Thieme

Developing and Assessing an Integrated Comprehensive Obstetric Ultrasound Training Program for Undergraduate Medical Students – the Fetal Assessment in Medical Education Study (FAME study)

Entwicklung und Beurteilung eines integrierten umfassenden geburtshilflichen Trainingsprogramms für Studierende der Medizin: die Fetal Assessment in Medical Education-(FAME-)Studie

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ABSTRACT

Objective
This study aimed to evaluate the effectiveness of a prenatal ultrasound course for medical students, focusing on enhancing competencies in fetal sonography through the integration of theoretical knowledge and hands-on practice.

Design
This was a longitudinal study conducted over the winter semester of 2023/24.

Setting
Study took place in a medical education setting, with practical sessions conducted in a clinical environment and theoretical instruction.

Population or Sample
Twenty medical students participated in the course.

Methods
The course was taught by expert faculty and included practical training with live models in real-life conditions, supplemented by online video lectures. The study used Objective Structured Clinical Examinations administered before and after the course, along with multiple-choice questionnaires following each of the six course modules, to assess learning outcomes. Learning success was measured using pre- and post-course OSCE results and MCQ scores. Statistical analysis was performed using the Wilcoxon signed-rank test for OSCE scores and the Spearman correlation test to examine relationships between MCQ results and practical skills.

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Main Outcome Measures
Primary outcomes included the change in OSCE scores and the correlation between MCQ scores and practical skills.

Results
Median OSCE scores improved from 18.94% pre-course to 95.45% post-course, indicating significant enhancement in practical skills. However, no significant correlation was found between MCQ and post-course OSCE scores. Students expressed high satisfaction with the course.

Conclusions
The study demonstrates effectiveness of a practice-oriented educational approach in improving medical students' competencies in fetal sonography, providing valuable insights for optimizing future medical curricula in prenatal imaging.

ZUSAMMENFASSUNG

Ziel
Die Studie zielte darauf ab, die Effektivität eines Kurses zur vorgeburtlichen Ultraschalluntersuchung für Studierende der Medizin zu untersuchen. Der Schwerpunkt lag auf eine Verbesserung der fetalen Sonografiekompetenzen durch die Integration von theoretischem Wissen und praktischem Können.

Konzept
Es handelt sich um eine Längsschnittstudie, die im Wintersemester 2023/24 durchgeführt wurde.

Umfeld
Die Studie wurde in einer medizinischen Ausbildungsstätte durchgeführt. Die praktischen Unterrichtseinheiten wurden in einer klinischen Umgebung durchgeführt und wurden von theoretischen Unterweisungen begleitet.

Studienpopulation
Es nahmen 20 Studierende der Medizin an dem Kurs teil.

Methoden
Der Kurs wurde von erfahrenen Mediziner*innen unterrichtet und bestand aus einem praktischem Training mit lebenden Personen unter realen Bedingungen, ergänzt durch Online-Video-Vorlesungen. Um die Lernleistungen zu beurteilen, wurden die Ergebnisse der Objective Structured Clinical Examinations, die vor und nach dem Kurs abgelegt wurden, und der nach jedem der 6 Lehrmodule ausgefüllten Multiple-Choice-Fragebogen (MCF) eingesetzt. Der Lernerfolg wurde anhand der vor und nach dem Kurs abgelegten OSCE und den MCF-Ergebnissen gemessen. Für die statistische Analyse wurde der Wilcoxon-Rangsummentest für die OSCE-Ergebnisse eingesetzt. Die Rangkorrelation nach Spearman wurde verwendet, um Zusammenhänge zwischen den MCF-Ergebnissen und den praktischen Fähigkeiten zu untersuchen.

Auswertung der Messungen
Primäre Ergebnisse waren Veränderungen der OSCE-Ergebnissen sowie eine Korrelation zwischen MCF-Ergebnissen und den praktischen Fähigkeiten.

Ergebnisse
Die OSCE-Ergebnisse verbesserten sich von durchschnittlich 18,94% vor dem Kurs auf 95,45% nach dem Kurs, was auf eine signifikante Verbesserung der praktischen Fähigkeiten hinweist. Es fanden sich aber keine signifikanten Korrelationen zwischen den MCF-Ergebnissen und den nach dem Kurs gemessenen OSCE-Ergebnissen. Die Studierenden äußerten eine große Zufriedenheit mit dem Kurs.

Schlussfolgerungen
Die Studie zeigt die Effektivität eines praxisorientierten Ausbildungsansatzes bei der Verbesserung der Kompetenzen von Studierenden der Medizin in der fetalen Sonografie auf und bietet wertvolle Erkenntnisse für die Optimierung künftiger medizinischer Lehrpläne mit Bezug auf die pränatale Sonografie.

