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PedROC 2.0: provider confidence in Wilms tumor management in sub-Saharan Africa: making the case for pediatric radiotherapy inclusion during basic medical training

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Abstract

Background To investigate the relationship between exposure to pediatric radiotherapy during basic medical training and healthcare provider confidence in managing Wilms tumor within sub-Saharan Africa.

Methods A cross-sectional study of 370 healthcare providers participating in a second iteration of the Pediatric Radiation Oncology Virtual Course (PedROC) held on the 29th of July 2023 was conducted. Participants were invited to fill an online survey after providing consent with the assurance of anonymity. For the study outcome, we developed a composite confidence score, ranging from 0 to 20, with higher scores reflecting greater self-reported confidence with managing Wilms tumor. The score was derived from participants' self-reported confidence levels in ten critical domains of Wilms tumor management assessed in the survey. The independent variable was any prior pediatric radiotherapy exposure during medical training (coded yes/no). Chi-square, Fisher's Exact test, multivariable linear regression, and ordinal logistic regression were used to analyze associations, adjusting for provider type, previous training, and clinical setting characteristics. Stata v. 18.5 was used for all statistical analyses with significance set at $p \leq 0.05$.

Results Of the cohort, 76.86% had no prior pediatric radiotherapy training, and 23.14% did. Confidence levels varied significantly between groups: among those without training, 34.77% reported low or no confidence, 50.54% moderate, and 14.70% high confidence; while those with training reported 7.14%, 50.00%, and 42.86%, low, moderate, and high confidence levels respectively ($p < 0.001$). In the primary adjusted model, any prior pediatric radiotherapy teaching during training was associated with a significantly higher composite confidence score (coefficient 2.60; 95% CI 1.51–3.69; $p < 0.001$). Secondary analysis confirmed increased odds of high confidence (OR 1.28; 95% CI 0.69–1.87; $p < 0.001$).

Conclusion Pediatric radiotherapy inclusion in basic medical training was significantly associated with higher provider confidence levels in managing Wilms tumor. These findings support the potential for integrated pediatric

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radiotherapy training into standard oncology programs in resource-limited settings to enhance provider preparedness and improve pediatric cancer care.

Keywords Pediatric radiotherapy, Medical education, Cross-curricular integration, Sub-Saharan africa, Wilms tumor

Background

Named after the German surgeon, Max Wilms, Wilms' tumor, Wilms tumor, or Nephroblastoma , is the most common renal tumor in children [1]. It is the most common pediatric renal malignancy and has a racial predilection for children of African and African-American descent compared to Caucasians [2]. Global incidence is reported to be about 4 to 10 cases per million population. Specific incidence rates in sub-Saharan African countries can be difficult to obtain due to inadequate documentation and unavailability of data [3].

Wilms tumor is a critical concern in sub-Saharan Africa, where clinical outcomes are significantly poorer than those reported in high-income countries (HICs) [4, 5]. A systematic review found that 57.7% of Wilms tumor cases in Africa present at advanced stages, with only 57.3% of patients completing treatment, resulting in an overall survival rate of 56.5%.[5] In contrast, high income countries (HIC) report survival rates as high as 90%, supported by integrated protocols incorporating chemotherapy, radiotherapy, surgery, and multidisciplinary care [6, 7]. Contributing barriers include late presentation, treatment abandonment, and limited specialized care, despite increasing use of chemo- and radio- therapy in sub-Saharan Africa (SSA) [5]. Economic constraints further impact outcomes, as disease-free survival rates decline from 69% to 54% when treatment is abandoned [8].

In a 10-year study from Nigeria, only 44.2% of Wilms tumor patients adhered to chemotherapy protocols, with 33.3% lost to follow-up and 26.7% experiencing relapse [9]. Among those completing treatment, survival reached 73.7%.[7] Recently, the Wilms Africa initiative reported a two-year event-free survival rate of 41.3%, with high abandonment and mortality during care [10]. Cohesive multidisciplinary care for Wilms tumor, involving a team of professionals who are both well-informed and specifically trained in Wilms tumor management, holds significant potential to enhance patient outcomes, and improve survival rates [11]. This collaborative approach involving professionals who all have training in the care of Wilms tumor, ensures that all aspects of care ranging from diagnosis and treatment planning to nursing care and post-treatment follow-up are delivered with proficiency, optimizing the quality of care delivered to patients.

