



## Gender differences in the perception and impact of ultrasound training among physicians: A survey analysis

Różnice płciowe w postrzeganiu i efektach szkoleń z zakresu ultrasonografii wśród lekarzy – analiza ankietowa

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### ABSTRACT

**INTRODUCTION:** Modern point-of-care ultrasound (POCUS) is assuming an increasingly important role in clinical practice across multiple specialisations. Training in this area is essential for developing medical competencies; however, there is still little known about the impact of students' gender on perception, outcomes, and educational needs. The aim of this study was to assess gender differences in the perception, participation and outcomes of ultrasound training courses organised by the Upper Silesian School of Ultrasonography (Górnośląska Szkoła Ultrasonografii – GSU). The study follows current trends in medical education, where demographic factors are increasingly recognised as influencing teaching effectiveness.

**MATERIAL AND METHODS:** The study analysed responses from 134 physicians who had completed ultrasound training courses at the GSU. A survey was conducted covering multiple topic areas, including motivation, experiences, training outcomes and opinions on modern technologies. Chi-square tests and cross-tabulations were used for statistical analysis.

**RESULTS:** Significant gender differences were observed in the perceived impact of the courses on clinical decision-making, willingness to pursue further education and expectations regarding the integration of technology – including artificial intelligence – into ultrasound diagnostics. Women were more likely to point to the need for further development, whereas men were more likely to report an impact of training courses on professional practice. These findings suggest differing learning styles and approaches to the implementation of new competencies.

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**CONCLUSIONS:** POCUS training was positively perceived by both genders; however, differences in attitudes and educational expectations highlight the need for a more individualised approach to curriculum design. Addressing these differences may enhance the effectiveness of training and promote better utilization of the acquired skills in clinical practice.

#### KEYWORDS

gender differences, medical education, professional competences, motivation, artificial intelligence, bedside ultrasound, point-of-care ultrasound, clinical decisions, anaesthesiology and intensive care

### STRESZCZENIE

**WSTĘP:** Współczesna ultrasonografia przyłóżkowa (*point-of-care ultrasound* – POCUS) odgrywa coraz większą rolę w praktyce klinicznej w wielu specjalizacjach. Szkolenia w tym zakresie są niezbędne do rozwoju kompetencji zawodowych lekarzy; jednak nadal niewiele wiadomo na temat wpływu płci na percepcję, efekty i potrzeby edukacyjne. Celem niniejszego badania była analiza różnic płciowych w postrzeganiu, uczestnictwie i efektach szkoleń ultrasonograficznych, organizowanych przez Górnośląską Szkołę Ultrasonografii (GSU). Badanie wpisuje się w aktualne trendy w edukacji medycznej, gdy coraz większą uwagę zwraca się na wpływ czynników demograficznych, w tym płci, na efektywność kształcenia.

**MATERIAŁ I METODY:** W badaniu przeanalizowano odpowiedzi 134 lekarzy, którzy ukończyli kursy ultrasonograficzne w GSU. Przeprowadzono ankietę obejmującą wiele obszarów tematycznych, w tym dotyczących motywacji, doświadczeń, efektów szkoleń oraz opinii na temat nowoczesnych technologii. Analizę statystyczną przeprowadzono z wykorzystaniem testów chi-kwadrat i tabel krzyżowych.

**WYNIKI:** Zaobserwowano istotne różnice między płciami w postrzeganym wpływie kursów na podejmowane decyzje kliniczne, chęci dalszego kształcenia oraz oczekiwaniach względem integracji technologii – w tym sztucznej inteligencji – z diagnostyką ultrasonograficzną. Kobiety częściej wskazywały na potrzebę dalszego rozwoju, natomiast mężczyźni częściej deklarowali wpływ szkoleń na praktykę zawodową. Wyniki te sugerują odmienne style uczenia się i podejścia do wdrażania nowych kompetencji.

**WNIOSKI:** Szkolenia ultrasonograficzne POCUS są pozytywnie oceniane przez obie płcie, jednak różnice w postawach i oczekiwaniach edukacyjnych wskazują na potrzebę bardziej zindywidualizowanego podejścia do projektowania programów nauczania. Uwzględnienie tych różnic może zwiększyć skuteczność szkoleń i promować lepsze wykorzystanie zdobytych umiejętności w praktyce klinicznej.

