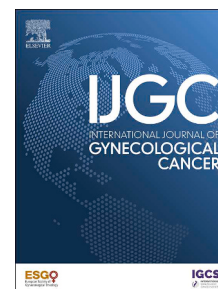


Implementation of a gynecologic oncology ultrasound training program to support cervical cancer staging at Queen Elizabeth Central Hospital in Malawi



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ABSTRACT

Objective: To describe the development, implementation and educational evaluation of a structured gynecological oncology ultrasound training program designed to support loco-regional assessment of cervical cancer in a low-resource setting.

Methods: A context-adapted ultrasound training program was implemented at Queen Elizabeth Central Hospital, Malawi, within the Blantyre Cervical Cancer Project. The program combined participation in the International Workshop on Ultrasound in Gynecologic Oncology, on-site supervised training, continued clinical practice, and refresher mentorship. Program implementation and educational outcomes were evaluated using the Kirkpatrick framework. Data were derived from trainer evaluation forms, program documentation, and clinical activity records.

Results: The training program was implemented in phases between 2019 and 2023 and involved 2 gynecological oncology trainees. During the initial on-site training period, 168 patients with cervical cancer were evaluated, and 131 supervised ultrasound examinations were performed. Trainees also participated in 38 gynecological oncology surgical procedures, providing opportunities to correlate preoperative ultrasound findings with intraoperative anatomy. Following training, ultrasound was integrated into routine clinical practice, with 2995 patients evaluated and 2852 ultrasound examinations performed over a 10-month period. Refresher training reinforced assessment skills through additional supervised clinical practice. Trainer assessments documented progressive improvement in trainees' knowledge, technical skills, and confidence in gynecologic oncologic ultrasonography. Ultrasound assessment was subsequently incorporated into routine outpatient assessment, multidisciplinary discussion, and treatment planning, demonstrating successful integration of the program into routine clinical workflows.

Conclusions: A structured, context-adapted ultrasonography training program can enable integration of ultrasonography-based loco-regional assessment into routine care for women with cervical cancer in resource-limited settings. This implementation model represents a feasible strategy for strengthening local imaging capacity.

Keywords:

Cervical Cancer; Ultrasound Staging; Gynecologic Oncology Training; Low-Resource Settings

WHAT IS ALREADY KNOWN ON THIS TOPIC

Although ultrasound provides reliable loco-regional staging for cervical cancer, its use in low-resource settings remains constrained by shortages of trained clinicians and appropriate equipment.

WHAT THIS STUDY ADDS

A context-adapted ultrasound training program that combines international theoretical instruction with supervised local clinical practice can support the development of ultrasound knowledge and staging skills and facilitate the integration of ultrasound into routine gynecologic oncology practice.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

The training model provides a feasible approach for strengthening imaging capacity in resource-constrained oncology settings where access to advanced imaging modalities is limited. The findings may support the development of similar locally embedded ultrasound training programs integrated within broader gynecologic oncology service development initiatives.

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INTRODUCTION

Cervical cancer remains a major public health challenge in sub-Saharan Africa, where it is a leading cause of cancer-related morbidity and mortality among women. Malawi has one of the highest global incidence and mortality rates of cervical cancer, largely due to a combination of factors such as the high prevalence of human papillomavirus and human immunodeficiency virus, early sexual debut, and high parity rates.¹⁻⁴ Accurate staging is essential for determining appropriate treatment and guiding clinical decision-making.

Clinical examination remains the foundation of cervical cancer staging, while imaging is recommended to refine assessment of tumor extent and guide treatment planning where available. Ultrasound and magnetic resonance imaging (MRI) are primarily used for loco-regional assessment of cervical tumors, whereas computed tomography and positron emission tomography-computed tomography are principally used to evaluate nodal and distant metastatic disease, particularly in women with locally advanced cervical cancer.⁵ The diagnostic performance of these modalities depends on both the quality of the equipment and the operator's expertise.⁶

International guidelines and emerging evidence have highlighted the value of ultrasound in the loco-regional staging of cervical cancer when performed by trained operators.⁶⁻⁸ According to a post hoc analysis of the SENTIX study, transvaginal, transrectal, and transabdominal ultrasound can provide a reliable assessment of tumor size, parametrial involvement, regional lymph nodes, and upper urinary tract obstruction, with diagnostic performance comparable to MRI for evaluating local tumor extent when performed by experienced operators.⁷ Ultrasound also offers practical advantages in resource-limited settings, including lower cost, portability, real-time assessment, and immediate availability within routine outpatient care.