Background/Introduction

Ultrasound (US) has become an indispensable tool in modern diagnostic and patient care, especially in obstetrics and gynecology (OB/GYN), due to its wide accessibility, cost-effectiveness, and non-invasive nature. The expanding use and importance of OB/GYN US highlight the critical need for foundational education in this evolving field. It is widely acknowledged that all OB/GYN trainees should acquire, at a minimum, basic understanding of both OB/GYN US theory and practical skills [1].

Traditionally, OB/GYN US education has been concentrated within residency programs, tailored for postgraduate learners [1, 2, 3, 4, 5]. However, the integration of general US training into medical school curriculum and into obstetric OSCEs has been increasingly recognized as beneficial during medical studies [6]. Such early exposure to US is believed to bolster the learning process, especially since real-time visual feedback deepens comprehension of anatomy, physiology, and pathophysiology. Introducing US in preclinical stages might not only enhance immediate knowledge acquisition but also foster long-term benefits [7, 8].

Innovative educational programs at institutions like the Ohio State University [9] and the University of South Carolina [10] have demonstrated the practicality and advantages of early US education. These programs suggest that introducing US training at the undergraduate level can alleviate the educational burden on resi-

dency programs, enhance overall physician proficiency, and enrich the medical students' experience. Feedback from these initiatives indicates high student satisfaction and a strong demand for more hands-on US training.

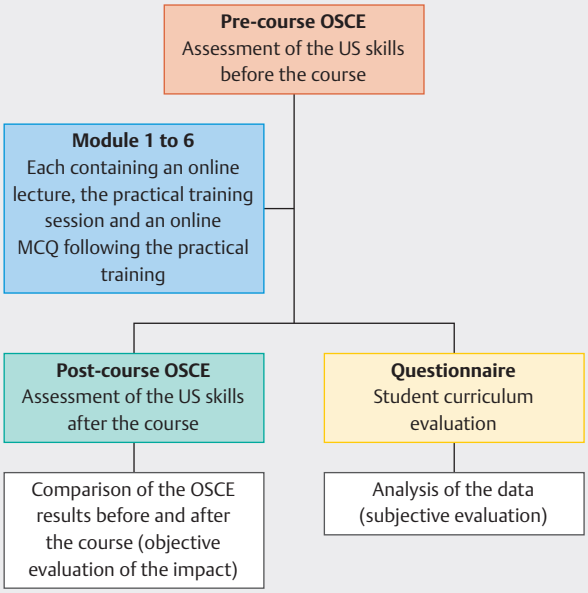
Despite the growing interest in early US education and advocacy for its integration into medical curricula as soon as feasible [11, 12, 13], there remains a significant lack of standardized teaching methods and thorough examinations of these courses' effectiveness. This gap is particularly evident in prenatal US imaging, where undergraduate courses offerings are even more limited. Although the few existing courses have demonstrated feasibility and success [14] there is a pressing need for more studies focused on prenatal ultrasound education for undergraduates. Future research should explore a variety of teaching approaches and evaluate these courses in different countries und settings using more valid and reliable methods. Comprehensive studies will provide valuable insights into the most effective ways to teach prenatal ultrasound, ensuring that educational programs are both efficient and impactful [15].

Addressing these educational challenges, we introduce the "FAME – Fetal Assessment in Medical Education" curriculum. This initiative seeks to establish and evaluate a hands-on US course tailored for undergraduate learners. It combines theoretical knowledge and practical skills of basic obstetric US during the second and third trimester of pregnancy, in alignment with both the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) recommendations [16] and the German Society for Ultrasound in Medicine (DEGUM) standards (Level 1) [17]. This course aims to address a significant gap in medical education by offering a comprehensive training program for future healthcare professionals. The objective is to equip participants with the necessary skills to proficiently integrate fetal sonography as a diagnostic tool into their clinical practice, thereby improving patient care and outcomes.

Methods

The study was structured as a longitudinal pre-post design, with the primary objective of capturing both pre-course and post-course OSCE scores to evaluate participants' learning progress. Kern's 6-step approach was applied to systematically develop and evaluate the curriculum, ensuring a comprehensive and structured educational experience [18]. This course was offered as an elective to medical students in their clinical semesters. To ensure effective learning and ample hands-on practice, enrollment was capped at 20 participants. Recruitment of pregnant volunteers was successfully conducted through the obstetric wards of the University Hospital Bonn, ensuring real-life conditions for practical training sessions. All participating pregnant women were in their second or third trimester.

The course was led by a team consisting of one resident and one assistant doctor, both of whom possessed extensive knowledge and practical experience. The curriculum comprised six modules that integrated theoretical knowledge with practical skills. The study design is illustrated in ▶ **Fig. 1**.



▶ **Fig. 1** Presentation of the study design. OSCE indicates Objective Structured Clinical Examination.

▶**Table 1** Content of the six modules.