The International Atomic Energy Agency (IAEA) reports that all African countries including Nigeria fall short of recommended radiotherapy treatment capability in all domains including infrastructure, personnel and access to care. Nigeria with a population of 220 million, has one of the widest reported gaps between treatment need and radiotherapy capacity in West Africa. This shortage in radiotherapy capacity spans all domains from infrastructure and equipment to workforce numbers and training programs and opportunities. To address the shortage of specialized pediatric oncology training in the region, initiatives such as the Pediatric Radiation Oncology Virtual Course (PedROC) and the Access to Care (A2C) Program at the University of Cape Town have emerged, demonstrating promise in improving specialized radiotherapy access [12, 13]. There has however been limited evidence on the relationship between pediatric radiotherapy integration in early/basic medical training curricula and healthcare provider confidence in managing Wilms tumor, especially within resource-limited settings.

We investigated the relationship between pediatric radiotherapy inclusion in medical training and healthcare provider confidence in managing Wilms tumor. We hypothesized that prior pediatric radiotherapy exposure during training will be associated with increased provider confidence, reflecting a potential impact on preparedness and clinical competency in Wilms tumor management.

Methods

Study design

This cross-sectional study, conducted online via remotely filled surveys, aimed to assess the relationship between pediatric radiotherapy inclusion during training and the confidence levels of African healthcare providers. The study was conducted as part of the PedROC program. Self-reported training experiences in their primary professional role and confidence levels were measured using digital questionnaires filled at the time of registration for the program. The questionnaire used in this study was developed for this study. An additional supplementary file shows this questionnaire in more detail [see supplementary file 1]. The PedROC curriculum was then designed collaboratively by an international team, using survey responses, needs assessment literature, clinical experience, and international guidelines. The training was delivered virtually over a 4 hour webinar covering a focused curriculum of Wilms tumor epidemiology, diagnosis, and treatment; with special emphasis on radiotherapy planning and delivery. More about the PedROC program can be found in our recent pilot study detailing the impact of the program [12].

The study focused on healthcare professionals involved in pediatric cancer care across sub-Saharan Africa.

Participants in PedROC comprised of a diverse group of professionals including pediatricians, pediatric oncologists, nurses, radiation oncologists, medical physicists, radiation therapy technicians, and various trainees. Recruitment was conducted through targeted invitations via professional networks and public announcements on social media platforms (primarily LinkedIn and Instagram). Participants were encouraged to enroll regardless of prior specialized training, facilitating representation from various backgrounds. Informed consent was obtained from all participants prior to their completion of the online survey forms at the point of registration for the program. The program and study adhered to ethical standards for research involving human subjects, with participant confidentiality maintained throughout data collection and analysis.

During data preparation, we excluded 82 participants from the original sample of 452 due to missing data on the study's dependent variable/outcome- the composite confidence score; resulting in a final analytic sample of 370 participants. As described below, the composite score measured participants' self-reported confidence in managing Wilms tumor across several critical domains, including staging, dose determination, treatment planning, and other key areas related to pediatric cancer care.

Study measures

The study *outcome* was the composite confidence score for Wilms tumor diagnosis and treatment. An ordinal composite confidence index was created by aggregating scores from ten domains assessing healthcare provider self-reported confidence in key aspects of Wilms tumor diagnosis and treatment: staging, dose determination, organs-at-risk contouring, target volume delineation, treatment planning and beam placement, plan review and evaluation, patient simulation and positioning, offline review, side effects management, and survivorship care. Each domain was rated on a 3-point Likert scale: 0 for low or no confidence, 1 for moderate confidence, and 2 for high confidence.

The ten domains used to assess self-reported confidence were selected through expert consensus among the PedROC course faculty, comprising pediatric radiation oncologists and global health educators with experience in sub-Saharan Africa. While not directly adopted from a single formal competency framework, the domains are broadly aligned with core competencies outlined by international organizations such as the International Society of Pediatric Oncology (SIOP) and the Children's Oncology Group (COG). The selection was also informed by prior informal needs assessments and recurrent themes identified in educational collaborations within the region.

Confidence levels were defined using survey responses as follows: low or no confidence combined "not confident" or "not confident at all," moderate confidence included "moderately," or "somewhat confident," and high confidence encompassed "confident" and "very confident." The individual domain scores were summed to generate a cumulative score ranging from 0 to 20, with higher scores reflecting greater overall confidence across these areas. Scores from 0 to 6 indicate low or no confidence, reflecting little to no confidence across most domains. Scores from 7 to 13 represent moderate confidence, indicating mixed levels of confidence across domains. Scores from 14 to 20 reflect high confidence, with providers consistently reporting high confidence across most or all areas. This cumulative score identifies overall confidence levels, providing an ordinal measure of providers' self-reported confidence and readiness in managing Wilms tumor care.

