaluations are essential. Future assessments should track fellows' career progression, their integration into local healthcare settings, and the lasting impact of their work on pediatric surgical oncology services. Additionally, ongoing monitoring of patient outcomes will be critical in determining whether the curriculum leads to measurable improvements in care delivery and survival rates for pediatric cancer patients in the regions served. By incorporating these evaluations, we aim to accurately gauge the curriculum's effectiveness and its role in transforming pediatric surgical oncology education and practice globally.

In conclusion, the consensus-driven development of this pediatric surgical oncology curriculum represents a pivotal step in addressing workforce challenges within this field, particularly in LMICs. Through fostering collaboration, ensuring contextual relevance, and promoting sustainable practices, this initiative aims to enhance the training of future pediatric surgical oncologists and ultimately improve care for children with cancer worldwide. The framework established by this curriculum lays the foundation for continued growth and innovation in pediatric surgical oncology education, offering hope for a brighter, more equitable future in global healthcare.

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Conflicts of Interest

The authors declare no conflicts of interest.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.