Module 1	Introduction, technical basics and, knobology
Module 2	Fetal and placental positioning
Module 3	Amniotic fluid volume and the 4-chamber view of the heart
Module 4	Biometry 1: Head and Abdomen (OFD, BPD, HC ATD, APAD, AC)
Module 5	Biometry 2: Femur/Humerus (FL, HL) and urinary bladder (filled or not)
Module 6	Free practice on different US devices + Introduction to Doppler Sonography

Objective Structured Clinical Examinations (OSCEs) were employed to evaluate the students, assessing both their practical scanning techniques and image interpretation skills in real-time [19]. This method is effective and aligns with daily clinical practice needs, ensuring a fair and standardized evaluation process [6].

The content of the six modules (▶ **Table 1**) was selected in accordance with both the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) recommendations for basic obstetric ultrasound [16] and the German Society for Ultrasound in Medicine (DEGUM) Level 1 standards [17]. This study was performed in line with the principles of the Declaration of Helsinki. An approval was granted by the Ethics Committee of University Bonn (269/23-EP) and all informed consent was obtained from all participants.

Problem identification and general needs assessment

Research on optimal training methods for novice fetal sonographers is limited. However, existing studies suggest that obstetric US training for medical students is well-received and has the potential to enhance both confidence and performance. This indicates a significant need for structured educational programs in this field.

Needs assessment and targeted learners

Through a systematic literature review, we performed an in-depth analysis of international published literature to identify the specific educational needs of medical students in the context of fetal ultrasound training. Following this analysis, we engaged with core group members to discuss the identified content-specific, technical, and implementation-related needs, aligning them with the competencies proposed by the German Society for Ultrasound in Medicine (DEGUM) and International Society of Ultrasound in Obstetrics & Gynecology (ISUOG), and tailoring them to our targeted learners.

To ensure a comprehensive needs assessment, participating students were surveyed about their requirements prior to the course's commencement. This pre-course survey identified specific needs, which were confirmed and addressed during the course implementation. Additionally, a post-course survey was conducted to thoroughly evaluate the learners' experiences and specific needs. The results from this post-course assessment enabled us to effectively adapt and prioritize the content for future modules, ensuring the continuous improvement and relevance of the training program.

Goals and objectives

Identified content-specific, technical, and implementation-related needs were operationalized based on their technical, physiological, and pathological characteristics. Consequently, goals and objectives were formulated through a synthesis of literature reviews, survey results, and the clinical expertise and prior evaluation of ultrasound curricula by panel members. To develop the curriculum content and define learning objectives, a scientific Delphi process was established. This process involved clinical experts with DEGUM qualification levels I–III from the obstetric department.

The Delphi methodology was conducted over two rounds and involved multilevel, self-completed questionnaires based on a Likert scale, complemented by individual feedback sessions. The author collaborated with an additional ten members to facilitate this iterative method, ensuring a comprehensive and consensus-driven approach to curriculum development. The integration of expert clinical insights and systematic feedback mechanisms ensured that the curriculum was rigorously developed to meet the specific learning needs of medical students in fetal ultrasound.

Educational strategies

The theoretical training component comprised pre-recorded lecture videos made available before each practical session, enabling students to learn at their own pace and revisit complex topics as needed. These lectures, designed by experienced physicians, encompassed both fundamental principles and advanced insights into fetal sonography. To reinforce theoretical learning, an online multiple-choice questionnaire (MCQ) was administered following each practical training session.

▶ **Fig. 2** Supervised ultrasound training session on a volunteer patient.

The practical component was conducted in classroom settings with sessions lasting between 1.5 to 2 hours, depending on the module. The instruction utilized Peyton's 4-Step Method, a pedagogical approach that enhances skill acquisition through four distinct phases [20]:

1. **Demonstration**: The instructor performs the skill at normal speed without commentary.
2. **Deconstruction**: The instructor repeats the procedure, explaining all necessary sub-steps.
3. **Comprehension**: The student articulates each sub-step, guiding the instructor's actions.
4. **Performance**: The student independently executes the complete skill.

This method has demonstrated superior effectiveness compared to conventional teaching techniques, facilitating faster and more proficient skill mastery as students initially apply what they have learned [21].

In practice, as shown in ▶ **Fig. 2**, students gained hands-on experience by performing ultrasound scans on volunteer patients under supervision, enhancing both their skill development and confidence.

Prior to the practical examinations, patients provided informed consent to participate in the course. No patients declined participation or expressed complaints post-session.

During practical sessions, we arranged for three volunteers per session, allowing the 20 students to be divided into smaller groups of six to seven.

Implementation

Before the course began, students underwent an initial assessment using three Objective Structured Clinical Examination (OSCE) stations designed to evaluate baseline knowledge and skills in key areas of fetal ultrasound.