The *independent variable* in this study was any prior academic exposure to pediatric radiotherapy as part of their respective professional training programs. Providers responded "Yes" or "No" to whether they had undergone such training, creating a clear binary categorization.

The study included a range of *covariates* to assess provider type, previous training, perceived course impact, center's provision of pediatric Wilms tumor care, available treatment modalities, average monthly Wilms tumor patient volume, awareness of pediatric radiation oncology programs, interest in pediatric radiation oncology, perceived barriers to diagnosis and treatment of Wilms tumor, and preferences for the PedROC program's next pediatric cancer focus area.

Provider type captured the diversity in professional roles and responsibilities, categorized into three groups. Respondents identified their job titles, which were then recoded as: Doctor/Oncologist, including pediatric oncologists, clinical and, or radiation oncologists, and attending or consultant oncologists, Allied Health Professional, comprising nurses, medical physicists, pharmacists, and administrators; and Trainee/Student, covering interns, residents, fellows, and other early-career professionals. *Previous training in pediatric cancer care* included participants who responded to the question, "Have you received any previous training on pediatric cancer care?" Responses were coded as "Yes" for those with such training and "No" for those without. *Previous training in pediatric cancer treatment* focused on specialized training in pediatric cancer treatment. In response to the question, "Have you received any previous training on pediatric cancer treatment?" answers were coded as "Yes" and "No." *Previous training in Wilms tumor management* assessed whether respondents had received specific training in managing Wilms tumor. The question "Have you received any previous training

on Wilms tumor management?" was coded "Yes" for trained and "No" for untrained respondents. *Perceived course impact*, included respondents who were asked, "How do you think this course will improve your ability to treat patients with Wilms tumor?" Responses were grouped into Limited Improvement, covering answers such as "Not at all," "A little," or "Somewhat," and Significant Improvement, encompassing "Significantly" and "Completely." This variable provided insight into participants expected benefit from the course. *Center's provision of pediatric Wilms tumor care* examined institutional capacity for pediatric Wilms tumor care, with the question, "Does your center provide care to pediatric patients with Wilms tumor?" coded as "Yes" if care was provided and "No" otherwise, measuring exposure to and experience with clinical Wilms tumor care. *Available treatment modalities for Wilms tumor* were measured by asking respondents at centers offering pediatric Wilms tumor care about the treatment modalities available. The responses were coded into five categories: Chemotherapy, Radiation, Surgery, Treatment Combinations (e.g., surgery, chemotherapy and radiation), and Other or Non-Treatment Related (e.g., initial assessment and referral). *Average monthly Wilms tumor patient volume* was measured using the question, "On average, how many Wilms tumor patients do you see in a month?" and coded as 5 or less and 6 or more to capture monthly caseload experience. *Awareness of pediatric radiation training programs* measured country availability of programs, asking, "Are you aware of any specialized training programs or fellowships on pediatric radiation in your country?" Answers were coded as "Yes" for those aware and "No" for those unaware, capturing potential further training opportunities. *Interest in pediatric radiation* was measured by the question, "Would you be interested in a pediatric radiation fellowship?" Responses were coded as "Yes" for those interested and "No" for those not interested. Two variables assessed common barriers to the diagnosis and treatment of Wilms tumor in respondents' regions. For the *barriers to diagnosis* variable, barriers were assessed as multiple-response items and recoded into three domains: lack of pediatric cancer expertise/awareness, lack of public awareness, and lack of training programs, infrastructure, or cost of testing. Lastly, to capture participants' preferences for the next pediatric cancer focus area of the PedROC program, they were asked, "What pediatric cancer would you like the PedROC program to tackle next?" Responses included "Neuroblastoma," "Brain Cancer," "Retinoblastoma", "Wilms tumor", "Other (e.g., Leukemia)."

Statistical analysis

All statistical analyses were conducted using Stata version 18.5, with significance set at a two-tailed p-value threshold of ≤ 0.05. Our analysis followed a four-step process: First, we summarized participant characteristics, training, care practices, and barriers related to Wilms tumor management. Second, we assessed the distribution of confidence levels in Wilms tumor diagnosis and treatment across provider characteristics, training experiences, and barriers, using chi-square and Fisher's exact tests to evaluate statistical significance where appropriate. Third, we applied multivariable linear regression to estimate the impact of prior exposure to pediatric radiotherapy during training on composite confidence scores, and an ordinal logistic regression to validate the association between training and confidence levels across ordered confidence categories, adjusting for potential covariates.