Despite these advantages, the use of ultrasound for cervical cancer staging in many low- and middle-income countries remains limited. Major barriers include shortage of clinicians trained in gynecologic oncologic ultrasonography, the required equipment, and the limited availability of structured subspecialty training programs.^{9,10} In high-resource settings, postgraduate education is increasingly supported through structured initiatives such as the European Society of Gynaecological Oncology Special Interest Training Program in Diagnostic and Interventional Ultrasound, the International Society of Ultrasound in Obstetrics and Gynaecology Advanced Training Curriculum for Cervical Cancer, and educational resources provided through the ESGO e-Academy and the International Workshop on Ultrasound in Gynaecologic Oncology (IWUGO). However, reports describing successful implementation of similar training programs within routine clinical services in low-resource settings, where operator-dependence makes structured training particularly consequential, remain scarce.

Within the Blantyre Cervical Cancer Project (BCCP), Queen Elizabeth Central Hospital (QECH) serves as a high-volume tertiary referral center providing surgery, chemotherapy, and multidisciplinary care for women with cervical cancer. Surgical capacity is limited relative to the number of women presenting with disease, making accurate loco-regional assessment essential for identifying patients most likely to benefit from surgery or neoadjuvant

chemotherapy while avoiding unnecessary laparotomy in women with unresectable disease. Ultrasound offers a pragmatic solution because it enables real-time assessment within the outpatient clinic without delaying treatment pathways. Prior to implementation of the BCCP, however, local expertise in gynecologic oncologic ultrasonography was limited.

This study describes the development, implementation, and evaluation of this structured ultrasound training program to support loco-regional ultrasound assessment of cervical cancer in a low-resource setting. The program was evaluated using the Kirkpatrick framework to assess learning, clinical application, and program implementation outcomes.

METHODS

Study Design

This was a retrospective descriptive implementation study with embedded educational evaluation of a structured gynecological oncology ultrasound training program. Educational outcomes were evaluated using the Kirkpatrick 4-level framework.

Setting, Infrastructure and Training Facility

In 2018, Médecins Sans Frontières (MSF), in collaboration with the Malawi Ministry of Health and the Kamuzu University of Health Sciences, launched a comprehensive oncology initiative, the BCCP, to strengthen local capacity for the diagnosis, staging, and management of cervical cancer by developing locally sustainable clinical expertise.¹¹ As part of this initiative, a dedicated gynecologic oncology unit was established at QECH, comprising an 18-bed inpatient ward, a dedicated operating theater and outpatient clinics, and providing chemotherapy, palliative care, physiotherapy, counseling, and point-of-care diagnostic services, as well as regular multidisciplinary team meetings.¹¹

The unit operates within the Department of Obstetrics and Gynecology and provides dedicated outpatient and surgical services from Monday to Thursday. Fridays are reserved for ward rounds, multidisciplinary meetings, academic teaching, and research activities. The hospital also provides radiology, hematology, and biochemistry services.

The ultrasound training facility consisted of a dedicated consultation room equipped with a GE Healthcare Voluson™ S8 ultrasound system (Fig. 1) fitted with high-frequency transvaginal and low-frequency transabdominal probes for pelvic and abdominal Ultrasound assessment. The system was procured by the BCCP, with maintenance and technical support provided by an MSF biomedical engineer. The room was air-conditioned to ensure equipment preservation and reliable performance in Malawi's high-temperature setting.

Training Program Rationale

The training program was developed in response to the limited availability of structured subspecialty training in gynecologic oncologic ultrasonography and restricted access to advanced imaging for cervical cancer at QECH. Within the BCCP, ultrasound was introduced as a pragmatic imaging modality to support loco-regional ultrasound assessment for pretreatment planning. The program was therefore designed to develop local capacity and



Figure 1 Ultrasound workstation used for gynecologic oncology training and Malignancy staging in Queen Elizabeth Central Hospital's gynecological oncology clinic.

integrate ultrasound assessment into routine gynecologic oncology practice.