The course was structured into six modules (▶ **Table 1**), each comprising an online lecture video to establish the theoretical foundation, practical US training sessions, and an online MCQ to reinforce and assess the gained knowledge. Module 6 did not include an MCQ, as it was solely intended for practice. At the end of the course, students were reassessed using the same OSCE stations to directly compare their initial and final competencies in key areas of fetal US. ▶ **Fig. 3** provides a clear overview of the course design.

Evaluation and feedback

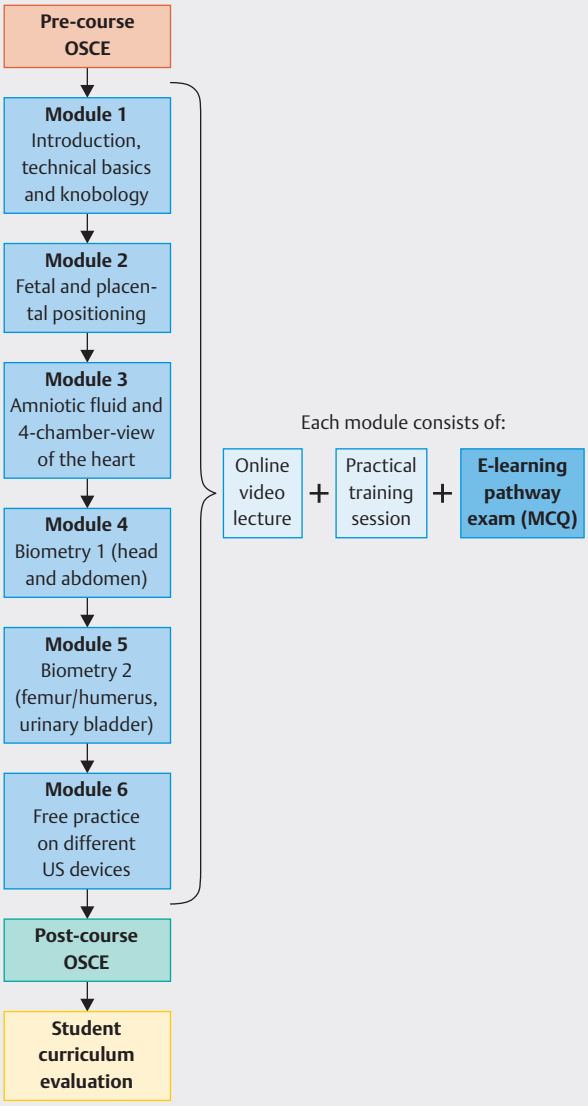
Post-course performance was assessed using the OSCEs, providing a direct measure of skill and knowledge improvement. To gain insights into the effectiveness of the curriculum and areas for improvement, a survey was distributed three months post-course. The survey included 19 statements about the course rated on a Likert scale from 1 to 5, a self-assessment of skills and knowledge before and after the course, ratings of the most challenging and easiest modules, and demographic questions (clinical semester and gender) to characterize the student population. The evaluation concluded with an open-ended question soliciting suggestions for course improvement.

Statistical Analysis

All statistical analyses were performed using SPSS Version 29 for Windows, with a two-sided P value of < 0.05 considered statistically significant. Scores from three identical Objective Structured Clinical Examination (OSCE) stations conducted before and after the course were analyzed. Scores were converted to percentages and summarized by median and range for each OSCE category. Due to non-normal distribution, the Wilcoxon signed-rank test was used to compare pre- and post-course scores. Skills assessed were grouped by course modules and analyzed similarly.

Multiple Choice Question (MCQ) exam scores were analyzed by mean, median, and range for each category, treated as continuous data. The correlation between MCQ and post-course OSCE scores was investigated using the Spearman rank correlation test.

Student feedback on the curriculum, collected via Likert scales, was analyzed for mean and median scores. Demographic data and ratings of challenging modules were included. Students' self-assessed competencies were rated before and after the course, and qualitative analysis of open-ended responses provided additional insights for course improvement.



▶ **Fig. 3** Presentation of the course design. OSCE indicates Objective Structured Clinical Examination. MCQ indicates Multiple Choice Questionnaire. * Module 6 did not include a MCQ, as it was solely intended for practice.