In terms of the adjusted models, the dependent variable or outcome measure, the *composite confidence score*, ranged from 0 to 20, and higher scores indicated greater overall confidence in Wilms tumor management. Given the bounded and ordinal nature of the composite confidence score, with exact values spanning from 2 to 19, we evaluated several modeling approaches. *Poisson regression* was initially considered due to its suitability for count-like data; however, the distribution characteristics of the score, including a skewness of -0.14 and kurtosis of 2.14, suggested an approximate symmetry inconsistent with the right-skewed distributions typically modeled by Poisson or negative binomial regressions. Additionally, the observed variance (20.31) was close to the mean (9.46), indicating only mild overdispersion, which further supported exploring alternative models. Considering these distributional properties, *linear regression* was selected as the primary analytical approach, treating the composite confidence score as an interval-like variable. This approach allowed us to model incremental changes across the score's range while deriving interpretable coefficients for factors hypothesized to influence provider confidence. *Robust standard errors* were applied to account for potential heteroskedasticity, thereby ensuring the validity of standard error estimates. As a secondary analysis, we categorized the composite score into three confidence levels (low: 0–6, moderate: 7–13, high: 14–20) and conducted an *ordinal logistic regression*. This secondary approach enabled us to validate our findings under the assumption that the score is strictly ordinal, thereby aligning the analysis with the original ordinal structure of the rating scale and providing an additional layer of robustness.

Results

Of the 370 providers, 28.38% reported low or no confidence (scores 0–6), 50.54% reported moderate confidence (scores 7–13), and 21.08% reported high confidence (scores 14–20) in Wilms tumor diagnosis and treatment.

Among the total sample of providers, 279 (76.86%) had not had any previous academic exposure to pediatric radiotherapy during training, whereas 84 (23.14%) had.

Table 1 contains further details on participant characteristics, training experiences, and barriers, including data on provider roles, training backgrounds, and institutional practices.

At the bivariate analysis, we focused on confidence levels in Wilms tumor diagnosis and treatment by provider characteristics, training, and barriers. Among those without pediatric radiotherapy exposure, 97 providers (34.77%) reported low or no confidence, 141 (50.54%) moderate confidence, and 41 (14.70%) high confidence. For providers with prior pediatric radiotherapy exposure, only 6 (7.14%) reported low or no confidence, 42 (50.00%) moderate confidence, and 36 (42.86%) high confidence. These results were statistically significant ($p < 0.001$), indicating an association between integration of pediatric radiotherapy into medical training curricula and increased confidence in Wilms tumor management. A comprehensive breakdown of confidence levels across various provider characteristics, training, and barriers is available in Table 2, including significant and non-significant associations.

In the primary multivariable linear regression analysis (Table 3), healthcare providers with prior pediatric radiotherapy training had significantly higher composite confidence scores in Wilms tumor management (coefficient, 2.60; 95% CI, 1.51–3.69; $P < 0.001$) compared with those without. The secondary multivariable ordinal logistic regression analysis indicated that radiotherapy exposure during professional training was associated with greater odds of higher confidence categories (OR, 1.28; 95% CI, 0.69–1.87; $P < 0.001$). Both models were adjusted for covariates such as provider type, previous training in pediatric cancer care, prior training in pediatric cancer treatment, prior training in Wilms tumor management, expected course impact on ability to treat Wilms tumor patients, center provision of care for Wilms tumor pediatric patients, care/treatment modalities available for Wilms tumor at center, average Wilms tumor patients seen per month, awareness of pediatric radiation oncology fellowship programs, interest in pediatric radiation oncology fellowship, barriers to detection/diagnosis of Wilms tumor, barriers to treatment of Wilms tumor, and suggested pediatric cancers for the PedROC program to address next.

Discussion

Our study provides novel insight into the relationship between exposure of health care professionals to pediatric radiotherapy during medical education and provider confidence levels in managing a common pediatric cancer (Wilms tumor) in sub-Saharan Africa. We found that prior pediatric radiotherapy training is significantly associated with higher self-reported confidence in key clinical competencies essential for pediatric cancer care. These results suggest that early exposure to the basic concepts of pediatric radiation oncology could significantly improve self-reported confidence in key clinical competencies essential for pediatric cancer care. Pediatric radiotherapy is an advanced specialty not typically included in basic medical curricula, and attempts to include it no matter how elementary, are especially constrained by resource limitations in sub-Saharan Africa. However, these sub-Saharan Africa unique limitations may be the argument for the necessity of earlier exposure to basic knowledge. The study findings suggest that introducing foundational concepts of pediatric radiotherapy may be worthwhile, as it could enhance provider preparedness and improve care delivery in resource-limited settings.