Training Objectives

The primary goal of the training program was to equip local specialists with the knowledge and practical skills to perform and interpret ultrasound examinations for the assessment of gynecological malignancies, with a primary focus on cervical cancer. The curriculum focused on developing competencies in loco-regional ultrasound assessment to support treatment planning. By the end of the program, trainees were expected to:

1. Perform systematic ultrasound assessment of normal pelvic and abdominal anatomy.
2. Recognize ultrasound features associated with common gynecological malignancies.
3. Perform loco-regional ultrasound assessment of cervical cancer, including evaluation of tumor extent, parametrial involvement, regional lymph nodes and the upper urinary tract, to support pretreatment staging and treatment planning.

Training Curriculum

The curriculum was based on internationally recognized educational frameworks in gynecologic oncologic ultrasonography and combined structured theoretical instruction with supervised clinical practice adapted to the local setting. Foundational training was provided through the ESGO-accredited IWUGO, complemented by hands-on training and mentorship at QECH.

The curriculum covered pelvic and abdominal anatomy, ultrasound examination techniques, imaging features of gynecological malignancies, and loco-regional ultrasound assessment of cervical

cancer, including tumor extent, parametrial involvement, regional lymph nodes, and the upper urinary tract. Teaching methods included lectures, case discussions, live demonstrations, and supervised ultrasound examinations integrated into routine clinical practice.

Participants

The training program was designed for specialist gynecologists involved in the clinical management of gynecological malignancies at QECH. Trainees were selected based on their clinical roles within the gynecologic oncology service and their anticipated long-term involvement in cervical cancer care.

Trainers

On-site training was delivered by 2 international experts in gynecologic oncologic ultrasonography from 2 European academic centers. The initial training program was delivered by a trainer from Charles University Prague, Czech Republic, and the refresher program by a trainer from the Policlinico Universitario Agostino Gemelli IRCCS, Rome, Italy.

Both trainers were gynecologic oncologists with expertise in ultrasound assessment of gynecological malignancies and were members of internationally recognized academic groups involved in education and training in gynecological oncology ultrasonography, including the IWUGO. Their participation was voluntary. Logistical support for the training visits, including international travel and accommodation, was provided by Médecins Sans Frontières as part of the BCCP.

Training Chronology

The training program followed a phased approach comprising 3 formal training phases separated by a clinical consolidation period (Fig. 1). The first phase consisted of participation in the ESGO-accredited IWUGO, a 2-day course that provided foundational theoretical instruction. This was followed by a 3-week supervised on-site training program at QECH. Following the initial supervised training, trainees continued independent clinical practice, allowing experiential learning and consolidation of acquired skills within routine service delivery. The program concluded with a 3-week refresher mentorship program to reinforce knowledge and practical skills through supervised review and comparison with expert examinations.

Educational Materials and Teaching Methods

The training program used a combination of virtual and in-person teaching methods. Participants accessed instructional materials on the ESGO Academy platform and participated in IWUGO training sessions that included lectures, case discussions, and live imaging demonstrations.

During on-site training visits, the educational approach combined lectures, bedside teaching, outpatient ultrasound examinations, and surgical case discussions. Trainers participated in surgical procedures in the mornings and outpatient clinics in the afternoons from Monday to Thursday. Fridays were dedicated to focused bedside teaching sessions, surgical planning meetings, formal lectures, and multidisciplinary team discussions.

During refresher training sessions, the first 3 outpatient consultations each day were dedicated to structured supervised ultrasound teaching, while the remaining consultations were conducted as part of routine clinical care to minimize disruption to the high-volume clinic workflow. Ultrasound examinations performed by trainees were reviewed by the expert trainers through repeat examinations where appropriate. Differences in image acquisition, interpretation, and clinical assessment were discussed immediately, and targeted feedback was provided to reinforce learning and guide subsequent practice.

Evaluation of the Training

The training Program was evaluated retrospectively using a structured trainer assessment informed by the Kirkpatrick four-level framework.¹² Following completion of the training program, the 2 international trainers independently completed structured assessment forms based on their observations and experiences during both the initial and refresher training visits. Program documentation and aggregated clinical activity records were also reviewed.