#### SŁOWA KLUCZOWE

różnice płciowe, edukacja medyczna, kompetencje zawodowe, motywacja, sztuczna inteligencja, ultrasonografia przyłóżkowa, ultrasonografia *point-of-care*, decyzje kliniczne, anestezjologia i intensywna terapia

### INTRODUCTION

Point-of-care ultrasound (POCUS) is playing an increasingly important role in everyday clinical practice, particularly in anaesthesiology, intensive care, emergency medicine and pain management. The growing availability of technology, the rapid development of artificial intelligence (AI)-supported systems and the implementation of simulation-based training methods make ultrasound training an indispensable component of postgraduate medical education across specialisations [1].

Although numerous studies have investigated the effectiveness of ultrasound training, relatively few have looked at demographic differences among the participants, gender in particular. Meanwhile, increasing evidence regarding medical education suggests that learning styles, motivation to acquire new skills and preferences for using modern technology

may vary by gender. Understanding sex-related variations in perception, participation and outcomes of ultrasound training is important not only for designing more individualised educational programmes, but also for ensuring equal opportunities for professional development and for optimising innovations in healthcare.

The aim of this study was to investigate potential gender differences in participation, experiences and opinions on ultrasound training courses organised by the Upper Silesian School of Ultrasonography (Górnośląska Szkoła Ultrasonografii – GSU). The analysis addressed the impact of training on clinical decision-making, the need for further development in specific areas of ultrasound, the perceived usefulness of modern technologies (including AI) and motivations and barriers to participate in training. Based on the data we collected, we attempted to identify relevant trends and correlations that may form the basis for future research and recommendations on ultrasound education.



## MATERIAL AND METHODS

The study was conducted using a proprietary, anonymous online survey distributed to participants of ul-trasound training courses organised by GSU, one of the leading educational centres in Poland. The institution specialises in practical POCUS training, with a particular emphasis on applications in anaesthesiology, intensive care, emergency medicine and chronic pain management.

### Characteristics of the study group

A total of 134 physicians, including 81 women and 53 men, took part in the study. All participants had completed at least one ultrasound course offered by GSU, and the group represented diverse clinical specialisations and levels of professional experience, which added to the value of the study. The sample size was consistent with survey-based research in this field [2].

### Questionnaire design

The questionnaire contained over 30 closed and open-ended questions relating to:

- motivations and barriers to participate in ultrasound training
- the impact of training courses on clinical decisions
- identifying further education needs
- attitudes towards modern technologies (including AI) in ultrasound practice
- assessing the usefulness of POCUS in everyday clinical practice.

Data were collected using the commercial survey platform *interankiety.pl*, which aided in distributing the questionnaires, performing quality control on the data and exporting the results to XLSX format. Using an anonymous online survey distributed to physicians who completed POCUS training courses at GSU is appropriate for the study's objectives and enables the collection of representative data on motivations, barriers, the impact of training on clinical practice and attitudes towards new technologies; it is consistent with approaches used in POCUS survey studies internationally [3,4,5].

### Statistical methods

Data analysis was performed using Microsoft Excel 365 and Python, along with the following tools:

- descriptive statistics – to present the basic characteristics of the sample and the distribution of the responses (frequencies and percentages)
- contingency tables (cross tables) – to assess the relationship between gender and responses to selected questions (including the impact of training course on clinical decisions, the need for further development, perceptions of AI and technology integration)

- chi-square ( $\chi^2$ ) independence test – used to assess the relationship between gender and responses to closed questions
  - Fisher's exact test – used as an alternative in cases where the cell sizes in the table were too small to use the chi-square test
  - qualitative analysis of open-ended responses – using thematic categories to supplement quantitative results with descriptive observations.
- The level of statistical significance was set at  $p < 0.05$ .

### Ethical considerations

Given the observational and anonymous nature of the study, and the absence of medical interventions, ethical approval from a bioethics committee was not required. Data were collected in accordance with the principles of good research practice, and the analysis was conducted in a way that prevents the identification of individual respondents.