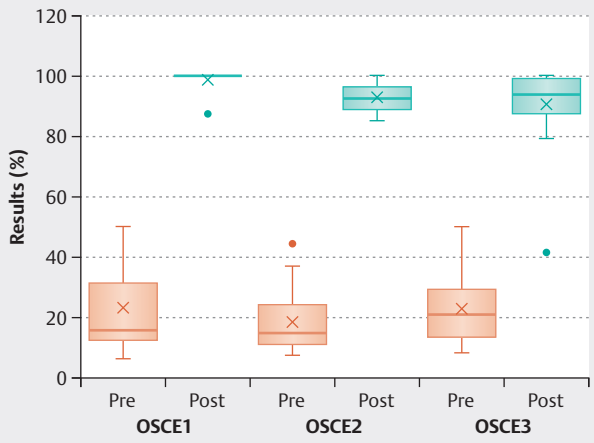
Results

Problem identification and general needs assessment

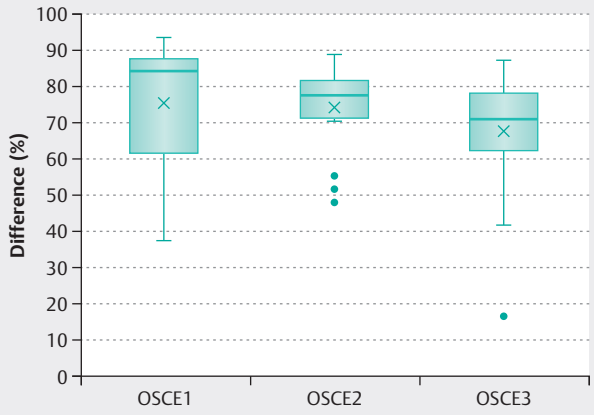
Prior to introducing this course, the training program for gynecology and obstetrics at the University Hospital Bonn consisted of lectures, seminars, a written multiple-choice examination, and an internship on the wards culminating in an OSCE [6, 22]. However, there was a significant gap in practical skills training, particularly in prenatal ultrasound, which is critically important in OB/GYN. Only few students had one day in the prenatal medicine outpatient clinic during their internship to observe, but not perform prenatal ultrasound. Additionally, their ability to conduct an OB ultrasound examination was never assessed. Recognizing this deficiency, we identified the need for a dedicated learning opportunity to teach OB ultrasound skills to students [23].

Needs assessment and targeted learners

The targeted learners were medical students at the University Hospital Bonn from the 1st to 6th clinical semester, showcasing a diverse range of clinical experience levels. This diversity allowed us to assess the course's applicability across different stages of medical education. For more detailed information on the student population, including sex and clinical semester, refer to **Figs. S1** and **S2** (Online Supplementary Material 1).



▶ **Fig. 4** OSCE-Scores Pre-Post-Comparison.



▶ **Fig. 5** Difference Pre- to Post-OSCE-Scores (Improvement).

▶**Table 2** Descriptive and statistical analysis of the pre- and post-course OSCE 1, 2, and 3.

Variable	Content	Pre-course (%)	Post-course (%)	P value
OSCE 1, median score (range)	Placenta, amniotic fluid	15.62 (43.75)	100.00 (12.50)	p < 0.001
OSCE 2, median score (range)	Head, abdomen	14.81 (37.04)	92.59 (14.81)	p < 0.001
OSCE 3, median score (range)	Heart, bladder, femur	20.83 (41.67)	93.75 (58.33)	p < 0.001
All OSCEs 1–3, median score (range)		18.94 (34.85)	95.45 (24.24)	p < 0.001

* P values were calculated using Wilcoxon signed-rank test

Two primary needs were identified [23]:

1. The lack of ultrasound training opportunities, which necessitated a course to build confidence and competence in OB ultrasound, and
2. the need for students to master practical skills and competencies as future physicians, which required modules and clerkships for supervised hands-on training.

Goals and objectives

The primary goal was to enhance students' practical scanning techniques and image interpretation skills in fetal sonography through structured and rigorous training. Specific objectives included improving OSCE scores and reinforcing theoretical knowledge via MCQ exams.

Educational strategies

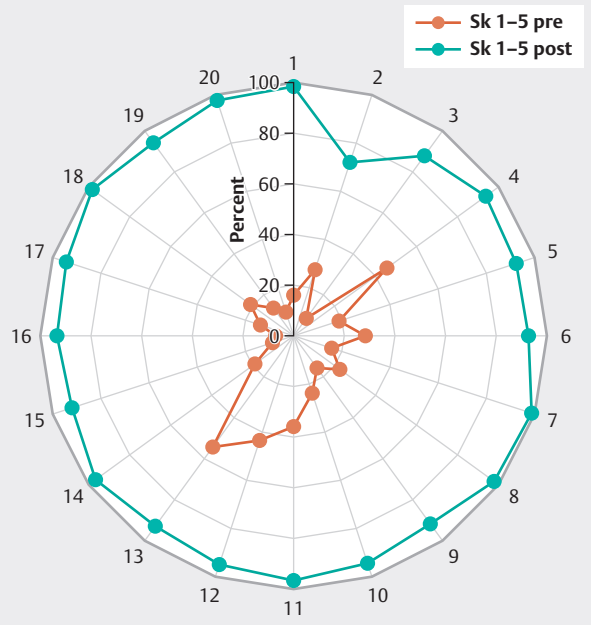
The course design incorporated a blend of theoretical training through pre-recorded lectures and practical training sessions following Peyton's 4-Step Method [20]. This approach ensured a thorough understanding of both the fundamental principles and practical competencies required for fetal sonography.