The trainer assessment forms evaluated trainee performance across the predefined training objectives, including ultrasound image acquisition, identification of pelvic anatomy, recognition of ultrasound features of gynecological malignancies, loco-regional ultrasound assessment of cervical cancer, and integration of ultrasound findings into clinical decision-making. Three units of analysis were defined:

1. trainees participating in the ultrasound training program;
2. the training program, including its curriculum and implementation process;
3. clinical practice outputs reflecting integration of ultrasound assessment into routine service delivery. No formal objective competency assessment or diagnostic accuracy evaluation was undertaken.

Ethics

The ultrasound training program was implemented between 2019 and 2023 as part of routine clinical service development under the BCCP and was not conducted as a research study. The present study is a retrospective evaluation of that program using trainer assessment forms, program documentation, and aggregated de-identified clinical activity records. No patients were enrolled specifically for this evaluation, and no identifiable patient-level data were collected. Ethical approval for the retrospective evaluation was obtained prospectively from the College of Medicine Research and Ethics Committee, Malawi (Protocol No. P.01/26-2068), as part of an approved PhD study protocol that included evaluation of the ultrasound training program. The requirement for consent was waived by the College of Medicine Research and Ethics Committee given the retrospective, de-identified nature of the review.

In accordance with the journal's guidelines, study data will be made available for independent analysis by a team selected by the Editors for additional analyses or to support reproducibility in other settings, if requested.

RESULTS

The gynecological oncology ultrasound training program was implemented in phases between 2019 and 2023 (Fig. 2). Foundational theoretical training was initiated through participation in the IWUGO. One trainee attended the in-person workshop in November 2019, and both trainees subsequently participated in the 9th IWUGO online course held from 14 to 15 June 2021.

An intensive 3-week supervised on-site training program was conducted at QECH in April 2022. This was followed by integration of ultrasound assessment into routine clinical practice and a 3-week refresher training program conducted between February and March 2023 to reinforce knowledge and practical skills. The program combined theoretical instruction, supervised ultrasound examinations, and progressive integration of ultrasound assessment into routine outpatient evaluation and pretreatment planning.

Two registered specialist obstetrician-gynecologists undergoing subspecialty training in gynecologic oncology participated in the program. Both had completed the ISUOG Basic Training Course held at QECH, Malawi, in 2017 and had routine experience in obstetric and gynecological ultrasonography acquired during residency training and subsequent specialist clinical practice. At the time of program enrollment, both were actively involved in the gynecologic oncology service at QECH, including the assessment and surgical management of women with cervical cancer and other gynecological malignancies.

During the initial on-site training program conducted from 4 to 28 April 2022, 168 patients were clinically evaluated, of whom 131 underwent supervised ultrasound examinations. During the same period, trainees participated in 38 gynecological surgical procedures, including 20 for malignant disease (13 cervical, 6 endometrial, and 1 vulvar cancer). Following completion of the initial