Prior studies on the challenges of managing Wilms tumor in sub-Saharan Africa highlight advanced-stage presentation, low treatment completion rates, and treatment abandonment as significant barriers to improved outcomes [5, 9, 10]. While other studies [6, 7] show that multidisciplinary and radiotherapy-integrated approaches in HICs achieve over 90% survival rates, this study's focus on pediatric radiotherapy training specifically addresses the gap in training curricula emphasized in recent studies [12, 13]. Our study contributes new insights by quantifying the association between prior radiotherapy training and provider confidence, suggesting that targeted training could support provider competence, especially in resource-limited settings where access to highly specialized multidisciplinary care is restricted.

A plausible explanation for our findings is that the inclusion of basic concepts of pediatric radiotherapy during medical training likely accompanies basic oncology concepts, and empowers providers with preparedness for identifying, managing, and or, referring common cases, potentially mitigating the effects of limited local resources on treatment outcomes.

The healthcare landscape of sub-Saharan Africa is burdened by shortages of specialized personnel and inadequately developed referral systems, which limit multidisciplinary team practice calls for innovative solutions to address care gaps and increase interest in pediatric cancer care.

Study strengths and limitations

Data from 370 healthcare providers from 39 countries including sub-Saharan Africa were analyzed following exclusion of 82 participants with incomplete data. The PedROC program benefits from a robust curriculum collaboratively developed by an international team, based on needs assessments, clinical experience, and standardized

Table 1 Participant Characteristics, Training, care Practices, and barriers related to Wilms tumor Management, *N* = 370

Study Measures	*n*	%
Provider Types		
Doctor/Oncologist	183	49.46
Allied Health Professional	116	31.35
Trainee/Student	71	19.19
Received any previous training on pediatric cancer care[a]		
No	168	46.28
Yes	195	53.72
Received any prior training on pediatric cancer treatment		
No	155	41.89
Yes	215	58.11
Received any prior training on Wilms tumor management[a]		
No	189	51.50
Yes	178	48.50
Course will improve my ability to treat Wilms tumor patients [b]		
Limited Improvement	22	5.95
Significant Improvement	348	94.05
Your center provide care to Wilms tumor pediatric patients[a]		
No	43	12.39
Yes	304	87.61
If yes, care/treatment modalities for Wilms tumor at your center		
Chemotherapy	24	6.49
Radiation	38	10.27
Surgery	13	3.51
Treatment Combinations [b]	277	74.86
Other or Non-Treatment Related [b]	18	4.86
Average Wilms tumor patients seen in a month[a]		
5 or less	321	87.70
6 or more	45	12.30
Previous training on pediatric radiotherapy		
No	279	76.86
Yes	84	23.14
Awareness of fellowship programs on pediatric radiation oncology in home country		
No	293	79.19
Yes	77	20.81
Interested in a pediatric radiation oncology fellowship		
No	48	12.97
Yes	322	87.03
Barriers to detection/diagnosis of Wilms tumor		
Lack of pediatric cancer expertise and awareness	34	9.19
Lack of public awareness	302	81.62
Lack of training programs, Infrastructure, and Cost of Testing	34	9.19
Barriers to treatment of Wilms tumor		
Lack of pediatric cancer expertise and awareness	260	70.27
Lack of public awareness	49	13.24
Lack of training programs, facilities/Infrastructure, and Cost of testing	61	16.49
Pediatric cancers the PedROC program should tackle next		
Neuroblastoma	45	12.16
Brain Cancer	41	11.08
Retinoblastoma	63	17.03
Wilms tumor	28	7.57
Other (e.g.: Leukemia)	193	52.16
Confidence Score for Wilms Tumor Diagnosis and Treatment Categories		
0–6 = low/no confidence	105	28.38

Table 1 (continued)

Study Measures	*n*	%
7–13 = moderate confidence	187	50.54
14–20 = high confidence	78	21.08

[a]Missing data: Missing frequencies may not add up to the overall sample. Included variables had ≤ 6.22% missing frequencies

[b]Definitions/Abbreviations:

• Limited improvement combined "not at all, little bit, and somewhat". Significant improvement combined "to a significant extent, and completely"

• Treatment combinations were surgery, chemotherapy, radiation, and immunotherapy. Other/non-treatment related included initial assessment and referral

• High confidence combined "confident, and fully confident". Moderate confidence combined "a bit, moderately, somewhat confident". Low or no confidence combined "not confident, not confident at all"

• *SD* Standard Deviation

guidelines to ensure contextual relevance. With extensive recruitment through professional networks and social media platforms, the program attracts a diverse range of professionals across roles and regions, making it an ideal opportunity to survey a generalizable cohort of health care professionals with enhanced representation across pediatric oncology practice.

The study used digital assessments to measure pre-program baseline and post-program changes in self-reported confidence levels across ten critical domains of Wilms tumor management, capturing data on staging, dose determination, treatment planning, and survivorship care. The reliance on self-reported confidence scores as a surrogate for clinical competence is a limitation, as such measures may not adequately reflect the practical skills essential for pediatric cancer care. Prior academic exposure to pediatric radiotherapy may encompass a broad range of educational experiences, a limitation with should be noted in the context of the findings from this study.

Implications for Research, Policy, and clinical practice

The PedROC program has previously emphasized the need for further exploration into the efficacy of remote, simulation-based training in pediatric oncology and radiotherapy, particularly in low-resource settings [12]. Such exploration is essential to determine the extent to which technology-driven educational approaches can bridge gaps in skill acquisition, enhance clinical competence, and ultimately improve pediatric cancer outcomes in resource-strained environments. The significant association between prior exposure to pediatric radiotherapy and provider confidence observed in this study suggests that curriculum changes across specialties to include basic or foundational pediatric radiotherapy content could potentially be valuable in enhancing clinical competence in regions where infrastructure and resources are limited [12, 13].

This study suggests the importance of pediatric radiotherapy exposure in provider confidence in the management of common pediatric cancers, using Wilms tumor as a case study, where provider competence and potentially confidence directly impact quality of care. The higher self-reported confidence among providers with prior pediatric radiotherapy exposure suggests that foundational training in pediatric radiotherapy could enhance multidisciplinary cohesion and practice [10]. While the consistent availability of subspecialists may vary, the definition and composition of a multidisciplinary team (MDT) is globally standardized and well-recognized in sub-Saharan Africa. For Wilms tumor, this typically includes the pediatric oncologist, pediatric surgeon, radiation oncologist, radiologist, and pathologist, with additional contributions from nephrology, nursing, palliative, and psychosocial services where available.

We thus advocate for the integration of pediatric radiotherapy training in standard medical professional training curricula across sub-Saharan Africa. Given the disparities in pediatric cancer survival rates between low- and high income countries, as documented in earlier studies [6, 7], policies prioritizing early exposure of all practicing health care professionals to foundational concepts of pediatric radiotherapy could ensure appropriate referral, enhance multidisciplinary care and strengthen pediatric cancer care capacity in the region.

Future studies should investigate the long-term impact of training on actual clinical outcomes and patient survival rates, bridging a critical gap in the literature on education-driven competency in pediatric oncology within sub-Saharan Africa. Examination of the correlation between training programs and measurable improvements in patient care could provide valuable insight into the validity and effectiveness for targeted educational interventions in resource-limited settings, providing an argument for sustainability. Additionally, mixed-method approaches incorporating qualitative assessments could enrich our understanding of how virtual training influences provider readiness and practical skills in resource-constrained environments.

Recommendations

One important limitation of this study is the reliance on self-reported confidence as the primary outcome measure. While confidence is a relevant and often studied proxy for preparedness, it is inherently subjective and may not accurately reflect actual competency

Table 2 Confidence levels in Wilms tumor diagnosis and treatment by provider Characteristics, Training, and Barriers