Implementation

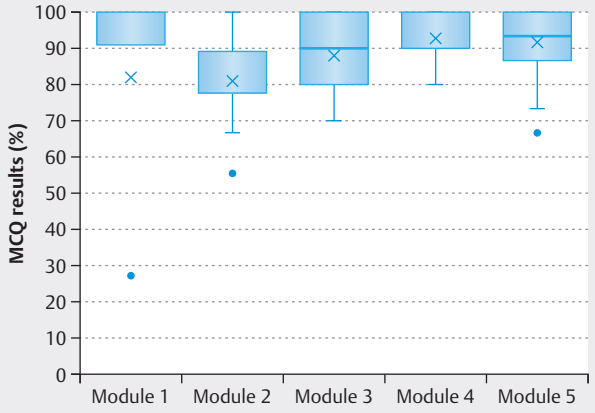
The course was offered as a voluntary elective during the winter semester of 2023/24, with 20 students participating from October 2023 to January 2024. The practical component was conducted in classroom settings with small groups of six to seven students, facilitated by two tutors. Each training session, three volunteers for hands-on practice were arranged to ensure adequate training opportunities. This arrangement maximized hands-on experience, although it required tutors to rotate among groups.

Evaluation and feedback

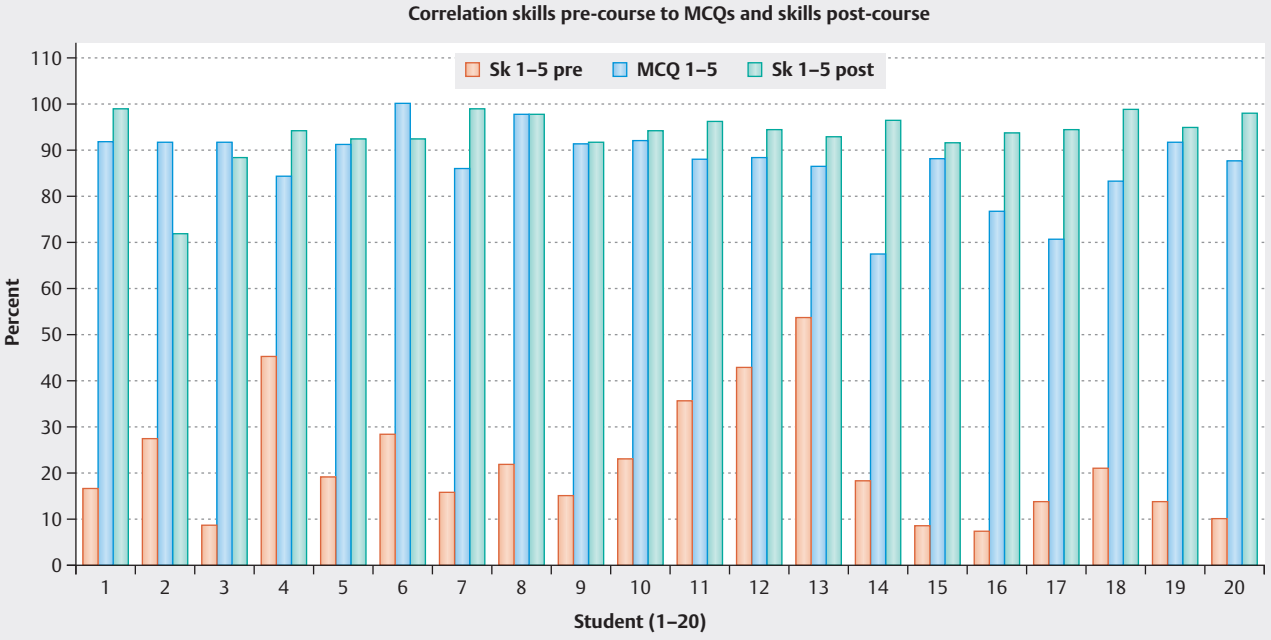
Data were available for all 20 students. The median overall OSCE scores increased from 18.94% before the course (range 9.09%–43.94%) to 95.45% after the course (range 75.76%–100.00%), with a statistically significant improvement in all sub-parameters ($P < 0.001$). Detailed data are presented in ▶ **Table 2**, and further illustrated in ▶ **Fig. 4** and ▶ **Fig. 5**. For a more in-depth analysis of the pre- and post-course development within each skill group, refer to **Figs. S3** to **S9** in the online supplementary material 1. Median scores across five distinct skill groups also showed significant improvement post-course, as detailed in **Table S1** (Online Supplementary material 1) and visualized for each student in



▶ **Fig. 6** Development of each student; Skills pre- and post-course.



▶ **Fig. 7** Boxplot – MCQ-Results in Percent. ** 1: knobology, technical basics; 2: placental and fetal positioning; 3: amniotic fluid, 4-chamber-view of the heart; 4: biometry 1 (head and abdomen); 5: biometry 2 (femur/humerus and urinary bladder).