## RESULTS

### Characteristics of the study group

The study included 134 physicians participating in GSU ultrasound training courses, of whom 60.4% ( $n = 81$ ) were women, which may reflect their greater interest in this form of professional development, higher availability or openness to acquiring procedural competencies (Figure 1).

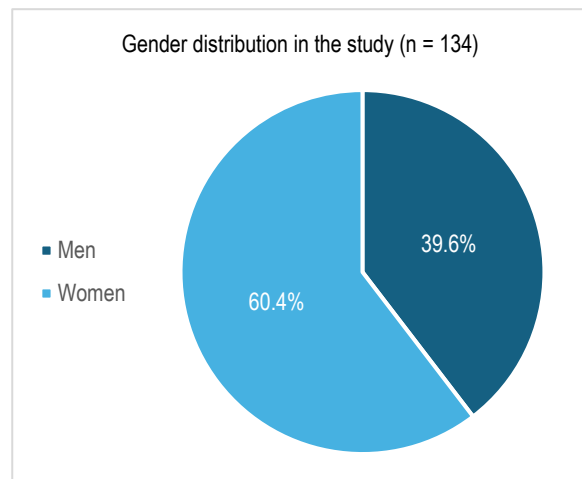


Fig. 1. Characteristics of the research group in terms of gender

### Impact of the training course on clinical decisions

The majority of participants, irrespective of gender, reported that completing the training course had an impact on their clinical decisions. However, women were more likely to report a positive impact of the course (89%) compared to men (76%; Figure 2). Crosstabulation analysis revealed a significant correlation between gender and the perceived impact of the course on clinical decisions ( $\chi^2 = 4.31$ ;  $p < 0.05$ ).

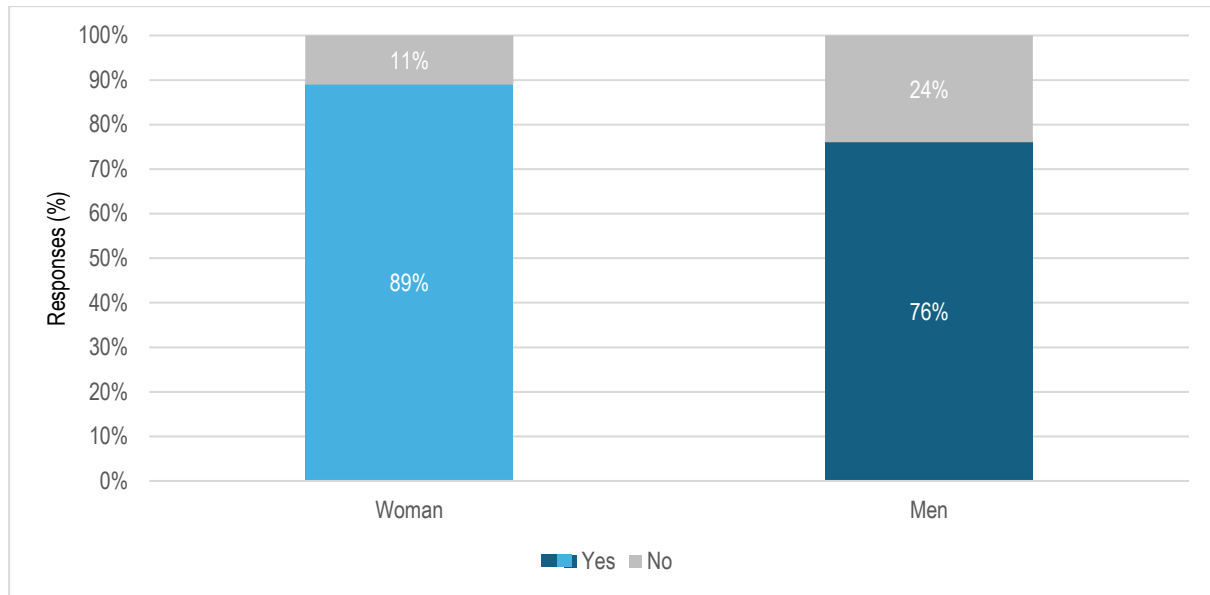


Fig. 2. Impact of training on clinical decisions

### Need for further development in specific areas

The majority of both women and men recognized the need for further development after completing the course (women: 91%; men: 83%). Although the difference was not statistically significant, women were more likely to select specific areas, such as echocardiography and lung ultrasound, whereas men more frequently opted for advanced techniques in regional anaesthesiology (Table I).