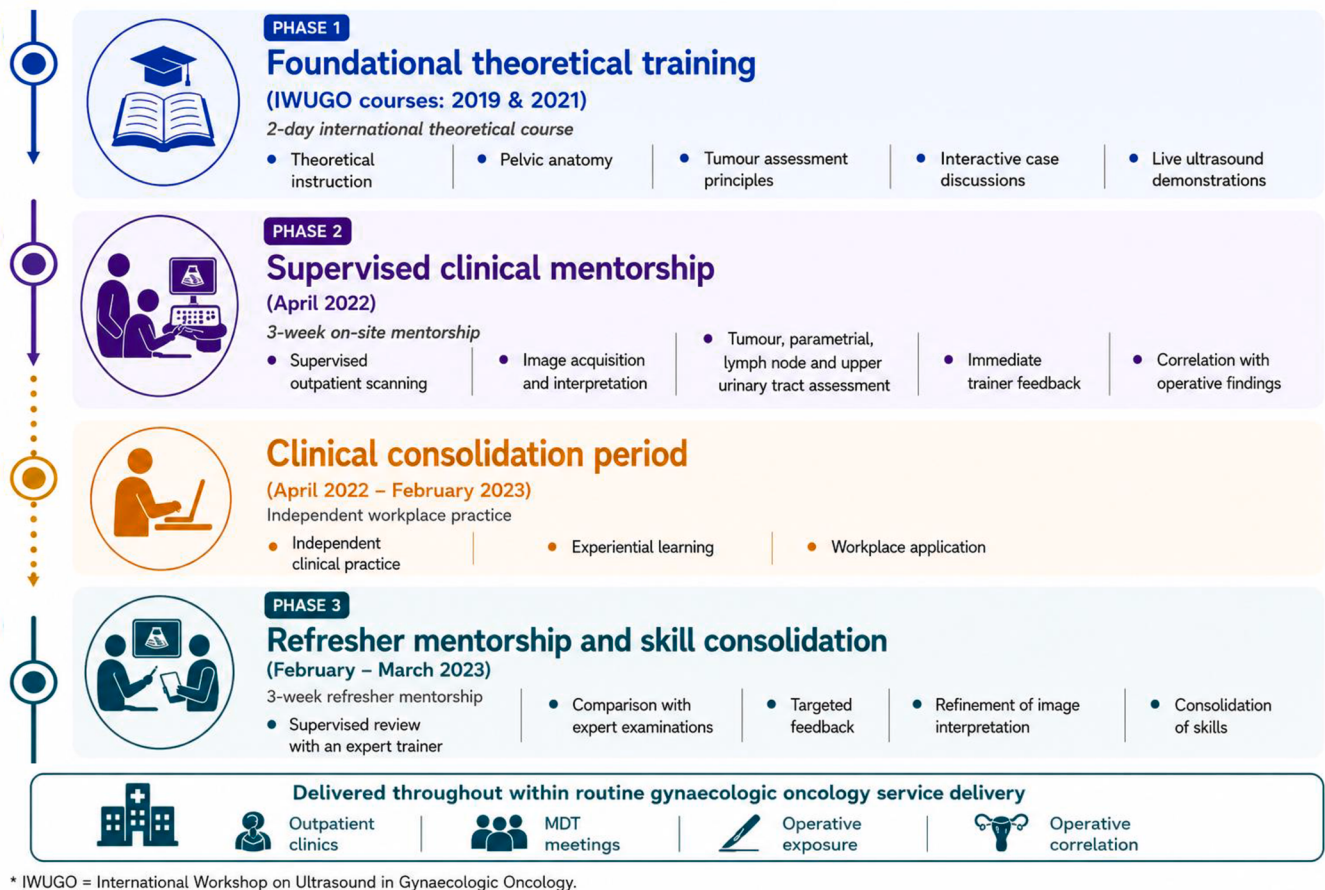


Figure 2 Phased implementation of the gynecologic oncology ultrasound training program at Queen Elizabeth Central Hospital, Blantyre, Malawi.

training, ultrasound assessment was integrated into routine clinical practice. Before the refresher training program, the trainees independently evaluated 2995 patients and performed 2852 ultrasound examinations.

During the refresher training period, 69 patients were evaluated, and 72 ultrasound examinations were conducted under expert supervision (Table). Trainees also participated in 29 gynecological surgical procedures, including 20 procedures for malignant disease: 15 cervical cancer, 4 for ovarian cancer, and 1 for vulvar cancer.

The training program was evaluated retrospectively using structured trainer assessments informed by the Kirkpatrick four-level framework (Fig. 3). Overall, the trainers considered the program to have been successfully implemented and integrated into routine clinical practice.

Trainer assessments indicated that the program objectives were clearly communicated and that the combination of theoretical instruction, supervised ultrasound examinations, multidisciplinary case discussions, and correlation with operative findings provided an appropriate learning environment. Trainers also reported high levels of trainee engagement throughout both training visits.

According to the trainer assessments, trainees demonstrated progressive improvement in knowledge and practical skills relevant to gynecologic oncologic ultrasonography. Improvements were observed in systematic pelvic ultrasound examination, identification of pelvic anatomy, recognition of ultrasound features of gynecological malignancies, assessment of tumor extent, evaluation of parametrial involvement, identification of suspicious lymph nodes, and assessment of the upper urinary tract.

Table Clinical Exposure during the Ultrasound Training Program

Training phase	Period	Patients evaluated ^a	Ultrasound scans
Initial on-site training	April 4-28, 2022	168	131
Clinical consolidation period	May 2022-Feb 2023	2995	2852
Refresher training	Feb 21-Mar 15 2023	69	72 ^b

^a Initial assessments only, defined as patients seen for the first time in the gynecological oncology clinic at enrollment.