▶ **Fig. 8** Skills Pre-Course, Skills Post-course and the MCQs during the course.

▶ **Fig. 6**. The median overall MCQ score was 88.20% (range 67.45%–100.00%), indicating a strong grasp of theoretical knowledge (▶ **Fig. 7**). Individual module scores varied, with detailed data in **Table S2** (Online Supplementary material 1). No statistically significant correlation was found between MCQ scores and post-course OSCE scores, suggesting that theoretical knowledge did not directly predict practical skill performance (see ▶ **Fig. 8**). Student feedback further underscored the importance of these MCQs in enhancing their understanding of the course material (▶ **Table 3**).

Feedback from students highlighted a positive reception of the course structure and content. Self-assessment scores indicated a

▶**Table 3** Descriptive analysis of the student curriculum evaluation. The mean, median, and percentage responding agree or strongly agree.

Questions	Mean Likert Score*	Median Likert Score*	Mean % responding agree or strongly agree
The course was clearly structured.	4.90	5.00	100
The timing allocation between theoretical and practical parts of the courses was good.	4.45	5.00	90
The course topics covered were appropriate for my level of knowledge.	4.50	5.00	85
I found the online video lectures helpful.	4.95	5.00	100
I found the online uploaded multiple-choice questionnaires helpful.	4.70	5.00	95
There was sufficient time and opportunities to ask questions.	4.55	5.00	90
The practical skills were demonstrated well enough.	4.25	4.00	85
I consider the skills learned in the course helpful for my further medical career.	4.80	5.00	95
The tutors seemed competent to me.	5.00	5.00	100
There was a pleasant learning atmosphere.	5.00	5.00	100
I enjoyed the course.	5.00	5.00	100
I would recommend the course.	5.00	5.00	100
I would appreciate it if more US courses were integrated into the medical curriculum.	4.95	5.00	100
I would be pleased with US courses in other disciplines.	4.90	5.00	100
Using US improved my understanding in gynecology and obstetrics.	4.90	5.00	100
I received enough knowledge about the technical basics and knobology.	4.60	5.00	95
The course motivated me to further pursue gynecology and obstetrics as a specialty.	4.40	4.50	85
I have gained confidence in using US.	4.85	5.00	100
Using US has enhanced my understanding of fetal anatomy and physiology.	4.55	5.00	95

* Scale 1 strongly agree, 2 agree, 3 neutral, 4 disagree, and 5 strongly disagree

significant improvement in perceived ultrasound skills. Detailed evaluation data, including module difficulty ratings and open-ended feedback, are presented in **Tables S3** and **S4** (Online Supplementary material 1). Based on student feedback, suggestions for improvement included increasing hands-on practice time, adding more volunteers, reducing group sizes, and involving additional instructors. These insights will be incorporated into future iterations of the course to enhance learning outcomes.

Discussion

Main findings

This study produced both objective and subjective outcomes derived from the Objective Structured Clinical Examinations (OSCEs), Multiple Choice Questions (MCQs), and student evaluations. The analysis of OSCE results revealed a statistically significant improvement post-training, indicating enhanced ultrasound (US) knowledge and image recognition skills among students. Each subparameter of the OSCE showed significant improvement, consistent with recent studies in ultrasound training [24, 25]. A key strength of this study was the use of practical examinations to directly assess skills, a method not universally adopted in similar research [26]. This direct assessment is crucial as it accurately reflects students' practical abilities and application of knowledge in clinical settings.

Student evaluations indicated high satisfaction with the course, particularly with the MCQs and online videos. Students recognized significant knowledge improvement and expressed strong motivation for additional US training, extending beyond obstetrics and gynecology to other medical fields, with ratings consistently between 4 and 5 on the Likert scale. These findings align with recent literature emphasizing the importance of structured and engaging educational frameworks in medical training [27, 28, 29, 30].

The integration of practical skills assessment through OSCEs and theoretical reinforcement via MCQs and multimedia learning tools provided a robust educational framework. This approach not only increased competency in US techniques but also enhanced student engagement and satisfaction. The positive student feedback and significant improvement in practical skills highlight the potential benefits of expanding this model to include more comprehensive US training across various medical disciplines. Future studies should explore the integration of similar training modules early in medical education to foster broader competency in ultrasound, which is becoming increasingly essential in clinical practice [23, 31, 32, 33].

Limitations and strengths

This study had several limitations. The sample size of 20 students may not be representative, though increasing the number of participants would have reduced hands-on experience per student, which was not a trade-off we were willing to make. The voluntary nature of participation might have introduced selection bias, attracting students more interested and motivated towards obstetrics and gynecology, potentially skewing results. The OSCE evaluation system may also harbor bias. Variability in examiner rigor could result in inconsistent scoring, affecting the fairness of assessments [34]. Additionally, pre- and post-OSCE score comparisons may not be entirely uniform due to students examining different pregnant women under varying conditions. Factors such as fetal positioning, placental location, and maternal body composition can significantly influence US imaging quality and examination experience [35]. This variability underscores the complex, real-world scenarios students will encounter in clinical practice, highlighting the importance of adaptability and comprehensive skill development in fetal sonography training. Future assessments could incorporate standardized scenarios or simulation-based components to ensure a more consistent evaluation framework [36].