Table I. Need for further development in specific areas

Area within sonography	Women (%)	Men (%)
Echocardiography	42%	28%
Lung ultrasound	35%	23%
Advanced regional anaesthesiology	28%	39%

### Modern technologies and ultrasound

The responses regarding the integration of modern technologies with ultrasound in clinical practice demonstrated distinct technological preferences between women and men. Four primary areas for technological integration were identified:

- clinical decision support systems (CDSS)
- mobile educational applications
- augmented reality (AR)
- teleconsultations and telemedicine.

Women were more likely than men to indicate the need to integrate ultrasound with CDSS (42% vs 31%) and mobile educational applications (37% vs 29%). Men, in contrast, more frequently preferred integration with augmented reality (38% vs 21%) and teleconsultation tools (34% vs 25%) (Figure 3).

### Assessment of the usefulness of artificial intelligence in ultrasonography

Women were significantly more likely to rate the usefulness of AI in a balanced or cautiously positive manner, acknowledging its value while emphasizing the need for clinician oversight. In contrast, men were more likely to express enthusiasm for AI and its potential role in the future of medicine:

- 65% of women considered AI ‘useful in specific clinical scenarios’
- 58% of men considered AI to be ‘a forward-looking and essential element of diagnosis’ (Table II, Figure 4).

Table II. Assessment of the usefulness of artificial intelligence (AI) in ultrasound (US) imaging

AI in US	Women (%)	Men (%)
Moderate acceptance or caution	65%	32%
Great enthusiasm and openness to AI	25%	58%
Not convinced / Not useful	10%	10%