^b Some patients underwent more than one ultrasound examination during the refresher training period.

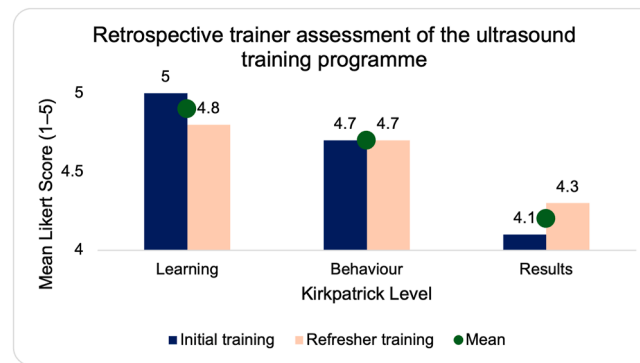


Figure 3 Retrospective trainer assessment of the ultrasound training program informed by the Kirkpatrick framework.

Following the initial supervised training, trainees progressively applied ultrasound assessment in routine clinical practice. According to the trainer assessments, they demonstrated increasing confidence and independence in performing ultrasound examinations and incorporating imaging findings into clinical decision-making.

At the service level, the program resulted in a sustained increase in ultrasound capacity within the gynecologic oncology unit, with ultrasound assessment becoming a routine component of pretreatment evaluation for women with cervical cancer. Trainers also identified opportunities for further program development, including additional supervised scanning opportunities and expanded ultrasound resources to accommodate the increasing clinical workload.

DISCUSSION

Summary of Main Results

A structured, context-adapted gynecologic oncology ultrasound training program was successfully integrated into routine practice within a dedicated cervical cancer service in a low-resource setting, combining internationally recognized theoretical instruction with supervised local clinical training. Retrospective trainer assessments informed by the Kirkpatrick framework indicated progressive development of trainees' knowledge and practical skills, alongside progressive application of ultrasound assessment in routine clinical practice.

A notable feature was the progressive transition from supervised training to independent clinical practice. The large volume of ultrasound examinations performed following the initial supervised training reflects successful integration into routine service delivery and provided ongoing opportunities for experiential learning.

In parallel, trainees participated in gynecologic oncology surgical procedures throughout the program, enabling correlation of preoperative ultrasound findings with intraoperative anatomy. This integrated approach embedded ultrasonography within the broader development of gynecologic oncology services rather than treating it as a stand-alone educational intervention.

Results in the Context of Published Literature

Recent international guidance has reaffirmed ultrasound as a key imaging modality for the pretreatment loco-regional assessment of cervical cancer, particularly in resource-constrained settings

where access to MRI is limited.^{8,13,14} The recently published ESGO Resource-Stratified Guidelines recommend ultrasound as an appropriate imaging modality for treatment planning in such settings, reflecting growing evidence that, when performed by trained operators, ultrasound provides reliable assessment of tumor extent and loco-regional disease. Our findings complement these recommendations by demonstrating that a structured ultrasound training program can be implemented within a dedicated gynecologic oncology service and integrated into routine outpatient assessment and multidisciplinary treatment planning.

The diagnostic performance of ultrasound is intrinsically dependent on operator expertise, making education and supervised clinical experience central to successful implementation. Historically, opportunities for structured postgraduate training in gynecologic oncologic ultrasonography have been limited, particularly in low- and middle-income countries. Since implementation of the present program, several international educational initiatives have expanded opportunities for advanced training, including the ESGO Special Interest Training Program in Diagnostic and Interventional Ultrasound, the ISUOG Advanced Training Curriculum for Cervical Cancer, and educational resources available through the ESGO e-Academy, including recordings from the IWUGO. Although these initiatives were established after implementation of our program, they reinforce the educational principles underpinning our training model, namely, the combination of structured theoretical instruction, supervised clinical practice, mentorship, and progressive integration into routine patient care.