Interpretation

Integrating a generalized US curriculum in medical schools, including obstetrics, presents challenges. The complexity of obstetrics might be overwhelming for undergraduate students with limited US experience, questioning the feasibility of such a broad curriculum. However, this study demonstrates that undergraduate students can significantly enhance their ultrasound skills through a short curriculum comprising only six training sessions, suggesting the potential for broader application in early medical education [37]. Implementing a generalized course would also face practical hurdles, notably in recruiting pregnant women willing to participate. Ensuring these volunteers are mentally stable is critical, especially considering many may be facing critical health conditions. Their willingness to commit two hours to be examined by multiple students adds another layer of complexity to the course's practical implementation.

Reflecting on the course design, we initially conducted three OSCEs pre- and post-course to challenge students with distinct case vignettes simulating clinical scenarios. A more statistically intriguing approach would have been to assess specific skills (e.g., placenta assessment, amniotic fluid evaluation, biometry) individually pre- and post-course, rather than combining different skills in a single OSCE. This was later addressed by dissecting each OSCE into individual skills and calculating scores based on the maximum achievable points for each skill, pre- and post-course. Future studies should consider allocating each skill its own OSCE station from the outset for clearer and more streamlined assessments [38].

Designing standardized assessment forms for obstetrical OSCEs is a valuable future direction. While current evaluation forms were crafted with care, achieving consensus among all authors, standardized forms could yield more precise and less biased evaluations. Inspired by Tolsgaard et al. (2022) [39] and their Delphi consensus survey for the OSAUS score, conducting a Delphi round to standardize OSCE evaluation forms for fetal US could be beneficial. The decision against using the OSAUS form was driven by its generality, which omits critical aspects of fetal US essential for assessing student competency [39].

To address student criticism of limited hands-on time, options include reducing the number of students while maintaining the current number of pregnant volunteers and instructors, thereby increasing hands-on practice time. Alternatively, the course could be restructured to accommodate smaller groups, with 20 students split into five groups, each attending practical sessions on different days. This approach maintains the overall student count per semester but ensures more focused training sessions.

Refining this course, or any obstetrical ultrasound course, requires overcoming logistical and organizational challenges. Adjusting the course to better meet students' needs for more practice time and direct supervision necessitates thoughtful consideration of these logistical aspects to enhance the learning experience. Future studies should explore these adjustments to maximize the effectiveness of ultrasound training in medical education.

Conclusion

The introduction of standardized US training for undergraduates has proven effective in enhancing obstetrics education, as evidenced by both objective OSCE assessments and subjective student feedback. This structured approach not only boosts skills and motivation but also deepens understanding in obstetric care. Continued refinement and expanded evaluation are essential to further integrate and optimize this training in medical curricula.

Supplementary Material

- **Table S1** Descriptive and statistical analysis of the pre- and post-course skills 1 to 5.
- **Table S2** Descriptive and statistical analysis of the MCQs 1–5.
- **Table S3** The student's self assessment of skills 1–5.
- **Table S4** Module difficulty rating.
- **Fig. S1** Student Population by Sex Category.
- **Fig. S2** Student Population by Clinical Semesters.
- **Fig. S3** Boxplot – An Overview of Each Module in a Pre-to-Post-Comparison.
- **Fig. S4** Boxplot – All Skills Pre-to-Post-Comparison.
- **Fig. S5** Boxplot – Knobology (Skill 1) Pre-to-Post-Comparison.
- **Fig. S6** Boxplot – Placenta (Skill 2) Pre-to-Post-Comparison.
- **Fig. S7** Boxplot – Amniotic Fluid & Heart (Skill 3) Pre-to-Post-Comparison.
- **Fig. S8** Boxplot – Head & Abdomen (Skill 4) Pre-to-Post-Comparison.
- **Fig. S9** Boxplot – Femur & Urinary Bladder (Skill 5) Pre-to-Post-Comparison.

Declarations

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Consent for publication: All authors gave consent for publication.

Contributors' Statement

JM: Conceptualization, Methodology, Writing – Original Draft, Writing – Review & Editing. RP: Resources, Writing – Review & Editing. AW: BS: Writing – Review & Editing, Resources. UG: BS: Writing – Review & Editing, Resources. BS: Writing – Review & Editing, Resources. FR: Conceptualization, Methodology, Formal analysis, Writing – Original Draft, Writing – Review & Editing.

Conflict of Interest

The authors declare that they have no conflict of interest.

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