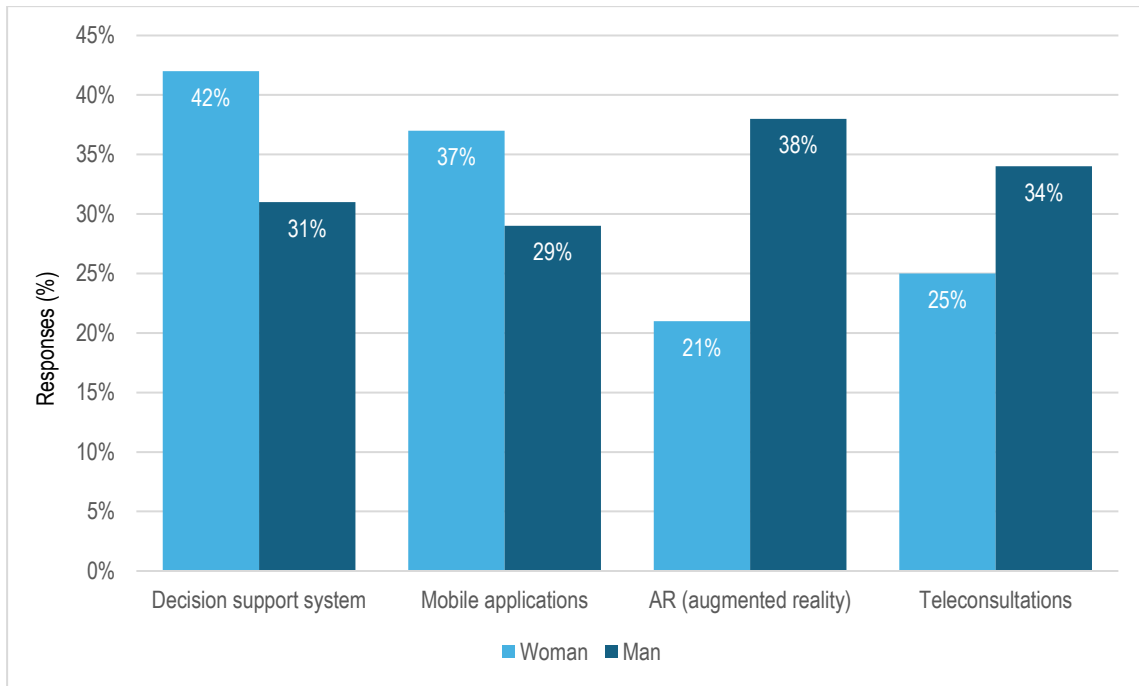


Fig. 3. Distribution of technological preferences by gender

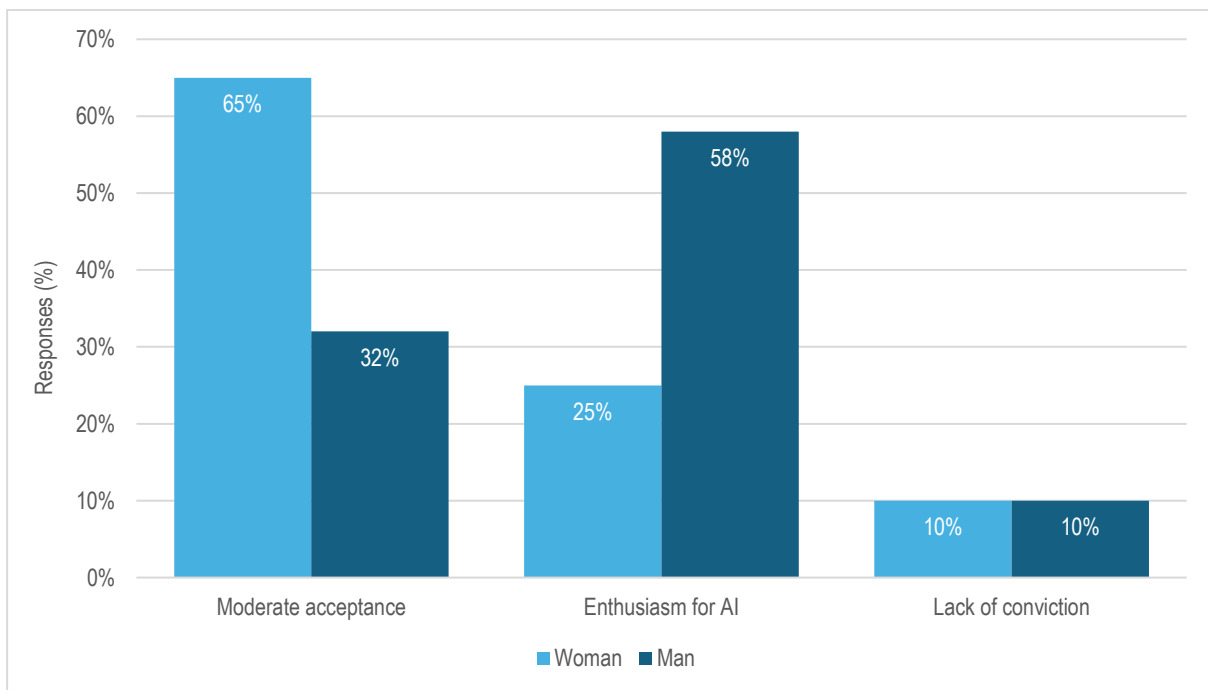


Fig. 4. Attitudes towards artificial intelligence (AI)-assisted ultrasound, by gender

### Motivations for and expectations of training

The responses among the 134 study participants to open-ended questions regarding expectations for ultrasound training courses revealed distinct differences in how women and men approach the educational process (Figure 5):

- 49 women (60.5%) highlighted the importance of mentoring support, a sense of security and a friendly teaching environment as key factors contributing to effective learning

- 42 women (52%) emphasized the need for more practice in small groups, allowing multiple repetitions and continuous error correction
- among men, 38 (71.7%) identified the need to enhance advanced diagnostic techniques and treatment procedures as a primary motivational factor
- 33 men (62.3%) expressed strong interest in modern technologies in ultrasound, including AI, AR and robotics.