Few published studies have described the implementation of structured gynecologic oncology ultrasound training programs embedded within routine clinical services in low-resource settings. Most published work has focused on diagnostic performance or comparisons between ultrasound and MRI, whereas considerably less attention has been given to how ultrasound capacity can be developed, implemented, and sustained in routine practice. Our study contributes to this gap by describing a pragmatic implementation model integrated within an existing cervical cancer program, rather than evaluating diagnostic accuracy or validating operator competence.

Several contextual factors appeared to facilitate implementation. The establishment of a dedicated ultrasound facility within the gynecologic oncology unit ensured consistent access for both clinical service delivery and training. The phased educational model, combining international theoretical instruction, supervised

on-site mentorship, continued clinical practice, and refresher training, supported progressive development of ultrasound knowledge and practical skills while promoting local ownership of the service. Delivering subspecialty training within the local clinical environment also allowed learning to be aligned with the available infrastructure, patient population, and clinical workflows at QECH.

The program also demonstrates the value of international academic collaboration in strengthening specialized oncology services. Collaboration with experienced international trainers facilitated transfer of technical knowledge while supporting a gradual transition toward independent local practice. Our experience suggests that combining international educational partnerships with locally delivered mentorship can support implementation of specialized ultrasound training within an established gynecologic oncology service.

Strengths and Weaknesses

A principal strength of this study is its description of a real-world implementation model for a structured gynecologic oncology ultrasound training program embedded within routine service delivery at a high-volume tertiary referral center in a resource-constrained setting, allowing assessment within everyday clinical practice rather than under experimental conditions.

The phased educational model, combining internationally recognized theoretical instruction, supervised on-site mentorship, integration with gynecologic oncology surgery, continued clinical practice, and refresher training, reflects a pragmatic approach to subspecialty capacity building, supported by experienced international trainers and prolonged clinical exposure.

This study also has several limitations. First, the educational evaluation was retrospective and relied exclusively on structured trainer assessments informed by the Kirkpatrick framework; trainee self-reported feedback was not collected.

Second, competency was not assessed using validated instruments such as the Objective Structured Assessment of Ultrasound Skills, nor were pre- and post-training knowledge testing, interobserver agreement, or concordance between trainee and expert ultrasound, MRI, surgical, or pathological findings formally evaluated; the findings should therefore be interpreted as evidence of program implementation and trainer-assessed educational progress rather than validation of diagnostic competence.

Third, only 2 trainees participated, reflecting the highly specialized nature of gynecologic oncology training at QECH but limiting the generalizability of the educational findings.

Fourth, implementation was interrupted by the coronavirus disease 2019 pandemic and by logistical challenges in equipment procurement and coordinating international trainer visits, extending the planned training timeline. Although trainees continued performing ultrasound examinations as part of routine clinical practice during these intervals, the large clinical volumes reported represent service activity rather than independently verified diagnostic accuracy.

Finally, this study focused on program implementation and integration into routine clinical practice; the diagnostic accuracy of ultrasound assessment and its impact on treatment selection or patient outcomes were not formally evaluated.

Implications for Practice and Future Research

This study provides a practical example of how a structured gynecologic oncology ultrasound training program can be embedded within routine cervical cancer services in a resource-constrained setting. In environments where access to MRI and other advanced imaging modalities is limited, locally delivered training supported by international mentorship may facilitate implementation of ultrasound assessment in accordance with contemporary resource-stratified recommendations. Integrating ultrasound training with routine outpatient care, multidisciplinary case discussions, and operative exposure may also strengthen experiential learning within developing gynecologic oncology services.

Future research should evaluate competency acquisition using validated educational assessment tools and examine diagnostic accuracy through comparison with expert ultrasound, MRI, surgery, and pathology where appropriate. Prospective studies should also assess the influence of ultrasound assessment on treatment planning, patient outcomes, and health system performance. Finally, evaluation of similar implementation models in other settings would help determine which program components are transferable and identify the contextual factors required for successful adoption.

CONCLUSION

A structured, context-adapted gynecologic oncology ultrasound training program can be successfully implemented within routine cervical cancer services in a resource-constrained setting. This implementation model supported the development of skills in gynecologic oncologic ultrasonography and facilitated routine clinical use of ultrasound assessment for women with cervical cancer. Although objective competency and diagnostic accuracy were not evaluated, the findings provide a practical implementation model for strengthening ultrasound capacity where access to advanced imaging remains limited.

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