Study Measures	Confidence Score for Wilms Tumor Diagnosis and Treatment Categories				
	0–6 = Low/NoConfidence	7–13 =ModerateConfidence	14–20 = HighConfidence	Total(*N*)	*P*-Value
n	**105**	**187**	**78**	**370**	
%	**28.38**	**50.54**	**21.08**	**100.00**	
Provider Types					
Doctor/Oncologist	55	94	34	183	0.105
	30.05	51.37	18.58	100.00	
Allied Health Professionals	28	54	34	116	
	24.14	46.55	29.31	100.00	
Trainee/Student	22	39	10	71	
	30.99	54.93	14.08	100.00	
Received any previous training on pediatric cancer care [a]					
No	56	89	23	168	**0.003**
	33.33	52.98	13.69	100.00	
Yes	45	96	54	195	
	23.08	49.23	27.69	100.00	
Received any prior training on pediatric cancer treatment					
No	54	73	28	155	0.058
	34.84	47.10	18.06	100.00	
Yes	51	114	50	215	
	23.72	53.02	23.26	100.00	
Received any prior training on Wilms tumor management [a]					
No	61	97	31	189	**0.039**
	32.28	51.32	16.40	100.00	
Yes	43	88	47	178	
	24.16	49.44	26.40	100.00	
Course will improve my ability to treat Wilms tumor patients [b]					
Limited Improvement	10	10	2	22	0.146
	45.45	45.45	9.09	100.00	
Significant Improvement	95	177	76	348	
	27.30	50.86	21.84	100.00	
Your center provide care to Wilms tumor pediatric patients[a]					
No	18	21	4	43	**0.011**
	41.86	48.84	9.30	100.00	
Yes	70	161	73	304	
	23.03	52.96	24.01	100.00	
If yes, care/treatment modalities for Wilms tumor at your center [b]					
Chemotherapy	9	11	4	24	**0.017**
	37.50	45.83	16.67	100.00	
Radiation	5	27	6	38	
	13.16	71.05	15.79	100.00	
Surgery	4	7	2	13	
	30.77	53.85	15.38	100.00	
Treatment Combinations	77	134	66	277	
	27.80	48.38	23.83	100.00	
Other or Non-Treatment Related	10	8	0	18	
	55.56	44.44	0.00	100.00	
Average Wilms tumor patients seen in a month[a]					
5 or less	91	166	64	321	0.218
	28.35	51.71	19.94	100.00	
6 or more	10	21	14	45	
	22.22	46.67	31.11	100.00	
Received any prior training on pediatric radiotherapy[a]					

Table 2 (continued)

Study Measures	Confidence Score for Wilms Tumor Diagnosis and Treatment Categories				
	0–6 = Low/NoConfidence	**7–13 =ModerateConfidence**	**14–20 = HighConfidence**	**Total(*N*)**	***P*-Value**
n	**105**	**187**	**78**	**370**	
%	**28.38**	**50.54**	**21.08**	**100.00**	
No	97	141	41	279	**< 0.001**
	34.77	50.54	14.70	100.00	
Yes	6	42	36	84	
	7.14	50.00	42.86	100.00	
Awareness of training programs on pediatric radiation in home country					
No	95	144	54	293	**0.001**
	32.42	49.15	18.43	100.00	
Yes	10	43	24	77	
	12.99	55.84	31.17	100.00	
Interested in a pediatric radiation					
No	21	24	3	48	**0.004**
	43.75	50.00	6.25	100.00	
Yes	84	163	75	322	
	26.09	50.62	23.29	100.00	
Barriers to detection/diagnosis of Wilms tumor					
Lack of pediatric cancer expertise and awareness	4	20	10	34	0.159
	11.76	58.82	29.41	100.00	
Lack of public awareness	89	152	61	302	
	29.47	50.33	20.20	100.00	
Lack of training programs, Infrastructure, and Cost of testing	12	15	7	34	
	35.29	44.12	20.59	100.00	
Barriers to treatment of Wilms tumor					
Lack of pediatric cancer expertise and awareness	81	130	49	260	0.125
	31.15	50.00	18.85	100.00	
Lack of public awareness	7	27	15	49	
	14.29	55.10	30.61	100.00	
Lack of training programs, Infrastructure, and Cost of testing	17	30	14	61	
	27.87	49.18	22.95	100.00	
Pediatric cancers the PedROC program should tackle next					
Neuroblastoma	18	20	7	45	0.332
	40.00	44.44	15.56	100.00	
Brain Cancer	9	24	8	41	
	21.95	58.54	19.51	100.00	
Retinoblastoma	15	37	11	63	
	23.81	58.73	17.46	100.00	
Wilms tumor	9	10	9	28	
	32.14	35.71	32.14	100.00	

Table 2 (continued)

Study Measures	Confidence Score for Wilms Tumor Diagnosis and Treatment Categories				
	0–6 = Low/NoConfidence	**7–13 =ModerateConfidence**	**14–20 = HighConfidence**	**Total(*N*)**	***P*-Value**
n	**105**	**187**	**78**	**370**	
%	**28.38**	**50.54**	**21.08**	**100.00**	
Other (e.g.: Leukemia)	54	96	43	193	
	27.98	49.74	22.28	100.00	