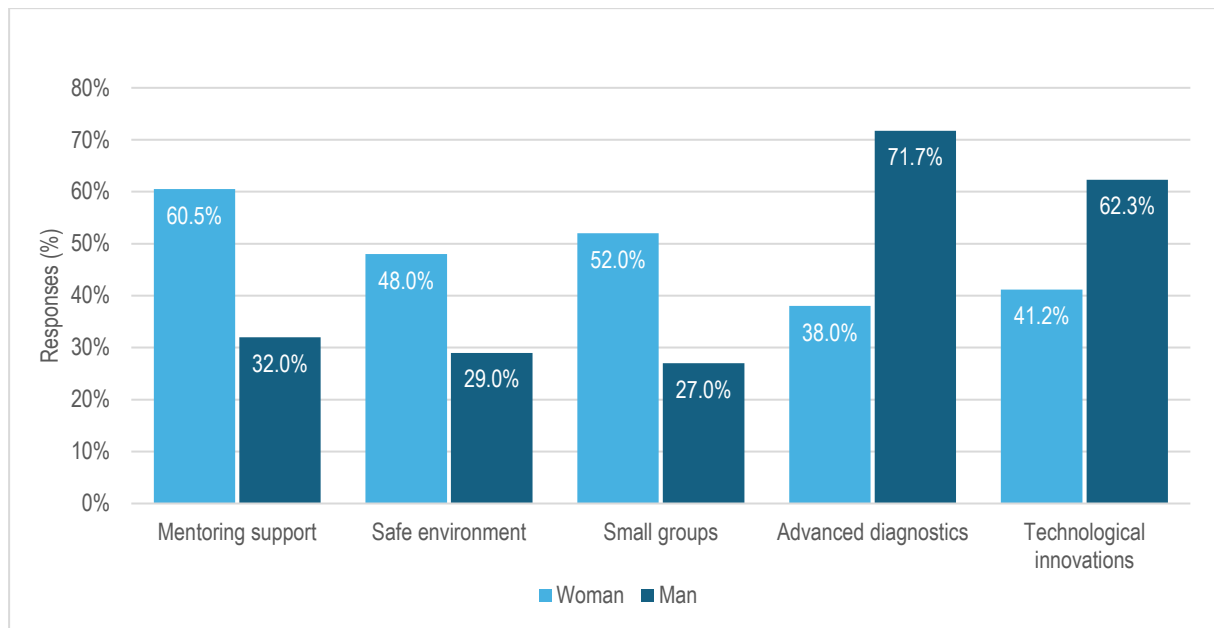


Fig. 5. Motivations for and expectations of ultrasound training, by gender

## DISCUSSION

This study confirms that POCUS training courses are highly valued by physicians irrespective of gender; however, there were clear differences in educational attitudes, motivations and preferences regarding the integration of modern technologies with diagnostic imaging. Women were more likely than men to view the training as a foundation for further education in specific areas of ultrasound, such as echocardiography or pulmonary diagnosis, likely reflecting their greater focus on skill development and the need to learn in a supportive environment. Women were also more likely to point to the need for enhanced mentoring support, small-group practice and the use of clinical decision support tools or educational applications. This aligns with previously reported differences in learning styles, with women more frequently opting for methods that emphasise relational engagement, sequential knowledge acquisition and a sense of educational security [6,7,8,9,10,11].

Men, in contrast, demonstrated greater motivation to improve their practical skills and were more open to modern technologies, including AR, telemedicine, robotics and AI tools. They were also more likely to perceive training courses as impacting their clinical decisions, potentially reflecting more rapid integration of new knowledge into daily practice. This diversity in educational and technological attitudes is supported by Heiligers [12], who surveyed over 2,300 medical students in the Netherlands and found that men were more likely to be motivated by prestige, innovation and professional autonomy when selecting a career path. Similar conclusions have been reported in a review by Varsou [13] on the implementation of ultrasound in medical education, which highlights dif-

ferences in approaches to teaching imaging techniques and emphasises the importance of tailoring the teaching process to the needs of diverse participant groups. Significant differences also emerged in the respondents' attitudes towards AI-assisted ultrasound. Women were cautiously optimistic, acknowledging the utility of AI while emphasising the importance of clinician oversight. Men, in contrast, more often expressed enthusiasm for automation and the potential for technological advancement in this field. These differences align with broader observations in medicine, where women tend to prioritise safety while men emphasise the potential for innovation [6,7,8,9,10].

It seems worth comparing these findings with the recommendations of international scientific societies, including the International Society of Ultrasound in Obstetrics and Gynecology, Deutsche Gesellschaft für Ultraschall in der Medizin, the American Institute of Ultrasound in Medicine and the World Federation for Ultrasound in Medicine and Biology. These organisations emphasise the need to standardise training programmes, adopt modern teaching methods – including virtual reality, AR, simulation and peer teaching – and tailor educational pathways to the needs of individual participants [14]. In light of these findings, ultrasound training courses should be designed to be flexible, enabling thematic modules to be selected, with access to mentoring and intensive practice, and content and teaching style should be adapted to the needs of diverse participant groups [15]. Evaluating the effectiveness of the training is essential, yet no universally accepted standards exist for assessing ultrasound competencies. The implementation of tools such as the Objective Structured Clinical Examination or practical skills tests could help standardise competency levels and improve education



[9,14,15]. The study also indicates that more women participate in training courses, which may reflect their greater motivation to develop their skills or greater willingness to engage in practical training. However, the gender make-up of the sample may also be influenced by broader demographic trends among physicians participating in ultrasound training.

In conclusion, the data clearly demonstrate that effective ultrasound education should account for gender differences in learning style, professional motivation, and technological preferences. Tailoring the form and content of training, including personalisation, standardisation and integration of innovative teaching tools, can substantially enhance its effectiveness and support the implementation of ultrasound competencies in daily clinical practice.

### Limitations

Despite the many conclusions drawn from this study, certain methodological and interpretative limitations should be acknowledged:

1. Unequal gender distribution – Although the study aimed to assess gender differences, women comprised the majority of the sample. This imbalance may have reduced the statistical power of comparative analyses.
2. Lack of long-term data – The study was cross-sectional and did not evaluate the long-term retention of educational outcomes. Consequently, it remains unclear whether reported changes in clinical practice were sustained or translated into actual professional behaviour.
3. Potential cultural and institutional differences – The study was conducted in a single country and within a single training institution (GSU).
4. Variability in interpreting open-ended responses – The responses to the open-ended questions may have been interpreted differently by the analysts, introducing an element of subjectivity into the qualitative assessment.

### Authors' contribution

Study design – S. Mika, H. Misiolek

Data collection – S. Mika, M. Wilk

Data interpretation – S. Mika, M. Gil-Mika, W. Gola, H. Misiolek

Statistical analysis – S. Mika

Manuscript preparation – S. Mika, H. Misiolek

Literature research – S. Mika, M. Wilk

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### CONCLUSIONS

1. Ultrasound training is highly valued by physicians of both sexes; however, women and men differ in their perceptions of its effects and further educational needs.
2. Women are more likely to view training courses as a stimulus for further development, highlighting the need for continued education in specific, specialised areas of ultrasound. This may suggest a more reflective and long-term approach to skills training.
3. Men are more likely to report that training courses contribute to their clinical decisions, which may reflect their greater readiness to immediately apply what they have learnt in practice.
4. Regarding the integration of modern technologies with ultrasound diagnosis, men are more interested in the use of artificial intelligence, whereas women show greater interest in tools that enhance procedural precision and safety, such as 3D visualisations and comprehensive training programmes.
5. The observed differences in educational preferences and approaches to technology support the design of modular training courses that would allow for personalised learning pathways.
6. The predominance of women in the study group may reflect their greater willingness to participate in this type of training, potentially influenced by both professional demographic trends and stronger engagement in developing professional skills.
7. Our findings offer valuable guidance for POCUS training course organisers: incorporating gender differences into the programme design can enhance participant satisfaction and effectiveness, ultimately contributing to improved patient care.

### Conflict of interest

The author declares no conflict of interest.

### Acknowledgements

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