First row has *frequencies*, and second row has *row percentages*

Bolded *p*-values were statically significant at $p < 0.05$

[a]Missing data: Missing frequencies may not add up to the overall sample. Included variables had ≤ 6.22% missing frequencies

[b]Definitions/Abbreviations:

• Limited improvement combined "not at all, little bit, and somewhat". Significant improvement combined "to a significant extent, and completely"

• Treatment combinations were surgery, chemotherapy, radiation, and immunotherapy. Other/non-treatment related included initial assessment and referral

• High confidence combined "confident, and fully confident". Moderate confidence combined "a bit, moderately, somewhat confident". Low or no confidence combined "not confident, not confident at all"

Table 3 Association between exposure to pediatric radiotherapy during initial training and confidence levels in Wilms tumor management

Primary Analysis - Linear Regression of Composite Confidence Score on Exposure to Pediatric Radiation During Initial Training				**Secondary Analysis - Ordinal Logistic Regression of Confidence Categories on Exposure to Pediatric Radiotherapy During Training**			
Independent Variable	**Coefficient**	***P*-value**	**95% Confidence Interval**	**Independent Variable**	**Odds Ratio**	***P*-value**	**95% Confidence Interval**
Received radiotherapy treatment on pediatric cancers training during residency				**Received radiotherapy treatment on pediatric cancers training during residency**			
No (Ref.)				No (Ref.)			
Yes	2.602	< 0.0001	1.511–3.693	Yes	1.278	< 0.0001	0.690–1.866

Both models adjusted for provider type, previous training in pediatric radiotherapy, prior training in pediatric cancer treatment, prior training in Wilms tumor management, expected course impact on ability to treat Wilms' tumor patients, center provision of care for Wilms tumor pediatric patients, care/treatment modalities available for Wilms tumor at center, average Wilms tumor patients seen per month, awareness of pediatric radiation oncology programs, interest in pediatric radiation, barriers to detection/diagnosis of Wilms tumor, barriers to treatment of Wilms tumor, and suggested pediatric cancers for the PedROC program to address next

or performance. Additionally, the observed association between prior training and increased confidence, although notable, may be expected due to known familiarity effects. Incorporating more objective and standardized assessments of competence , such as simulation-based evaluations, examination scores, or clinical performance outcomes, would provide a more robust evaluation of training effectiveness and skill acquisition.

Conclusion

This study highlights that pediatric radiotherapy exposure during medical training is statistically significantly associated with higher confidence levels among healthcare providers managing a common pediatric cancer - Wilms tumor - in sub-Saharan Africa. Providers with any extent of pediatric radiotherapy knowledge exhibited significantly higher confidence scores and greater odds of being in higher confidence categories. These findings underscore the potential value of elementary training in pediatric radiotherapy to address gaps in pediatric oncology competency in resource-limited regions. This increase could translate into improved provider preparedness and mitigate challenges associated with limited access to expert multidisciplinary oncology care in low-resource settings. With only 23.14% of participants in this study having had prior pediatric radiotherapy exposure during training, and the significant gaps in radiotherapy capacity reported by the IAEA, sub-Saharan Africa countries may begin to consider the potential advantages offered by cross-curricular integration of basic concepts of pediatric cancer care. This may offer a practical approach to stimulate interest in pediatric cancer–related specialties for both medical and allied health workers, while enhancing provider confidence, and potentially contribute to improving outcomes for children with Wilms' tumor in sub-Saharan Africa.

Abbreviations

COG	Children's Oncology Group
PedROC	Pediatric Radiation Oncology (Virtual) Course
HICs	High-income countries

IAEA	International Atomic Energy Agency
SIOP	International Society of Pediatric Oncology

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Supplementary Information

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Supplementary Material 1.

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Authors' contributions
AOJ, AMA, AOA, and KA conceptualized and executed the virtual training program. AOA analyzed and interpreted the survey data. All authors were contributors in writing the manuscript. All authors read and approved the final manuscript.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
Ethical approval was sought from the Human Research and Ethics Committee (HREC) of the Lagos University Teaching Hospital before starting the study. Informed consent to participate was obtained from respondents before filling out the surveys. This original research was conducted in strict adherence to the ethical principles outlined by the Declaration of Helsinki.

Consent for publication
Not Applicable.

Competing interests
The authors declare no competing interests.

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